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# VARIATIONS IN CHLOROPHYLL, SPAD VALUES AND SOME NUTRIENT CONCENTRATIONS DEPENDING ON CHLOROSIS IN PEACH LEAVES

**İbrahim ERDAL[1], Remziye TÜRKMEN[1], Ayten AKGÜN[1]**

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**Abstract**

The objectives of this study was to measure greenness (SPAD), chlorophyll concentrations and Fe, Mn, Zn, Cu and Mg concentrations and examine the relations among them in the leaf having different chlorosis levels. The SPAD chlorophyll meter readings were used to measure the leaf greenness. Leaf chlorophyll contents were also determined using the acetone extraction method and other nutrients were measured with AAS. Leaf chlorophyll content, SPAD readings and Fe, Mg, and Mn concentrations increased with the leaf green colour increase. SPAD readings were significantly correlated with leaf chlorophyll content, Fe, Mn and Mg. Also, close correlation was seen between chlorophyll content and leaf Fe concentration.

**Key words:** Leaf greenness, SPAD, chlorophyll, nutrients

The most active pigments playing role in photosynthesis are the green pigments called chlorophylls. Also chlorophyll gives the green color to the plants. All plants have chlorophyll, which is a green pigment in leaves and stems. Chlorophyll is a light-absorbing pigment enabling plants, and some other organisms, to carry out photosynthesis by converting carbon dioxide and water to glucose and oxygen (Salisbury F.B., Ross C.W., 1992). A Chlorophyll molecule consists of an Mg as a central atom and four N atoms bounded pyrrole rings. So Mg and N are two of the main chlorophyll constituents (Kacar B., Katkat A.V., 2007). There is a close relation between leaf greenness (SPAD) and chlorophyll concentrations and for this, SPAD measurement is being used to estimate chlorophyll concentrations in the leaf of different plants in a short time and with high accuracy (Rodriguez I. R., Miller G. L., 2000; Uddling *et al*, 2007; Sharma P., 2015; Sim *et al*, 2015). In study conducted on sugarcane, it was suggested that SPAD meter readings can be used rapidly to estimate leaf chlorophyll and it can also be used to identify sensitivity of varieties to iron deficiency (Radhamini *et al*, 2016). In another studies, close correlations were found among leaf Fe concentrations, SPAD readings, active and total Fe in the leaves of apple and tomato plants (Erdal *et al*, 2008; Erdal *et al*, 2014). Although Fe is not a constituent of chlorophyll, it plays important roles in chlorophyll synthesis. So, chlorosis is closely associated with Fe deficiency and Chlorophyll contents can decrease in Fe-deficient plants (Marschner H., 2012).

The objectives of this study was to measure greenness (SPAD), chlorophyll concentrations and Fe, Mn, Zn, Cu and Mg concentrations and examine the relations among them in the leaf having different chlorosis levels.

## MATERIAL AND METHODS

Leaf samples were collected from 33 peach orchards and they were grouped under 3 classifications as pale green, green and dark green depending on their greenness using Minolta-502 SPAD meter. The same aged leaves were tried to be collected to minimize nutritional differences due to leaf old.

The SPAD chlorophyll meter readings were used to measure the leaf greenness. For this 4 readings from the different side of the leaf were made and the means of them was taken as a main reading. Leaf chlorophyll contents were determined from the same leaves used for SPAD reading using the acetone extraction method. For this, 0.5 g leaf sample was homogenized in 80% acetone then filtrated and filled up 50 ml with acetone. The colour of this homogenate was read at 645 and 663 nm with spectrophotometer. Using both readings chlorophyll a and b and total chlorophyll were calculated using equations given below as in fresh weight (Witham *et al*, 1971).

Chlorophyll a (mg $g^{-1}$) m = [12.7 x (D663)-2.69 x (D645)] x V/ 1000 x W

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Chlorophyll b (mg g $^{-1}$) = [22.91 x (D645)-4.68 x (D663)] x V / 1000xW
Total chlorophyll (mg g$^{-1}$) = chlorophyll a + chlorophyll b
V= filtrate volume (ml); W= extracted plant weight (g); D = wave length

Leaf nutrient concentrations were determined using same leaves used for SPAD and Chlorophyll readings. For this, leaves were dried, grinded and wet digested and filtrated to 100 ml. Al nutrients in filtrate were determined using AAS (Kacar B. and Inal A., 2008). All parameters were evaluated using Co-stat statistic programs.

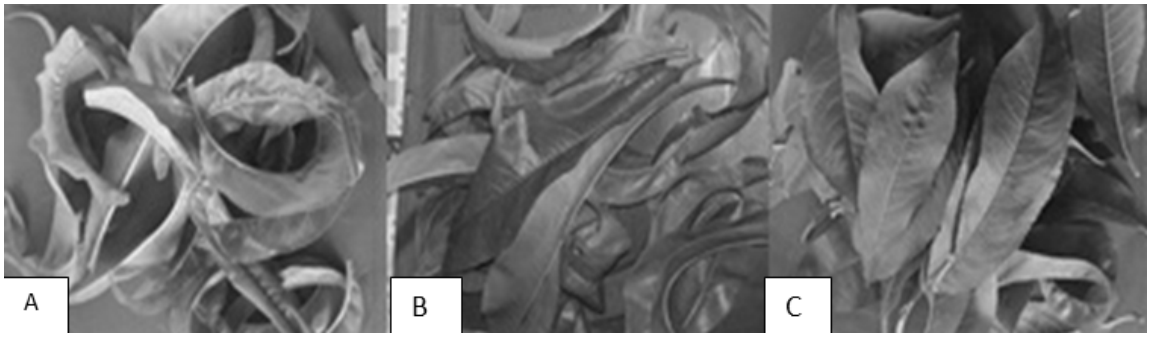


Figure 1 **Classification of leaves depending on their greenness (A: Pale green, B: Green, C: Dark green)**

Figure 2 **SPAD readings and grouping leaf samples**

## RESULTS AND DISCUSSION

### SPAD values and Chlorophyll contents

Leaves were collected under tree groups in terms of their SPAD readings (*figure 1 a, b, c*). SPAD readings in pale green, green and dark green leaves varied between 18 and 27, 33 and 35 and 40 and 46 with the means of 24, 34 and 43 respectively (*figure 2*). Also leaf chlorophyll contents for each group showed variation as in SPAD and the means were 2.8, 3.3 and 3.5 mg g$^{-1}$ with the same order. Differences between the mean values for both SPAD and chlorophyll contents were significant generally. When examined the relation between SPAD and chlorophyll, it can be seen that there is a significant (*P<0.01*) positive correlation between SPAD and chlorophyll values (*figure 3*). Similar results were found in different studies (Shaahan *et al*, 1999; Sohrabi *et al*, 2015).

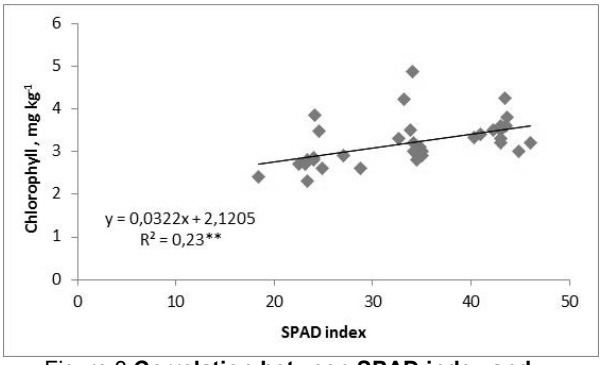


Figure 3 **Correlation between SPAD index and chlorophyll content in leaf**

### Leaf mineral concentrations

Leaf Fe and Mn concentrations significantly varied depending on leaf color but Zn and Cu concentrations were not varied (*table 2*). While leaf Fe concentration in pale green leaves was 82 mg kg$^{-1}$ which can be accepted as deficient, this value showed linear increase until sufficient levels in green and dark green leaves (Jones *et al*, 1991). When leaf Fe concentrations and the parameters related to leaf greenness were examined, it can be seen that there is significant positive correlations (*figure 4*). Similarly, leaf Mn and concentrations showed increasing tendency with the leaf greenness from 34 to 45 mg kg$^{-1}$. Also Mg concentrations significantly varied with leaf color and while Mg concentration was the lowest in pale green leaf, it was highest in the dark green leaves. There was a 3 fold differences between pale green and dark green leaves in terms of Mg. Being higher Fe concentration in green colored leaves is not a

surprising result because it's role in chlorophyll synthesis. There are positive correlations between leaf Mn and Mg and SPAD index (*figure 5*) As it was reported previous studies, the role of the Fe in chlorophyll formation was well described and increases in leaf greenness and chlorophyll contented were related to leaf Fe concentrations (Sanz *et al*, 1998; Shaahan *et al*, 1999; Chen *et al*, 2016 ). Also determining higher Mg in dark green leaves comparing to others is due to direct effect of Mg as constituent in chlorophyll (Shaahan *et al*, 1999; Kacar B., Katkat A. V. 2007).

Table 1

**SPAD values and chlorophyll contents in different color group**

| Leaf color | SPAD | | | Total chlorophyll, mg $g^{-1}$ | | |
|---|---|---|---|---|---|---|
| | Min. | Max. | Mean | Min. | Max. | Mean |
| Pale green | 18 | 27 | 24 C | 2.4 | 3.9 | 2.8 B |
| Green | 33 | 35 | 34 B | 2.8 | 4.9 | 3.3 A |
| Dark green | 40 | 46 | 43 A** | 3.0 | 4.3 | 3.5 A** |

**P<0.01

Table 2

**Variations of Fe, Mn, Zn and Cu concentrations in different colored leaves**

| Leaf color | Fe | Mn | Zn | Cu | Mg |
|---|---|---|---|---|---|
| | mg $kg^{-1}$ | | | | % |
| Pale green | 82 C** | 34B* | 46 | 13 | 0.4 C** |
| Green | 95 B | 39B | 42 | 10 | 0.7 B |
| Dark green | 121 A | 45A | 50 | 10 | 1.2 A |

*P<0.05,**P<0.01

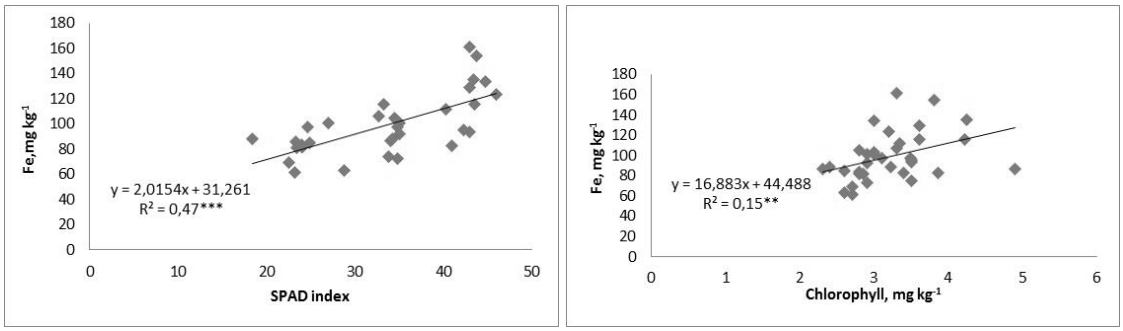


Figure 4 **Correlations leaf Fe concentrations and SPAD and Chlorophyll**

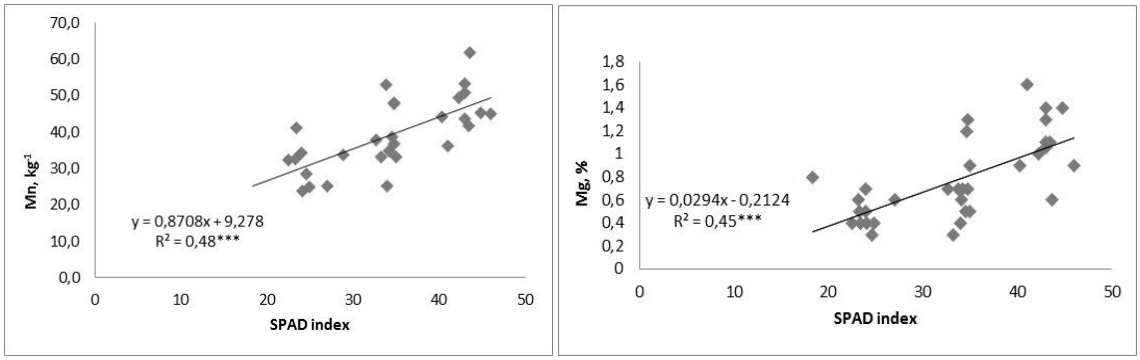


Figure 5 **Correlations leaf Mn concentrations and SPAD index**

## CONCLUSIONS

Leaf greenness gave the strong correlations with SPAD readings and chlorophyll contents. Also leaf Fe, Mn and Mg concentrations showed increment with the leaf green colour. There were close correlations between SPAD reading and leaf chlorophyll, Fe, Mn, and Mg concentrations. Looking at these findings, SPAD values can be used to estimate leaf chlorophyll content and leaf Fe, Mn and Mg concentrations.

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# AGRICULTURAL LAND MANAGEMENT AND RESULTS OF LAND REFORM IN ROMANIA

**Gabriela BIALI[1], Paula COJOCARU [1], Valentin BOBOC [1]**

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**Abstract**

This paper sets out a survey on the evolution of Romanian agricultural real estate for a period of 19 years. Based on the data and on the statistical processed information, this provides few pieces of information on the implementation impact of the Agricultural Real Estate Fund Law no. 18/1991, impact that was significantly felt (in negative manner) with respect to agricultural plots of land.
One of the consequences is that the contribution of agriculture to the Gross Domestic Product decreased during the last 15 years (from 19.4 % in 1995 to 13.6% in 2009). This survey also sets out the contraction of agricultural plots of land which still have hydroameliorative systems.
The paper provides useful data for those who can promote consolidation measures for lands of agricultural destination. On agricultural total lands, good and very good fertility it is 53%, middling 17%, low 13%.

**Key words**: analysis, agricultural land, use cover

Romania is situated in the south eastern part of Central Europe inside and outside of the Carpathians Arch, on the Danube (1,075 km) lower course and has exit to the Black Sea.

Main features of relief unit's area proportionality: 31 % mountains (the highest peak 2,544 m), 36 % hills and plateaus, 33 % plains and meadows.

Romania's climate is temperate – continental: average yearly temperature is variable 8 – 10°C; precipitations 400 – 1400 mm. The vegetation is determined by the relief and by pedo – climatic elements. Preponderant soil is the chernozem.

Total area country is 238391 km$^2$; population 22.46 million inhabitants; density of population 94.2 in habitant/km$^2$.

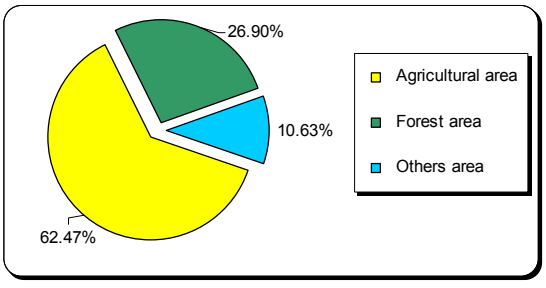


Figure 1 **Distribution of land in Romania according to types of land use (2009)**

Discussing about the land fund use the agricultural area is the biggest part of the land fund (62.47%), represent 0.66 hectares/person; the most founded is arable land (39.4%). Distribution is (in according by *figure 1*):

- Agricultural area: 14,836·10$^3$ ha
- Forest area: 6,388·10$^3$ ha
- Others area: 2,526·10$^3$ ha

## MATERIAL AND METHOD

In this paper I have watched changes that occurred after applying the law no. 18/1991: evolution agricultural area by use type and lands with agricultural destination, owned by natural or legal persons.

A agricultural reform trough Land Fund law no. 18 has been approved in 1991 by the Romanian Parliament, which mainly instituted the private propriety re-possession over the agricultural land, inclusively agricultural lands, through dissolving the Agricultural State Units and Cooperative Agricultural farms. For the same purpose, afterwards has been adopted by Parliament and Government other laws about forming other types of agricultural units like: Legal persons unit, Agricultural companies, Commercial companies, Cooperative units, others types agricultural units (Sion I. Gr., 2003).

Based on data and analysis of the statistics date in according yearbooks of Romania's resulted *Table 1 and Table 2 (figure 2, 3)* .

[1] "Gheorghe Asachi" Technical University, Iasi

Table 1

**Agricultural area by different category use, in Romania (1989)**

| Unit category | Agricultural area use | | Number units | Area/unit (hectares) |
|---|---|---|---|---|
| | (hectares) | % | | |
| Agricultural state units | 4488221 | 30.0 | 407 | 1103 |
| Cooperative agricultural farms | 9061853 | 60.5 | 4643 | 1952 |
| Private agricultural farms | 1413853 | 9.5 | - | - |
| TOTAL | 14963417 | 100 | - | - |

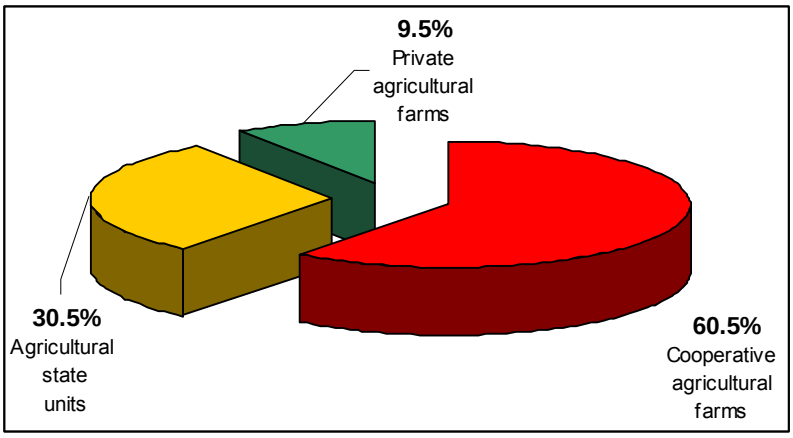


Figure 2 **Agricultural area by use, in 1989 year**

Table 2

**Agricultural exploitations, agricultural area use and agricultural mean area use with one agricultural exploatation, after legal statute, 2009 year**

| Legal statute theirs agricultural exploatations | Number of agriculturals exploatation (%) | Agricultural area use (%) | Mean area use with one exploatation (hectares=ha) | ***Number of agricultural explotation (%)*** | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | < 0.1 (ha) | 1-2 (ha) | 2-5 (ha) | 5-10 (ha) | 20-30 (ha) |
| Agricultural fellow exploatations | 99.5 | 55.4 | 1.73 | 12.6 | 20.9 | 22.1 | 5.0 | 0.12 |
| Units with legal statut: | 0.50 | 44.6 | 274.43 | 2.5 | 5.8 | 13.0 | 14.3 | 2.0 |
| • Agricultural companies | 0.05 | 7.0 | 431.47 | 0.3 | 0.9 | 1.3 | 1.8 | 2.15 |
| • Comercial companies | 0.13 | 15.6 | 353.34 | 2.2 | 3.9 | 4.7 | 3.8 | 3.1 |
| •Administrative teritorial units | 0.13 | 20.6 | 503.22 | 3.7 | 5.6 | 9.1 | 5.8 | 1.3 |
| •Cooperative units | 0.02 | 0.01 | 27.19 | 22.0 | 5.1 | 3.8 | 5.6 | 1.2 |
| •Other types | 0.19 | 1.4 | 24.49 | 1.4 | 8.5 | 24.4 | 30.9 | 1.6 |
| TOTAL | No. exploatation 4484893 | 13930710 hectares | 3.11 | | | | | |

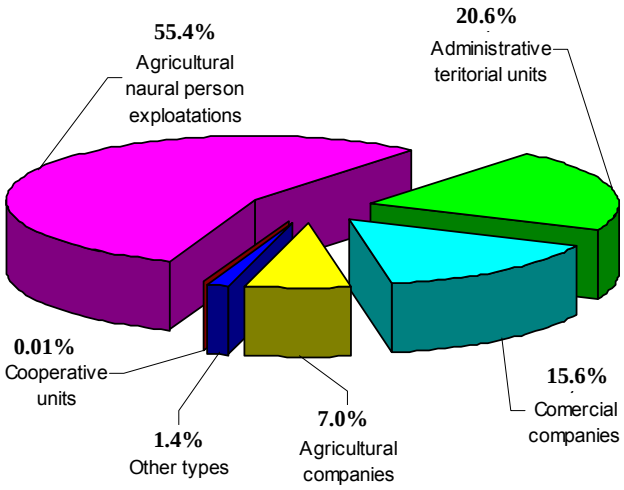


Figure 3 **Agricultural area by use, in 2009**

Obs. In present, total agricultural area and partial forest area is in private ownership (of state, of administrative – territorial units, of legal persons and of natural persons).

## RESULTS AND DISCUSSIONS

Comparing the arable land percentage of other countries (Germany: 33.4%, France: 33.2%, Spain: 30.1%, Italy: 26.9%, United Kingdom: 24.1% and USA: 19.8%) and therefore the land area per person in Romania is 0.418 ha, our country is situated, from this point of view, in a very high position, comparable with the most important producers and exporters in agro-food products (0.58 ha in USA, 0.53 ha in Spain, 0.26 ha in Italy).

As you can see in *Table 3* and *Figure 4*, during the last two decades resulted in an agricultural land diminish, especially the arable lands, because of the unsurveyed expansions of inner city lands and out of city limits buildings, also forsaking or changing the purposes of land on steep hills.

Cultivated area, by main crops in 2009 year: 67 % Cereals for grains (of which: 48 % Maize, 38 % Wheat and rye); 12.7 % Technical crops (of which: 92.6 % Oilseed crops – 84 % sunflower); 13.2 % Fodder crops (Lucerne, etc.)

Table 3

**Total land by use in Romania (1989 –2009)**

| Use categories | 1989 year | | 2009 year | | 2009/1989 | |
|---|---|---|---|---|---|---|
| | $10^3$ hectares | % | $10^3$ hectares | % | +/-$10^3$ hectares | % |
| **Arable land** | **9833** | **41.4** | **9399** | **39.4** | **- 434** | **- 4.7** |
| Pastures | 3044 | 12.8 | 3424 | 14.4 | + 380 | + 11.1 |
| Hayfields | 1423 | 6.0 | 1514 | 6.3 | + 91 | + 6.0 |
| Vineyards and nurseries | 306 | 1.3 | 260 | 1.1 | - 46 | - 15.0 |
| Orchards and nurseries | 357 | 1.5 | 241 | 1.0 | - 116 | - 32.4 |
| **Total agricultural area** | **14963** | **63.0** | **14838** | **62.2** | **- 125** | **- 8.35** |
| Forest and other areas with forest vegetation | 6568 | 27.7 | 6791 | 28.4 | + 223 | + 3.2 |
| Waters and ponds | 880 | 3.7 | 879 | 3.7 | - 1 | 0.0 |
| Other areas | 1428 | 5.6 | 1331 | 5.6 | + 99 | + 7.4 |
| Total non agricultural area | 8976 | 37.0 | 9001 | 37.7 | + 232 | + 2.4 |
| **Total general** | **23839** | **100** | **23839** | **100** | **0.0** | **0.0** |

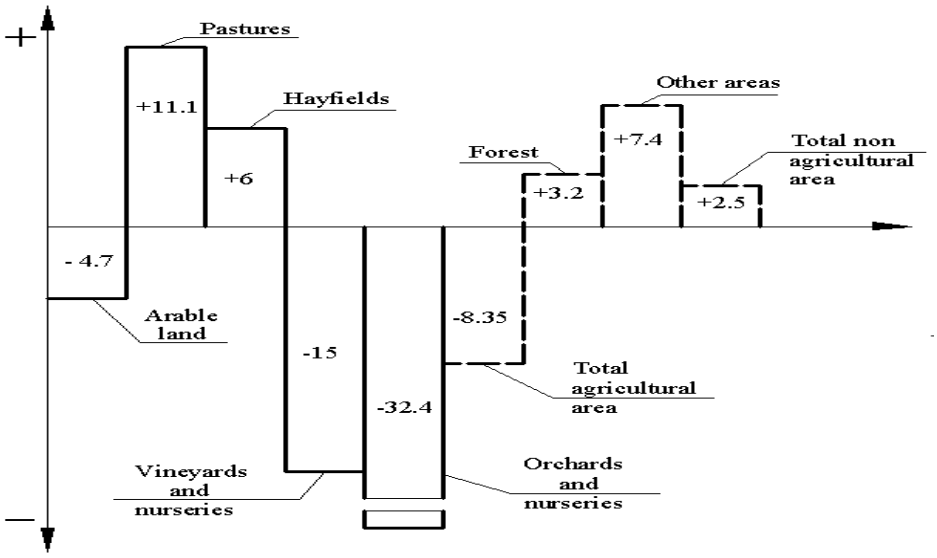


Figure 4 **Agricultural areas by use, difference (%) of 1989/2009 years**

This paper also studied the evolution of hydroameliorative improvements in Romania and, according to the conclusion, the negative trend was noticed in all areas (Biali Gabriela, 2015).
The current problems related to the versant improvement works in Romania (*Table 4)* and the investigations (on the spot and scientific) concerning the preservation of soil on slope plots of land showed that the soil erosion can be prevented by means of a set of anti-erosion actions, both of preventive and improvement nature, regarding the already damaged plots of land (Biali Gabriela, Cojocaru Paula, Martinas Astrid Roberta, 2015).

Taking into consideration the large area of the land subject to anti-erosion actions in Romania (approx. 5.3 mil ha), taking into consideration the pace at which such improvements were performed so far (on approx. 42% of the required area), special further financial efforts are required for the extension thereof.

Table 4

**Status of Land Improvement works in Romania in 1990**

| Improvement works | Required (economically convertible) | | Performed | | To be performed | |
|---|---|---|---|---|---|---|
| | $10^6$ ha | (%) | $10^6$ ha | (%) | $10^6$ ha | (%) |
| Irrigation | 5.5 | 100 | 3.2 | 8 | 2.3 | 42 |
| Draining | 5.5 | 100 | 3.1 | 56 | 2.4 | 44 |
| Fight against soil erosion | 5.3 | 100 | 2.2 | 42 | 3.1 | 58 |

In the first stage, the soil protection and preservation improvement works (c.e.s.) were backed by draining and irrigation works in the hilly and plateau areas, the protection and preservation improvement works being intended for the protection thereof against erosion-related damages. Based on the extension and complexity of the protection and preservation improvement works, representative are the hydrographic basins Bârlad (190,000 ha), Jijia and Bahlui (77,300 ha), Jiu (122,800 ha), Argeşul (56,900 ha), Someşul (62,200 ha), Valea Hârtibaciului (44,100 ha), Almaş and Acriş 30,200 ha, Valea Carasu (42,000 ha), Câmpia Covurlui (50,600 ha).

If during 1990-2000, the irrigation and draining improvement works languished, the works related to the fight against soil erosion have extended for approximately 248,000 ha more, but are still insufficient compared to the demand.

The destruction of certain important soil protection and preservation works on the versants were also recorded in the same period of time (grassed straps, terraces, shoulders, coast channels and openings), and between 2000-2009 these affected 18% of the overall anti-erosion improved area (for instance, the counties: Suceava, Iaşi, Vaslui, Bihor, Sălaj, Hunedoara, Cluj, Dolj etc.).

The main economic indicators required for the assessment of an anti-erosion improvement works scheme are: the overall investment, the specific investment, the net revenue and the investment term of recovery.

Although in Romania the agricultural contribution in forming Gross Domestic Product has decreased in the last 15 years (from 19.4 % in 1995 to 13.6% in 2009), it represents nowadays a very important branch of the national economy (*Table 5*).

Because these changes took place in a short period of time (although necessary), some negative aspects were born:

- dismantling the agricultural land in small parts belonging to farmers doesn't offer the possibility of a normal exploitation, based on mechanization, chemical land treatments and applying some measures of soil fertility preservation and protection (*Table 6*); just the natural erosion of the soil on steep hills affects 47% of the land:
- production planning was affected by rezoning of the agricultural land;
- decreased exploitation of natural resources of the soil.

Table 5

**Agricultural contribution of the Gross Domestic Product in Romania**

| Years | 1938 | 1950 | 1960 | 1980 | 1989 | 1994 | 1995 | 1996 | 1997 | 1998 | 2000 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % GDP (Gross Domestic Product) | 30.1 | 25.7 | 24.5 | 13.0 | 11.3 | 19.4 | 19.3 | 18.7 | 17.6 | 14.1 | 14.0 | 13.6 |

Table 6

**Agricultural exploitations, after parcels number which it is dividet agricultural area use and legal statute (2009)**

| Legal statute theirs agricultural exploatations | Number of parcels which it is dividet agricultural area use | | | | | | Number (media) of the parcels/exploatation |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | > 5 | |
| Agricultural fellow exploatations | 30.0 | 20.4 | 15.5 | 11.2 | 7.2 | 15.7 | 3.34 |
| Units with legal statut: | 25.1 | 15.4 | 10.3 | 8.0 | 5.8 | 35.4 | 9.88 |
| - Agricultural companies | 6.7 | 4.7 | 6.7 | 6.8 | 6.5 | 35.4 | 9.88 |
| - Comercial companies | 22.3 | 9.8 | 7.6 | 6.7 | 6.4 | 47.2 | 13.52 |
| - Administrative teritorial units | 28.1 | 13.4 | 7.8 | 5.8 | 5.1 | 39.8 | 13.52 |
| - Cooperative units | 58.4 | 14.3 | 10.4 | 1.3 | 5.2 | 10.4 | 3.06 |
| - Other types | 29.3 | 23.2 | 15.0 | 10.3 | 5.7 | 16.5 | 3.67 |
| TOTAL agricultural exploatations | | | | | | | 3.38 |
| Total number agricultural exploatations ……. 4299361 | | | | | | | |
| Total number parcels …….…… 14520731 | | | | | | | |

## CONCLUSIONS

Presently we can say that the Reform's main purpose to restore the right of law over the land has been reached (with small exceptions). The land market has been formed; land transactions are something very common these days.

Because these changes took place in a short period of time (although necessary), some negative aspects were born:

- dismantling the agricultural land in small parts belonging to farmers doesn't offer the possibility of a normal exploitation, based on mechanization, chemical land treatments and applying some measures of soil fertility

preservation and protection (*Table 6*); just the natural erosion of the soil on steep hills affects 47% of the land:

- production planning was affected by rezoning of the agricultural land;

- decreased exploitation of natural resources of the soil.

On agricultural total lands, good and very good fertility it is 53%, middling 17%, low 13% (in according *table 3*).

Although in Romania the agricultural contribution in forming Gross Domestic Product has decreased in the last 20 years (from 20 % to 14%), it represents nowadays a very important branch of the national economy (*Table 5*).

The latest laws, started to promote corrective action to diminish the negative effects. Some examples are:

- consolidation of the lands for agriculture by forming certain landowners organizations, in special cooperative units;

- incentives for people involved in the land transactions (tax and imposses breaks, subsidys et.al.).

Please note that the investments in anti-erosion actions and works are larger than the immediate production benefit (revenues) response under these circumstances, where benefits are negative in the first 5-7 years after the completion of works.

That is the reason why the soil erosion fighting improvement works should be considered of public interest, because the effects thereof have an impact on several economic and social objectives (communication roads, water management, localities etc.)

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# MODELING OF EARTH DAMS FAILURE

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**Abstract**

The safety of hydrotechnical structures is a very important element that must enter the concerns of designers and society in general, given the fact that these are important works , with large investments. In the case of their distruction due to accidents, other activities from the area, the settlements and human lives may be strongly affected. These accidents are called hydrological hazards. Breaking dams accidents do not occur suddenly but almost always there are signs of danger that would allow preliminary measures to limit or even avoid disasters. One of these measures may be modeling the failure of a dam. In order to model the behavior of a structure made of local materials discharghed by water over the crest or affected by water evacuation due to a breach in its body, it will be used Mike 11 mathematical model (hydrodynamic module). Its calibration is performed with the hydrological module Mike by DHI-NAM.
In the case of a breach development at the crest level, after recording the discharghe of the dam, the dam behavior must be addressed by specifying the breach slope at the initial moment and at the final one. The breach evolution in time is calculated from the moment it begins to develop. The description of the breach development can be made using Engelund-Hansen equations, which analyze sediment transport driven from the dam through the breach. The development of the breach can be specified as evolving over time or can be calculated based on sediment transport capacity in the gap formed.

**Key words**: dam, soil, modelling, discharge, breach, flood

Hydrotechnical structures and facilities are important works, executed with great investment and that can affect, in the case of their destruction due to accidents, the other activities in the area, especially the settlements and human lives.

The purpose of this paper is to consider the many damages that may occur due to human negligence or most of the time due to accidents, for example, the breaking of a dam. The failure of a hydraulic structure, important event that may occur during its existence, is a very complex phenomenon, both in terms of cause and the manner in which it is conducted. Regarding the time interval, this phenomenon can take place within a longer or shorter period of time. The slow or sudden character is given by the way the limit state is reached, state in which the construction collapses (Lopardo R.A., 1983)

Although there were taken technical measures for the design, construction and operation of hydrotechnical constructions and facilities, there were recorded destructions or accidents. From the statistical studies made, it results that the average risk of destruction of a hydrotechnical structure is about 0.5% and the risk of shutdown for a long period, due to accidents is about 2% - 3%. From the analysis of dam breaking, it was found that the percentage of destruction risk is much higher in dams of small heights than in the ones of large heights. Dams from local materials are less secure than concrete ones because they are subjected to specific phenomena related to construction materials, such as uneven settlements (Hartford D., 2004) .

In a study done by the International Committee on Large Dams (ICOLD) on damages in hydraulic structures, it was concluded that the geological, design, execution and operation risk factors, are a fact proven by the destruction of about 2 % and serious damaging of other about 6% of the approximately 16.500 existing dams in the world. (Abdulamit A., 2009)

Currently the company has become very sensitive to safety issues that technical developments imply. Dams and hydraulic structures in general, are today the subject of special attention and rigorous controls in terms of security.

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## MATERIAL AND METHOD

Modeling of dam failure can be addressed in different ways: by developing a breach at the crest level after discharge and / or failure of plant, disposed in the dam, followed by the development of a breach in the dam body. In order to model the behavior of a structure made of local materials discharghed by waters over the crest it will be used the mathematical model Mike 11, hydrodynamic module, its calibration being performed with the hydrological module Mike by DHI-NAM (Danish Hydraulic Institute, 2014).

The breach can be modeled initially considering it of trapezoidal form or as being initiated in the bottom discharghe. Thus, in the fist moment the breach has trapezoidal shape in the case of discharghe over the dam and in the case of failure in the bottom discharghe area, the opening is considered having circular form (Abbott M.B., Jefsgaard J.C., 1996).

During the breach development the trapeze dimensions increase, suffering modifications in dimensions and slopes. The initial opening can be described by three parameters (*figure 1)*:

- Base breach elevation (HB);
- Base breach width (WB);
- Breach slope (horizontally and vertically) (SS). The slope on the left is considered equal to the slope to the right so the gap development is considered symmetrical to the trapeze axis.

The breach development can be specified as evolving over time or can be calculated from the sediment transport capacity in the formed gap.

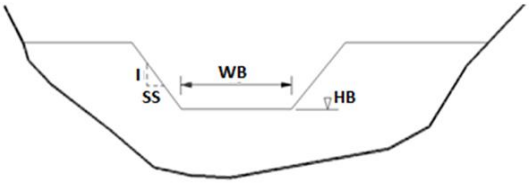


Figure 1 **Breach geometrical parameters**

Breach parameters can be simulated as a time series and consist of boundary conditions of the analyzed domain. $T_0$ is the time when the gap begins to develop. In the analyzed time frame , used parameters are obtained by linear interpolation for a breach of trapezoidal shape. The lower level of the gap has a lower elevation in comparison with the crest.

Flood wave propagation caused by the breaking of a dam is carried out in the downstream area of the dam on a certain length that depends on the spatial characteristics. In terms of hydraulic calculation, the model is based on St. Venant equations. These equations are suffering simplifications when addressing a hydrological problem. These simplifications are induced by knowing some parameters based on previous measurements.

Analysis models of rain discharge phenomenon analyze all discharge components, so by default even the periods without precipitation, when the flow discharghe is made only of basic discharge. In the internal structure of the hydrological system is found also the continous modeling of soil humidity. So, when a high rainfall that will generate flood flows is produced, soil humidity is known, and thus rain-flow process modeling is more realistic (Crăciun I., 2014).

Mike 11 by DHI, NAM module (Nedbal Afstrømning Models / The Rain – drain module) is a conceptual model that reproduces the terrestrial phase of the hydrologic cycle. There is simulated surface flow, intermediate flow and the base flow in a river basin, as a function of the amount of water stored in four reservoirs of the basin, interlinked.

As input data for the model there can be used the hydrologic cycle parameters such as temporal variation of evaporation, soil humidity, aquifer recharge and aquifer water level evolution.

As simulation results there can be obtained the evolution of the hydrological cycle parameters such as flow on slopes, intermediate flow and base flow.

As a case study it was used Granicesti facility, located on the Horaiț brook, left branch of the Suceava River, in the village Granicesti, Suceava county, having fishing use, irrigation and flood control. During 17.06-2.07.2010 there were significant amounts of rainfall in several rounds of 2-3 days, which, in combination with high atmospheric pressures over the Russian Plain and in the central western Europe, have led to a dangerous development of hydrometeorological phenomena in Superior Siret, Suceava and Moldova river basins (Boboc V., 2014).

To calibrate Mike by DHI-NAM model (*figure 2*) it was realised a climatological and hydrological database for Granicesti dam, located in Horaiț catchment, Suceava County. The basic data neccessary for rainfall-runoff modeling approach consisted of defining the model parameters, setting the initial conditions, meteorological, hydrological measurement data related to the hydrographic network.

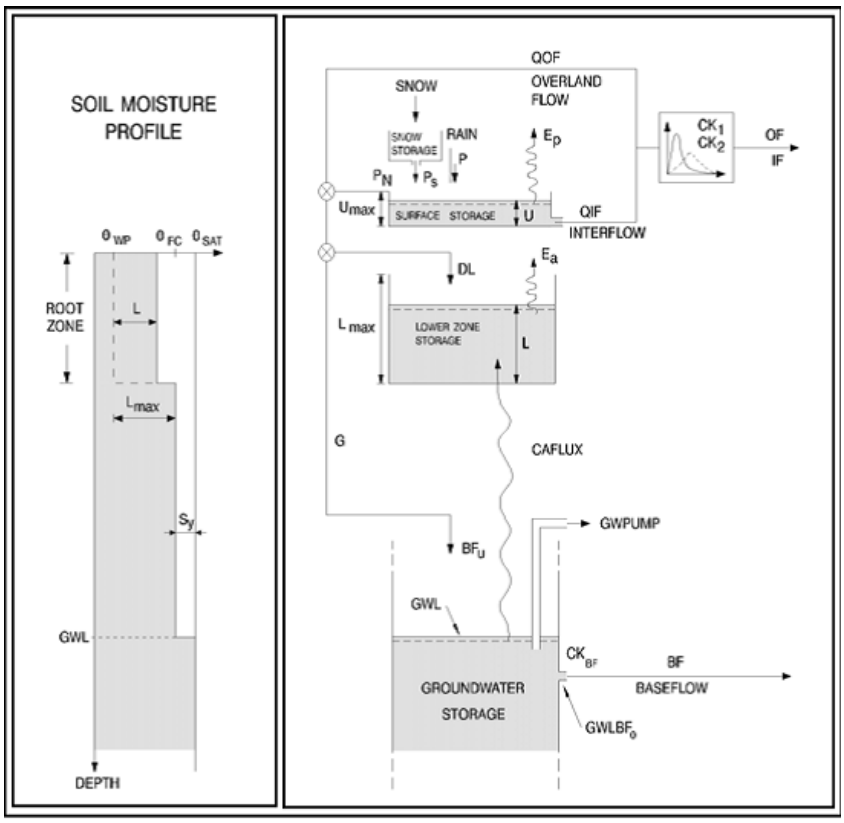


Figure 2 **NAM Model scheme**

The calibration of Mike 11-NAM model was done by the autocalibration procedure. It is a process that can address the most important simulated parameters. Automated calibration routine includes nine parameters: maximum surface water quantity (Umax); maximum water content from the active area for plant roots (Lmax); surface flow coefficient (CQOF); infiltration time constant (CKIF); flow time constants (CK1,2); the threshold value of the unsaturated zone at which the surface discharge is initiated (TOF); the threshold value for initiating infiltration (TIF); time constant for base flow (CKBF); Aquifer recharge threshold limit (TG).

In the case of Horaiț hydrographic basin, the calibration was performed for R2 Nash-Sutcliffe coefficient having the value 0.40, an acceptable one. Also, the simulated discharghe volume is equal to the observed discharghe. Autocalibrated parameters are presented in *table 1*.

Tabelul 1

**Autocalibrated parameters**

| Parameter | Value |
|---|---|
| Umax (mm) | 10.4 |
| Lmax (mm) | 106 |
| $CQ_{OF}$ (-) | 0.327 |
| $CK_{IF}$ (Hour) | 223.7 |
| $CK_{1,2}$ (Hour) | 47.9 |
| $T_{OF}$ (-) | 0.193 |
| $T_{IF}$ (-) | 0.0184 |
| TG (-) | 0.527 |
| Cnow | 2.3 |
| CKBF (Hour) | 1130 |
| Cqlow (-) | 52.5 |
| Cklow (hr) | 11008 |

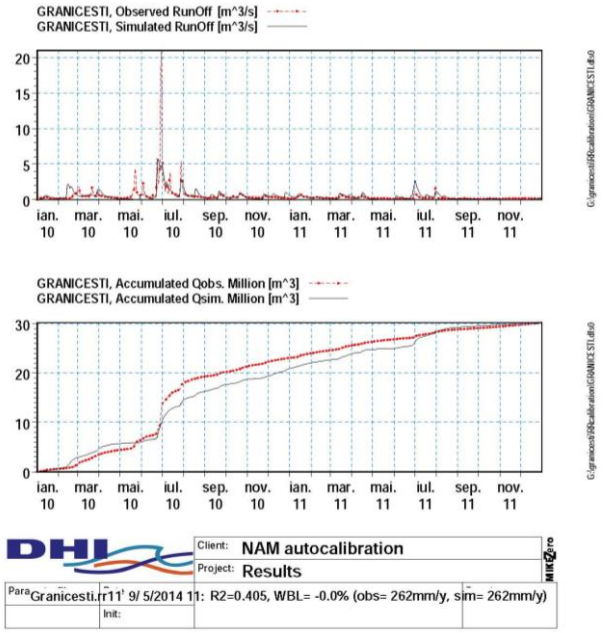


Figure 3 **Mike11-NAM model calibration result for river Horaiț hydrographic basin**

To determine the flood hydrographs in the event of breakage of the earth dams homogeneous, with height under 15 m, the following considerations are made: the failure is gradual due to erosion; erosion is growing rapidly and the massive is washed in a short time.

In the case of discharge, upstream and downstream limits of the crest decline in a uniform manner (Lopardo R.A., 1983).

## RESULTS AND DISCUSSIONS

In *figure 4* is presented the water level in the dam axis at 40 minutes after breach initialization. Maximum flow in the axis of the dam (193 $m^3/s$) obtained by dam discharge simulation, is identified with the maximum discharge with probability of exceeding of 0.5% , discharge that was recorded after reconstitution calculations made after the extraordinary rain of 117 $l/m^2$ recorded in Horaiț hydrographic basin on 30.06.2010 (given the fact that for the specified basin cumulative amounts of rainfall reached 247 $l/m^2$ between 29.06 - 1.07.2010).

*Figure 5* presents velocities evolution which lead to the erosion and washing of the dam body after the discharghe over the crest, at the lower level of the breach. It appears that between the time of the breach initiation and the one in which the lower level of the breach is reached, the water velocity reaches up to 3.0 m/s, which causes the development in height and width of the breach and the washing of the material from the dam. Structures made of local materials, that is various sorts of soils, can not avoid such erosion occurs if the discharge of the crest is produced or if breaches occur in their body. For this reason the structures designed to be discharged, are protected with coverings able to withstand erosion caused by these velocities (concrete, asphalt).

During the flood wave propagation, downstream from the discharged infrastructure, due to topography and large volumes of discharged water, propagation velocity increases, according to the simulation, at a distance of 500 m from the dam at 6.0 m/s, lowering to 5.6 m/s at a distance of 1000 m from the dam. Velocity is reduced, condition that determines the attenuation phenonema in the riverbed.

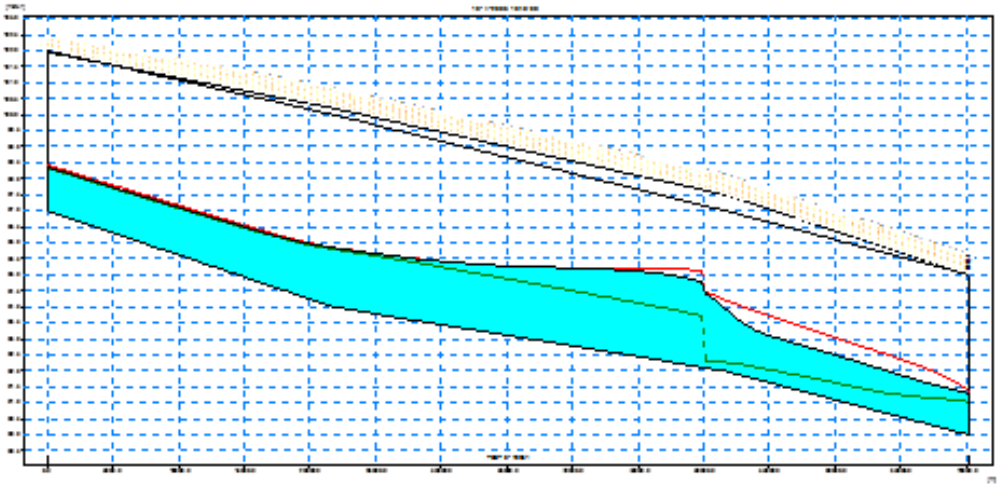

Figure 4 **Water level evolution at 40 minutes after breach initialization**

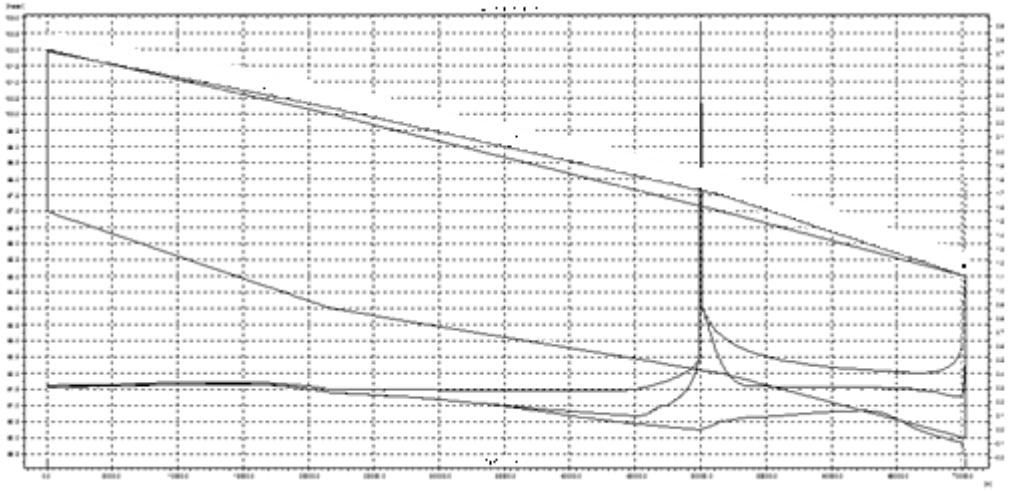

Figure 5 **Water velocity evolution during dam body erosion when the lower level of the breach is reached**

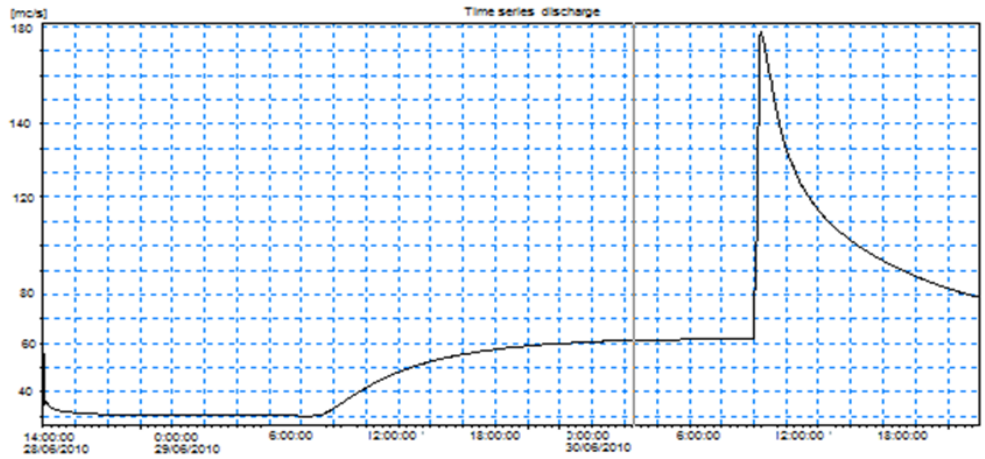


Figure 6 **Flood hydrograph at a distance of 500 m from the dam (Maximum flow rate of 180 m$^3$/s) caused by the discharge of the dam and the breach initiation**

Flood hydrographs caused by crest discharge and breach development in the dam body have maximum values of discharghe of 193 m$^3$ / s in the axis of the dam, this value being reduced as we position ourselves towards the downstream of the dam: 180 m$^3$/s at 500 m from the dam, 168 m$^3$/s at 1000 m from the dam, 154 m$^3$/s at 3,000 m from the dam, 147 m$^3$/s at 5,000 m from the dam and 130 m$^3$/s at 7,000 m from the dam.

Downstream propagation created by the breaking wave has a strong three-dimensional character. Changes along the main riverbed flow (narrower sections alternating with large ones, tributary streams, bridges, control structures) produce accelerations with vertical and horizontal components on the flow axis. Water can flow laterally extending in open areas or to the tributary streams beds (Giurma I., 2003).

## CONCLUSIONS

The results of the flooding study can be better used if they are integrated into a GIS model (Geographic Information System). By overlaying technique, all data of interest can be stored with specific representations for levels, velocities, time, etc.

The flooding strips determined after calculations and numerical simulations can contribute to the achievement of evacuation plans and emergency alarms for protecting people and economic assets located downstream of the accumulation.

Determination of the flooded area through calculations and flow characteristics in this area must take into account the high values of the peak flow and water depths associated, rapid flooding of the main riverbed, very irregular shape of the free surface and oblique shocks presence, flow over normal dry land, suspension transport of lake eroded material from the lake and eventually of fragments of the dam, border limits at the confluence with the tributary streams.

The results of the flooding study must include at least the initial flow before the arrival of the breakage wave, maximum discharge, the time at which the maximum discharge is produced, the initial level of the water, the highest level reached, the time at which the maximum level is reached, maximum flow velocity.

Map of flooding must indicate location of calculation sections, outline the flooded area as an envelope of the maximum levels achieved in the calculation sections, contours of flooded areas in successive intervals of 0.5 h after breakage and the time needed to get to peak value in the calculation section, measured from the initiation of the breach.

Numerical simulation enables not only more accurate reproduction through calculations of observed natural phenomena , but also incorporates assumptions related their development, aspect which can solve risk impact analysis and hydraulic structures safety.

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# AGROPEDOAMELIORATIVE STUDY OF AN REPRESENTATIVE AREAL, LOCATED IN THE POLOCIN BASIN, TUTOVEI HILLS

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**Abstract**

The research objectives were aimed at highlighting the possibility of higher recovery potential fertilization slopes, which have suffered from inappropriate and aggressive human interference in the last quarter of the century which favoured the acceleration of erosion and activation of landslides, with negative impact on agro potential of farmland on the slopes in the studied area.
Given the multitude and variety of degradation processes in the investigated area and the predominant slopes between 5-15%, we recommend implementing measures and improvement works to prevent and control soil erosion.
Also, avoiding deepening degradation of the soils on slopes imposed identifying solutions to determine erosion diminishing and to prevent landslides on the slopes in the area.

**Key words**: soil, slope land, erosion, fertility, ameliorative.

The "Drageşti - Tataraşti" area is located in the Southern county of Bacau, in the east of the Siret River, in the Polocin Basin, in the South - West of the Tutovei Hills.
The researched area is 555.60 hectares. The whole area belongs to the administrative territorial unit Tataraşti and is accessed via communal roads DC 99A, DC 99C, DC 100 and county road DJ252C, which in turn connects with the main cities and towns in the perimeter through national roads DN 11A (Oneşti - Bârlad), DN2F (Bacau - Vaslui) and DN2/European-E85 (Bucharest - Siret).

The area is dominated by a multitude of meadows and slopes with gradients within the range 5-25%, frequently with marl-clay lithology, which were added by torrential rainfall in the warm seasons, and improper human intervention, by practicing agro-technical works from hill to valley, with weed predominance in the structure of crops and overgrazing. All this accelerated land degradation, particularly erosion and landslides, something which inevitably led to deteriorating productive capacity of the land area.
Within this paper, we've highlighted the need to find solutions that can lead to improving the current state of affairs in the territory.

## MATERIAL AND METHOD

To achieve the researched topic, the data were obtained from the study of topographic maps (sc.1:5.000, 1:10.000 and 1:25.000) and soil (sc. 1:10.000) of Tataraşti village, Bacau county, information regarding the evolution and works for antierosional agriculture, accessible through the archives and databases of the Pedological and Agrochemical Institute Bacau (OSPA) and from the Local Agency for Land Reclamation Bacau (ANIF) and from the findings which the author have made in the field on the slope processes and prevention of soil erosion.

## RESULTS AND DISCUSSION

The landscape is varied, derived from the geological structure and monoclinic pattern of the hilly region. As such, the area has a hilly cuesta fragmentation relief. The area is located primarily on a cuesta reverse, located between the Ezerei and Polocin valleys. The brow cuesta from Souththern Tataraşti village is poorly expressed (Micului Coast). The height difference is 163 m of altitude in perimeter to 135 m absolute altitude at the confluence of the streams with Polocin and Ezerei and 298 m in the Comorilor Hill. The structure of the slopes reflects habitat groups of mesorelief and its features. In the territory we find slopes of all kind of categories (*table 1*).

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Table 1

**Slope classes present in the studied territory**

| Slope classes (%) | Land types | Area | |
|---|---|---|---|
| | | hectares | % |
| 0 – 2 | Horizontally | 8.7 | 1.57 |
| 2 – 5 | Very Weak sloping | 94.8 | 17.07 |
| 5 – 10 | Weak Sloping | 181.5 | 32.67 |
| 10 – 15 | Weak - Moderately sloping | 132.1 | 23.76 |
| 15 – 20 | Moderately sloping | 52.0 | 9.36 |
| 20 – 25 | Moderate - Heavily tilted | 47.0 | 8.46 |
| 25 – 35 | Heavily tilted | 11.1 | 2.00 |
| 35 – 50 | Very - Heavily tilted | 6.1 | 1.10 |
| 50 – 100 | Extremely heavily tilted | 22.3 | 4.01 |
| TOTAL | | 555.60 | 100% |

It appears, due to reversible cuesta mentioned, that prevailing land with slopes less than 15%, 75.07% of the extensive surface and overall 81.36% of the surface is subject to a serious risk of erosion.

Lithologically, the area consists of clay deposits – marl and sands. Over these Pre-Quaternary rocks, there are, in recent deposits, a coating of territory, consisting in clay-clay loam, home colluvium - wind (loess) delluvium-colluvium and low-eluvium (residual deposit). The bottoms of the valleys are rhythmic accumulated alluvium deposits-colluvium soils buried. The sloping surfaces on the back of cuesta consist predominantly (85%) of loess and slopes consisting predominantly of clays or clay – clay loam. The slope of Micului Coast in the South of the area is a brow cuesta, "unveiling" layers clay - marl. In conclusion, 95% of the surface area, and underlying parent materials are clay (grain size, which is the type clay – clay loam).

The basin area falls in the Siret basin, Polocin sub-basin. As a practical location, the studied area overlaps the Ezerei Creek, with its tributary on the right - Tataraşti and Mațcani Valley creek with its tributary on the right - Giurgeni Valley.

Areal weights of the two sub-basins is about equal. The North-West corner of the area (below 10%) exception, being oriented either to stream basin Repede, either to Drageşti basin. Mațcani creek and its alluvial plain is not included in the studied perimeter. Streams of the perimeter (Ezerei, Tataraşti and Giurgeni) have very low flow rates (~2 l/s), draining the sources of their basins. Rain debts grow strongly, depending on the volume and intensity of the rainfall. We noticed the strong character of the Ezerei torrential valley.

Hydrogeologically, the area is characterized by the pedophreatic clear predominance level of over 5 m depth. Only about 17% of the perimeter (94 ha) plants or soils are influenced by intake water system. On the valley floor Ezerei, at the confluence with Tataraşti Valley, there appears an area with excess groundwater intake (7.5 ha). The phreatic level is about 3 – 5 m depth and it is distributed on lower slopes with colluvial processes (74 ha). Fluvisols flood occur on the bottoms of valleys located (10.8 ha) and moderate frequency - rare.

Climatically, the area is located in the pedo-geo-climatic moderately warm semi-humid zone. The average annual temperature is about 9,3 $^0$C and average annual rainfall of 530 mm.

Hydroclimatically, the annual deficit balance is poor. The annual number of days without frost is 190.

The maximum rainfall occurs, on average, in early summer. Rainfalls during May 1 to August 31 are on average 275 mm, which is 52% of the annual average.

Frequent droughts occur in April, August and September. In the area, heavy rains are common. In some cases, such as the latest recorded on 5 and 6 September 2007 (Galațeanu M., 2007), the effects of rainfall on lands with basic tillage done, were very strong and the whole arable layer stripped completely near Drageşti village.

Vegetation: the area has a steppe character. Only North-West of Comorilor Hill area is located in the forest floor. The forest in the vicinity of this hill is made up of oak, field maple, maples, elms and hornbeams.

Anthropogenic influence is reflected in the perimeter by:

- The occurrence of a specific micro-relief (embankments, excavations, loam pits, Field terraces ~ 10% of the perimeter);
- Accelerated erosion of the perimeter is a general phenomenon, caused by the operation disorganized as arable land. Status deep erosion is the result of uncontrolled exploitation and inappropriate land at risk of erosion in the area. In this regard, there is the mention that the perimeter does not have soil erosion control facilities;
- Plow sole perimeter appears on 153 hectares, sloping land;
- Acidification of soils due to unilateral fertilization with mineral fertilizers on 58 hectares.

Soils in the area, following studies, highlight as eight types (*table 2*). It may be noted that specific types of soil slopes (regosols and anthrosols) are the most extensive.

Table 2
**Soil classes present in the Drageşti – Tataraşti area**

| Soil type | Area | |
|---|---|---|
| | hectares | % |
| Fluvisols | 10.80 | 1.94 |
| Chernozems | 16.80 | 3.02 |
| Eutric Cambisols | 63.10 | 11.35 |
| Anthrosols (Erosive) | 68.20 | 12.28 |
| Phaeozems | 48.50 | 8.73 |
| Luvisols | 15.50 | 2.79 |
| Hapludalfs | 233.50 | 42.03 |
| Regosols | 99.20 | 17.86 |
| TOTAL | 555.60 | 100.00 |

The soil texture is loamy on 92% of the perimeter (511.2 ha). 8% of the surface texture is clayey-loam (24 ha), loamy-sandy (15 ha) or sandy-loam (5.4 ha).

Soil reaction (*table 3*) is determined by many factors, especially erosion and landslide.

Reaction of the acid is strong, the amount of hydrolytic acidity is less than 70% $V_{AH}$ on 58.1 ha, which means 10.44% of the total surface.

Table 3
**Status soil reaction in the studied area**

| Soil reaction types | Area | |
|---|---|---|
| | hectares | % |
| Weak Alkaline | 164.00 | 29.52 |
| Neutrals | 26.00 | 4.68 |
| Weak Acid | 180.00 | 32.39 |
| Moderately Acid | 127.50 | 22.95 |
| Strong Acid | 58.10 | 10.46 |
| TOTAL | 555.60 | 100.00 |

In the progress of landslides and erosion, we mention the presence of weak vertices processes in an area of 18 hectares of land on the Micului Coast in the area of contact between the surface sloping to reverse cuesta southern forehead represented by this coast.

Secondary settlement or plow soles appears on 153 ha (27.54% of the area).

The average content of $CaCO_3$ on 0 – 50 cm depth, are over 8% on 65 ha (ie 11.70% of the total area).

Depth carbonate accumulative horizon ($C_{CA}$) under 100 cm, appears on 285 ha (51.30%).

The emergence of the material surface by less favorable textures on 44 ha, meaning 7.92% of the area studied are the type loamy sand textures, clayey-loam and loamy-sandy that are in the current phase in the horizon medium surface of the soils. The permeability is small and medium on 86.34% of the area (table 4).

Soil porosity (tab. 4) to layer up to 75 cm depth is smaller in only 50.3 ha (9.05%).

Gleyied soil occurs about 20 ha restrictive, which represents 3.6% of the perimeter.

Soil moisture deficit is restrictive (and very large) about 90 ha (16.2%).

Alkalizing is weak and it appears insular on an area highlighted in the Ezer Valley, on a regosol soil type textural contrast and with the contribution of the coastal groundwater and springs. The land also have active landslides.

Soils with low humus reserve (*table 4*), and horizon thickness (table 4) below 10 cm are expanded nearly 90% of the surface. The situation is a reflection of erosion, siltation and land use arable (both duration and intensity) and more less pedo-genetic processes.

Table 4
**The main characteristics of the soils in the area Drageşti – Tataraşti**

| Soil feature<br><br>Soil deposit (ha) | Total porosity (<75 cm depth) | Permeability | Humus horizon thickness (<10 cm depth) | Humus deposit |
|---|---|---|---|---|
| Great | 164.8 | 75.9 | 66.4 | 32.0 |
| Middleweight | 340.5 | 427.1 | 390.5 | 19.1 |
| Lesser | 50.3 | 34.3 | 15.1 | 357.5 |
| Very small | - | 18.3 | 83.6 | 93.0 |
| Extremely small | - | - | - | 54.0 |
| TOTAL | 555.60 (100%) | | | |

The structure of agricultural land use categories (table 5) is dominated by arable land (83.71% of the area), followed by meadows (9.52%) and vine fruit-plantations (3.48%). A high percentage (2.79%) is distributed to land at an advanced stage of degradation slope processes.

Table 5
**The use of the land from the investigated perimeter**

| Category use | Area | |
|---|---|---|
| | hectares | % |
| Arable | 465.10 | 83.71 |
| Pastures | 52.90 | 9.52 |
| Vineyards | 16.70 | 3.01 |
| Orchards | 2.60 | 0.47 |
| Forest | 2.80 | 0.50 |
| Unproductive | 15.50 | 2.79 |
| TOTAL | 555.60 | 100.00 |

*Soil degradation processes*

The slopes and landforms are copying main degradation soil molds. The latter are essentially accelerated geomorphological processes in the context of land use in time. As such, the main kinds of land degradation are the following:

Surface soil erosion - is the largest expansion degradation and affects 477.3 ha (tab. 6). The situation reflects both the normal ratio between land degradation, geomorphological processes and anthropogenic state of acceleration of the process. Erosion affects 85.92% of the surface area. This high percentage is explained both by land as arable (83.71% of the area) and the

organization and work of inappropriate land slope, the biggest part of the history of exploitation of those lands, but also by facilitating erosion of natural background (long hills and loamy texture). The perimeter area affected by erosion is clearly dominated by low intensity of erosion (53.07% of the area) in the current phase.

Table 6

**The intensity of soil degradation by erosion processes in the studied area**

| Intensity of erosion | Area | |
|---|---|---|
| | hectares | % |
| Weak | 253.30 | 53.07 |
| Moderate | 140.40 | 29.41 |
| Strong | 20.60 | 4.32 |
| Very strong | 8.70 | 1.82 |
| Excessive | 54.30 | 1138 |
| TOTAL | 477.30 | 100.00 |

One can notice that surface erosion tends to expand the perimeter on the slopes as well of 2-5%, on very long lines on the reverse slope of the cuesta.

Depth soil erosion - manifests itself on an area of 395.5 ha, so that 71.20% of the perimeter has deep erosion formations of various intensities (table 7). The explanation for this wide area of damage is the same as for surface erosion: operation as arable 83.71% of the perimeter, long slopes and texture of clayey-clay-sandy. Weaker is the dominant intensity (on gutters 77.52% of the total surface formations by deep erosion).

Table 7

**Deep erosion forms present in the perimeter**

| Type of erosion | Density of erosion | Area | |
|---|---|---|---|
| | | hectares | % |
| Rill | Lesser | 237.70 | 60.10 |
| Rill | Average | 68.90 | 17.42 |
| Advanced rill | Little | 39.30 | 9.94 |
| Advanced rill | Average | 14.10 | 3.57 |
| Advanced rill | Large | 2.90 | 0.73 |
| Gully | Little | 8.50 | 2.26 |
| Gully | Average | 1.80 | 0.46 |
| Ravine | Large | 22.30 | 5.64 |
| TOTAL | | 395.50 | 100.00 |

A reflection of the state of activation of deep erosion is the situation from the Ezerei Valley, which was a strong aggravate bed (ravine bottom of the valley), two thirds of its length. Upstream of the confluence with the Tataraşti small tight valley, the deepened reactivation was so strong that it triggered hillside complex processes: collapses and landslides, with the emergence of badland sectors type, upstream of the village;

Therefore, gullies appear on an area of 66.6 ha (16.96% of the total area affected by depth erosion), and gutters on 306.6 hectares (77.52% of the total area affected by depth erosion).

Active ravines are expanded on 22.3 ha (5.64% of the total area affected by depth erosion).

Landslides, a process of degradation, undergo a process of deepening and development of the valleys in the area and therefore their weight in perimeter is most reduced, these manifesting themselves in 138.1 hectares (24.86% of the habitat). Training and landslides reactivation of the perimeter (table 8) is closely linked to the deepening valleys and then widening sunken beds on a background litho-hydro-geology favorable movement of masses of rocks on the slope.

Table 8

**The intensity of the landslides in the studied area**

| Formations | Types | Area | |
|---|---|---|---|
| | | hectares | % |
| Furrows | Stabilized | 4.10 | 2.97 |
| Waves | Stabilized | 59.00 | 42.72 |
| Waves | Semi Stabilized | 13.70 | 9.92 |
| Footsteps | Stabilized | 16.20 | 11.73 |
| Footsteps | Semi Stabilized | 9.30 | 6.73 |
| Mound | Semi Stabilized | 7.40 | 5.36 |
| Crumbling | Semi Stabilized | 6.10 | 4.42 |
| Crumbling | Active | 22.30 | 16.15 |
| TOTAL | | 138.10 | 100.00 |

Landslides in the narrow sense are of several types: stabilized on 79.30 ha (57.42% of the area affected by landslides) and semi-stabilized on 36.5% (26.43%). The above mentioned areas were excluded subsidence, which, strictly speaking, are not really slides. Subsidence occurs on 28.4 ha (16.15%), of which 22.3 ha active.

There are three areas of development landslides:

*Area 1* - Giurgeni, the wider area, developed on the right side of the middle Mațcani Valley. It is an area with slides consisting in waves and footsteps. Reactivation occurred as a result of the deepening Giurgeni ravine. The area is spread over 65.8 hectares, of which the reactivation on 11.2 ha (17.02% of total).

*Area 2* – The Ezerei Valley is developed upstream of the confluence Tataraşti. It is a narrow area, held along the creek Ezer, notably the right valley, linked to the structure of litho - hydro - geological area. The form of the landslides is diverse: footsteps, waves and mounds. Reactivation landslides occurred in this area by immersion. The area is spread over 31 hectares, of which the reactivation on 19.2 ha (61.6%). In fact, this area with active landslides is the most fragmented and unstable area of sliding landslide.

*Area 3* - Micului Coast is the lowest, as expansion, at the current phase, landslides are stabilized and aunder the form of waves or

furrows. The surface of this area is of 8.1 hectares active subsidence occurs on ravines in the perimeter of the bottom of the valley, being ordered by the share occupied as follows: the Ezer Valley, the Tataraşti Valley and the Giurgeni Valley. These collapses are complex, affecting slopes just adjacent to the confluence with Tataraştii Ezer and downstream subsidence strictly bottom of the valley, affecting the alluvial plain.

Cloggings – are produced on 40 ha (7.20% of the total), of which weak-moderate (deposited layer thickness is under 25 cm), 64% of the area being affected by the process.

The cloggings mentioned are weak and appear on the lower slopes, the slope saddles and trade downstream areas with high erosion and gullies. On the valley bottoms, strong cloggings occur.

*Improvement requirements*

The main measures and improvement works necessary are works meant to prevent soil erosion and control it:

- Basin Ezer anti-erosion works and the right valley slope Mațcani, located between Blageşti and building of the former state farms Tataraşti (side overlaps on the eastern side of Comorilor Hills and Ezerei and Basin Ravine Giurgeni);

- Fitting of ravines and valleys of torrents of Ezer, Tataraşti and Giurgeni.

Also, it is considered necessary the timely completion of the drainage, leveling capital, regularization of rivers (including the drainage system), spring intake, drainage (a small area of 2 ha).

In particular it must prevent and control landslides, including subsidence.

At the agropedoameliorative level, a first radical fertilization is (necessary humus soil reserve and phosphorus content is low) anti-erosional culture system organization drainage area, the establishment of plantations for protection, deep loosening and amendment limestone (with slightly lower share).

Particular attention will be given to protective plantations, especially afforestation, urgently needed in the area.

## CONCLUSIONS

The area proposed for improvement is complex through its features. There are a series of degradations, which seriously affect land in the studied area (surface erosion 85.92%, 71.20% on deep erosion, landslides on 24.86% and 7.20% on clogging of the territory).

The hilly landscape consists of cuesta fragmented relief. The predominant slopes are between 5-25%, something that represents 74.25% of the surface area. Soils are dominated by preluvisolic with poorly differentiated textures, followed by regosols and erosive soils. A percentage of 92% of the habitat has a loamy texture.

The total porosity of the soil is on 61% of middle and low surface, the only 9%. Permeability is average and 86.34% lower on the perimeter. Reserve humus is low on 90.80% of the territory.

Given the aforementioned synthesis, studying the area in terms of soil degradation, caused by erosion in the broad sense, which may put at risk the very backbone of the dwellings that make up human settlements in the perimeter, this study is topical.

The agropedoameliorative study of the agricultural land in terms of natural and anthropogenic factors which contribute to the degradation of soils on slopes enables the enunciation of solutions for preserving soil fertility and the environment.

Implementation of the 18/1991 law, by reconstituting the old locations of properties caused excessive fragmentation of land through demarcation of their long side towards the hill – valley, inhospitable soil conservation aspect. Besides this, subsistence farming practised and / or ignorance of the common people made it grow steadily, year after year, corn, crop plants which raised to a large extent the degree of water erosion and other slope processes.

However, we believe that the reunification of certain areas of farmland in various forms, one could meet an adequate agrotechnics in order to restraint erosion in the tolerabkle limits and make some special arrangements work again in order to fight and control soil erosion, or possibly extend them by accessing European funds.

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# CONTRIBUTIONS TO SOLVING THE EQUATIONS OF THE FUNCTIONAL FEATURES OF TURBOPUMPS

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**Abstract**

Turbopumps are hydraulic generators that are indispensable to the pressurized and/or free level hydrotechnical systems. These are used mainly for high pumping flows. They are characterized by high velocity of the fluid in relation to the active parts and the fact that the pumped flow varies in relation to the pumping height. For accurate sizing and simulation of their functioning, we suggest a new analytical expression for the determination of the power feature for a constant rpm. Unlike the polynomial function of the second degree, present in field literature, we approximated the analytical expression for the power feature for constant rpm of the turbopump using a rational function with five coefficients. We theoretically determined the analytical expression for the loading feature for variable rpm and applied various methods of statistical processing in order to determine the actual numerical values for the coefficients of functional features of the turbopumps. We noticed that among the statistical processing methods of the experimental data, the most accurate results were achieved by our mathematical model, using the method of minimisation of the sum of the absolute values of the deviations.

**Key words**: functional features of turbopumps, variable rpm, statistical methods

Turbopumps are used mainly for high pumping flows and the pumped flow varies in relation to the pumping height.

At the level of irrigation networks, the equations characteristic to the function of turbo pumps that are used for the effectiveness of a system which is composed from pipes under pressure and the station of the pressure pipes (SPP), (Alexandrescu A., 2004).

The functional equations may serve to simulate the operation of the pumps within the framework of the hydro-power systems.

The main functional characteristics of the turbopumps, at variable speed are (Popescu St., 2004; Popescu St., 1993):

- the load characteristic,

$$H = f_Q(n,Q) \quad (1)$$

- the yield characteristic,

$$\eta = f_\eta(n,Q) \quad (2)$$

- the power characteristic,

$$N = f_N(n,Q) \quad (3)$$

- the feature of the dynamic load at the entry into the impeller (*the requested NPSH*),

$$NPSH = f_c(n,Q) \quad (4)$$

In all the formed expressions (1)÷(4), the speed *n* and flow *Q* are considered independent variables; when the speed presents a constant value $n_0$, the flow remains the only independent variable.

The actual analytic expressions of the characteristics (1)÷(3), at the speed $n_0$, are the following (equations 1÷4):

- the load characteristic,

$$H = f_{H0}(Q) = a_{H0} \cdot Q^2 + b_{H0} \cdot Q + c_{H0} \quad (5)$$

- the yield characteristic,

$$\eta = f_{\eta 0}(Q) = a_{\eta 0} \cdot Q^2 + b_{\eta 0} \cdot Q + c_{\eta 0} \quad (6)$$

- the power characteristic,

$$N = f_{N0}(Q) = a_{N0} \cdot Q^2 + b_{N0} \cdot Q + c_{N0} \quad (7)$$

The analytical coefficient expressions (5) ÷ (7) can be deduced by statistical processing of *M* couplers experimental data (obtained from measurements or, in their absence, taken from the curves provided by the supplier of turbo pumps),

$$(Q_{0i}, H_{0i}, \eta_{0i}, N_{0i}), i = 1,2,\ldots,M \quad (8)$$

We will present each of the 3 main methods, which are differenced trough, the afferent performance criteria.

The main methods of statistical processing data (8) are: 1 the least squares method

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(M.C.M.M.P.), proposed by Gauss; 2° method of minimizing the sum of the absolute values of deviations (M.S.V.A.A.) and 3°rd mini-max method (M.M-M).

We will present each of the three principle methods that are differentiated by performance related criteria, in the specific case of the load characteristic (equation 5):

- The data (equation 8) value pairs are selected for load flow,

$$\left(Q_{0i}, H_{0i}\right), i = 1, 2, \ldots, M \quad (9)$$

- The introduction of set values (9) in equation (5) is generated following string of errors (deviations):

$$\delta_i = a_{H0} \cdot \left(Q_{0i}\right)^2 + b_{H0} Q_{0i} + c_{H0} - H_{0i}, i = 1,2 \ldots M \quad (10)$$

where deviations $\delta_i$ are dependent on the coefficients of the (equation 5),

$$\delta_i = \delta_i \left(a_{H0}, b_{H0}, c_{H0}\right), i = 1,2,\ldots,M \quad (11)$$

- Performance criteria for M.C.M.M.P it consists of minimizing the sum of squares of errors (equation 10).

$$\min\left[\sum_{i=1}^{M}\left(\delta_i\right)^2\right] = \min\left\{\sum_{i=1}^{M}\left[a_{H0} \cdot \left(Q_{0i}\right)^2 + b_{H0} \cdot Q_{0i} + c_{H0} - H_{0i}\right]^2\right\} \quad (12)$$

- Performance criteria for M.S.V.A.A. consists in minimizing the sum of the absolute values of the deviations (equation 10),

$$\min\left[\sum_{i=1}^{M}\left|\delta_i\right|\right] = \min\left\{\sum_{i=1}^{M}\left|a_{H0} \cdot \left(Q_{0i}\right)^2 + b_{H0} \cdot Q_{0i} + c_{H0} - H_{0i}\right|\right\} \quad (13)$$

- Performance criteria for M.M-M consists of minimizing the deviation of the sequence (equation 10) with maximum absolute value,

$$\min\left\{\max_{i=1,2,\ldots,M}\left|\delta_i\right|\right\} \Leftrightarrow \min\left\{\max_{i=1,2,\ldots,M}\left|a_{H0} \cdot \left(Q_{0i}\right)^2 + b_{H0} \cdot Q_{0i} + c_{H0} - H_{0i}\right|\right\} \quad (14)$$

These three methods in MATLAB can be directly applied using standard functions relating to:

- for M.C.M.M.P., for polynomial relations, polyfit.m;
- forM.M-M., fminimax.m;
- for M.V.A.A., fminsearch.m.

## MATERIAL AND METHOD

**A new analytical expression for power at constant speed feature**.

It has been found the pump power (equations 1,3):

$$N = \gamma \cdot \frac{Q \cdot H}{\eta} \quad (15)$$

where γ it represents the specific gravity of water.

Introducing in (equation 15) the expressions (5) and (6), the resulting expression are:

$$N = \gamma \cdot \frac{Q \cdot \left(a_{H0} \cdot Q^2 + b_{H0} \cdot Q + c_{H0}\right)}{a_{\eta 0} \cdot Q^2 + b_{\eta 0} \cdot Q + c_{\eta 0}}$$

that with notations:

$$a_{N0} = \gamma \cdot \frac{a_{H0}}{a_{\eta 0}}, b_{N0} = \gamma \cdot \frac{b_{H0}}{a_{\eta 0}}, c_{N0} = \gamma \cdot \frac{c_{H0}}{a_{\eta 0}}, d_{N0} = \frac{b_{\eta 0}}{a_{\eta 0}}, e_{N0} = \frac{c_{\eta 0}}{a_{\eta 0}}$$

will become:

$$N = f_{N0}(Q) = \frac{Q\left(a_{N0} Q^2 + b_{N0} Q + c_{N0}\right)}{Q^2 + d_{N0} \cdot Q_{N0} + e_{N0}} \quad (16)$$

The coefficients of the (equation 16) can be determined with high precision by direct statistical processing of pairs of experimental values:

$$\left(Q_{0i}, N_{0i}\right), i = 1, 2, \ldots, M \quad (17)$$

values that are retrieved from the data set (equation 8).

Deductions on theoretical equation load variable speed feature.

For (equation 1), corresponding load characteristic speed *n* is considered an expression of the form (equation 5),

$$H = f_{Hn}\left(Q, n\right) = a_{Hn} Q^2 + b_{Hn} Q + c_{Hn} \quad (18)$$

but with coefficients $a_{Hn}$ ,$b_{Hn}$ and $c_{Hn}$ that depend on speed n.

Considering the similarity relations:

- for debits:

$$Q/Q_0 = n/n_0 \quad (19)$$

- for hydraulic tasks:

$$H/H_0 = \left(n/n_0\right)^2 \quad (20)$$

(equation 18) becomes:

$$H_0\left(\frac{n}{n_0}\right)^2 = a_{Hn}Q_0^2\left(\frac{n}{n_0}\right)^2 + b_{Hn}Q_0\left(\frac{n}{n_0}\right) + c_{Hn} \quad (21)$$

When entering the set of values (9) in (equation 21) gives the following series of errors:

According to the method of least squares, the coefficients $a_{Hn}$, $b_{Hn}$ and $c_{Hn}$ for (equation 18) and (equation 21) they are determined from the condition of maximizing the sum of squares of errors (equation 22).

$$\delta_i = \delta_i\left(a_{Hn}, b_{Hn}, c_{Hn}\right), i = 1,2,\ldots,M \quad (22)$$

$$\delta_i = a_{Hn}Q_0^2\left(\frac{n}{n_0}\right)^2 + b_{Hn}Q_{0i}\left(\frac{n}{n_0}\right) + c_{Hn} - H_{0i}\left(\frac{n}{n_0}\right)^2, i = 1,2,\ldots,M \quad (22) \quad (23)$$

where:

$$\sum_{i=1}^{M}\left(\delta_i\right)^2 = \sum_{i=1}^{M}\left[a_{Hn}\left(Q_{0i}\right)^2\left(\frac{n}{n_0}\right)^2 + b_{Hn}Q_{0i}\left(\frac{n}{n_0}\right) + c_{Hn} - H_{0i}\left(\frac{n}{n_0}\right)^2\right]^2 \quad (24)$$

The necessary condition for minimizing the amount (equation 24) it depends of simultaneous cancellation of its partial derivatives in relation to each of the coefficients: $a_{Hn}$, $b_{Hn}$ and $c_{Hn}$:

Performing above derivation relations, we obtain the following system of equations in three unknowns $a_{Hn}$, $b_{Hn}$ si $c_{Hn}$:

$$\min\left\{\sum\left(\delta_i\right)^2\right\} \Rightarrow \begin{cases} \dfrac{\partial}{\partial a_{Hn}}\left\{\sum\left(\delta_i\right)^2\right\} = 0 \\ \dfrac{\partial}{\partial b_{Hn}}\left\{\sum\left(\delta_i\right)^2\right\} = 0 \\ \dfrac{\partial}{\partial c_{Hn}}\left\{\sum\left(\delta_i\right)^2\right\} = 0 \end{cases} \quad (25)$$

$$\begin{cases} \sum\left[a_{Hn}\cdot\left(Q_{0i}\right)^2\cdot\left(\dfrac{n}{n_0}\right)^2 + b_{Hn}\cdot Q_{0i}\cdot\left(\dfrac{n}{n_0}\right) + c_{Hn} - H_{0i}\cdot\left(\dfrac{n}{n_0}\right)^2\right]\cdot\left(Q_{0i}\right)^2\cdot\left(\dfrac{n}{n_0}\right)^2 = 0 \\ \sum\left[a_{Hn}\cdot\left(Q_{0i}\right)^2\cdot\left(\dfrac{n}{n_0}\right)^2 + b_{Hn}\cdot Q_{0i}\cdot\left(\dfrac{n}{n_0}\right) + c_{Hn} - H_{0i}\cdot\left(\dfrac{n}{n_0}\right)^2\right]Q_{0i}\left(\dfrac{n}{n_0}\right) = 0 \\ \sum\left[a_{Hn}\cdot\left(Q_{0i}\right)^2\cdot\left(\dfrac{n}{n_0}\right)^2 + b_{Hn}\cdot Q_{0i}\cdot\left(\dfrac{n}{n_0}\right) + c_{Hn} - H_{0i}\cdot\left(\dfrac{n}{n_0}\right)^2\right] = 0 \end{cases}$$

transcribed with next form, following general (equations 26):

$$\begin{cases} a_{Hn}\cdot\left(\dfrac{n}{n_0}\right)^2\sum\left(Q_{0i}\right)^4 + b_{Hn}\left(\dfrac{n}{n_0}\right)\cdot\sum\left(Q_{0i}\right)^3 + c_{Hn}\sum\left(Q_{0i}\right)^2 = \left(\dfrac{n}{n_0}\right)^2\sum\left(Q_{0i}\right)^2 H_{0i} \\ a_{Hn}\cdot\left(\dfrac{n}{n_0}\right)^2\cdot\sum\left(Q_{0i}\right)^3 + b_{Hn}\cdot\left(\dfrac{n}{n_0}\right)\cdot\sum\left(Q_{0i}\right)^2 + c_{Hn}\cdot\sum\left(Q_{0i}\right) = \left(\dfrac{n}{n_0}\right)^2\cdot\sum Q_{0i}\cdot H_{0i} \\ a_{Hn}\cdot\left(\dfrac{n}{n_0}\right)^2\cdot\sum\left(Q_{0i}\right)^2 + b_{Hn}\cdot\left(\dfrac{n}{n_0}\right)\cdot\sum\left(Q_{0i}\right) + c_{Hn} = \left(\dfrac{n}{n_0}\right)^2\cdot\sum H_{0i} \end{cases} \quad (26)$$

It can be said that the system (26) presents the coefficient matrix of the symmetric unknown variables, for solving it we applied Cramer's rule; so the system solution (equations 26) is obtained as the following determinants ratio:

$$a_{Hn} = \Delta_a/\Delta, b_{Hn} = \Delta_b/\Delta, c_{Hn} = \Delta_c/\Delta \quad (27)$$

Where for the determinants $\Delta, \Delta_a, \Delta_b$ and $\Delta_c$ have been obtained, after elementary calculus, the next expressions (28) ÷ (31):

$$\Delta = \left(\frac{n}{n_0}\right)^3 \cdot \begin{bmatrix} \sum(Q_{0i})^4 & \sum(Q_{0i})^3 & \sum(Q_{0i})^2 \\ \sum(Q_{0i})^3 & \sum(Q_{0i})^2 & \sum(Q_{0i}) \\ \sum(Q_{0i})^2 & \sum(Q_{0i}) & N \end{bmatrix} = \left(\frac{n}{n_0}\right)^3 \cdot \Delta_1 \quad (28)$$

$$\Delta_a = \left(\frac{n}{n_0}\right)^3 \cdot \begin{bmatrix} \sum(Q_{0i})^2 H_{0i} & \sum(Q_{0i})^3 & \sum(Q_{0i})^2 \\ \sum(Q_{0i}) H_{0i} & \sum(Q_{0i})^2 & \sum(Q_{0i}) \\ \sum H_{0i} & \sum(Q_{0i}) & N \end{bmatrix} = \left(\frac{n}{n_0}\right)^3 \cdot \Delta_{1a} \quad (29)$$

$$\Delta_b = \left(\frac{n}{n_0}\right)^4 \cdot \begin{bmatrix} \sum(Q_{0i})^4 & \sum(Q_{0i})^2 H_{0i} & \sum(Q_{0i})^2 \\ \sum(Q_{0i})^3 & \sum(Q_{0i}) H_{0i} & \sum(Q_{0i}) \\ \sum(Q_{0i})^2 & \sum H_{0i} & N \end{bmatrix} = \left(\frac{n}{n_0}\right)^4 \cdot \Delta_{1b} \quad (30)$$

$$\Delta_c = \left(\frac{n}{n_0}\right)^5 \cdot \begin{bmatrix} \sum(Q_{0i})^4 & \sum(Q_{0i})^3 & \sum(Q_{0i})^2 H_{0i} \\ \sum(Q_{0i})^3 & \sum(Q_{0i})^2 & \sum(Q_{0i}) H_{0i} \\ \sum(Q_{0i})^2 & \sum(Q_{0i}) & \sum H_{0i} \end{bmatrix} = \left(\frac{n}{n_0}\right)^5 \cdot \Delta_{1c} \quad (31)$$

Introducing the expressions of determinants (28)÷(31) in solution (27), resulting (equations 32÷34):

$$a_{Hn} = \frac{(n/n_0)^3 \cdot \Delta_{1a}}{(n/n_0)^3 \cdot \Delta_1}, \; a_{Hn} = \frac{\Delta_{1a}}{\Delta_1} \quad (32)$$

$$b_{Hn} = \frac{(n/n_0)^4 \cdot \Delta_{1b}}{(n/n_0)^3 \cdot \Delta_1}, \; b_{Hn} = \left(\frac{n}{n_0}\right) \cdot \frac{\Delta_{1b}}{\Delta_1} \quad (33)$$

$$c_{Hn} = \frac{(n/n_0)^5 \cdot \Delta_{1c}}{(n/n_0)^3 \cdot \Delta_1}, \; c_{Hn} = \left(\frac{n}{n_0}\right)^2 \cdot \frac{\Delta_{1c}}{\Delta_1} \quad (34)$$

Introducing of solutions (32)÷(34) in (equation 18), the expression for the loading feature for variable rpm n gets:

$$H = f_{Hn}(Q,n) = \frac{\Delta_{1a}}{\Delta_1} \cdot Q^2 + \frac{\Delta_{1b}}{\Delta_1} \cdot \left(\frac{n}{n_0}\right) \cdot Q + \frac{\Delta_{1c}}{\Delta_1} \cdot \left(\frac{n}{n_0}\right)^2 \quad (35)$$

which is cited in the literature as (Alexandrescu A., 2004, Popescu St., 1993).:

$$H = A_0 \cdot n^2 + A_1 \cdot n \cdot Q + A_2 \cdot Q^2 \quad (36)$$

where:

$$A_0 = \frac{\Delta_{1c}}{\Delta_1 \cdot (n_0)^2}, A_1 = \frac{\Delta_{1b}}{\Delta_1 \cdot n_0}, A_2 = \frac{\Delta_{1a}}{\Delta_1} \quad (37)$$

In the particular case $n = n_0$, from (equations 32-34) resulting (equations 38÷39):

$$a_{H0} = \Delta_{1a}/\Delta_1, \; b_{H0} = \Delta_{1b}/\Delta_1, \; c_{H0} = \Delta_{1c}/\Delta_1 \quad (38)$$

and

$$a_{Hn} = a_{H0}, \; b_{Hn} = \left(\frac{n}{n_0}\right) \cdot b_{H0}, \; c_{Hn} = \left(\frac{n}{n_0}\right)^2 \cdot c_{H0} \quad (39)$$

With consideration of relations (37), expressions (36) for coefficients $A_0$, $A_1$ si $A_2$ become:

$$A_0 = \frac{1}{(n_0)^2} \cdot c_{H0}, A_1 = \frac{1}{n_0} \cdot b_{H0}, A_2 = a_{H0} \quad (40)$$

The (equation 35)- the loading feature for variable rpm n may be transcribed with this form (equation 41):

$$H = f_{Hn}(Q,n) = a_{H0} \cdot Q^2 + b_{H0} \cdot \left(\frac{n}{n_0}\right) \cdot Q + c_{H0} \cdot \left(\frac{n}{n_0}\right)^2 \quad (41)$$

The (equations 39-41) are available for all the methods (M.C.M.M.P., M.S.V.A.A., M.M-M) of statistic processing of the data (9) in order to determine the coefficients $a_{H0}$, $b_{H0}$ si $c_{H0}$.

The (equations 5÷7 and 36) are used for the determinations of the kinematic and energetic functional parameters of the turbopump, both at constant speed and variable speed.

## RESULTS AND DISCUSSIONS

The theoretic recitals from the previous paragraph where applied to the radial turbopump, with double flow NDS 250-200-510 with the rotor Φ 510 mm.

The set of *M* couplers of experimental data (8) were taken over from the characteristic curves provided from the pump provider and it was centralized in (*table 1).*

Table1

***M*=35 couplers values for operational parameters NDS_250_200_510, pump type at constant speed $n_0$=1450 r.p.m.**

| No. crt., *i* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| $Q_{0i}$,[m³/h] | 140.0 | 160.0 | 180.0 | 200.0 | 220.0 | 236.2 | 240.0 | 260.0 | 277.1 |
| $H_{0i}$, [m] | 95.18 | 95.00 | 94.95 | 94.76 | 94.63 | 94.42 | 94.29 | 94.08 | 93.66 |
| $N_{0i}$, [kWh] | 80.91 | 83.86 | 87.66 | 90.69 | 94.41 | 101.27 | 97.78 | 101.16 | 108.78 |
| $\eta_{0i}$, [%] | 42.33 | 46.67 | 50.21 | 53.79 | 56.73 | 60.00 | 59.58 | 62.21 | 65.00 |
| No. crt., *i* | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| $Q_{0i}$,[m³/h] | 280.0 | 300.0 | 310.4 | 320.0 | 340.0 | 360.0 | 365.9 | 380.0 | 388.1 |
| $H_{0i}$, [m] | 93.63 | 93.21 | 92.90 | 92.61 | 92.08 | 91.53 | 91.22 | 90.74 | 90.22 |
| $N_{0i}$, [kWh] | 104.95 | 108.75 | 112.22 | 111.28 | 114.23 | 118.88 | 121.24 | 121.83 | 123.88 |
| $\eta_{0i}$, [%] | 64.37 | 66.28 | 70.00 | 68.75 | 70.73 | 71.66 | 75.00 | 73.17 | 77.00 |
| No. crt., *i* | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| $Q_{0i}$,[m³/h] | 400.0 | 420.0 | 440.0 | 460.0 | 469.9 | 480.0 | 500.0 | 520.0 | 525.4 |
| $H_{0i}$, [m] | 89.85 | 88.90 | 87.70 | 86.70 | 85.99 | 85.54 | 84.07 | 82.49 | 82.07 |
| $N_{0i}$, [kWh] | 124.78 | 128.16 | 131.53 | 134.91 | 142.03 | 139.13 | 142.92 | 148.41 | 152.56 |
| $\eta_{0i}$, [%] | 74.45 | 75.51 | 76.23 | 76.71 | 77.5 | 76.76 | 76.66 | 75.61 | 77.00 |
| No. crt., *i* | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | - |
| $Q_{0i}$,[m³/h] | 540.0 | 543.0 | 560.0 | 580.0 | 600.0 | 620.0 | 640.0 | 660.0 | - |
| $H_{0i}$, [m] | 80.81 | 79.86 | 79.02 | 77.08 | 74.98 | 72.61 | 70.04 | 67.09 | - |
| $N_{0i}$, [kWh] | 154.31 | 157.50 | 159.80 | 165.28 | 171.19 | 177.94 | 185.11 | 192.28 | - |
| $\eta_{0i}$, [%] | 74.13 | 75.00 | 72.71 | 71.17 | 70.00 | 67.11 | 65.00 | 61.71 | - |

The values from (*table 1)* were used in the direct representation of the afferent experimental points of the work load characteristics, of the power of the pump NDS 250-2000-510, at the constant rpm $n_0$=1450 r.p.m. *(figure 1),* as well as the determination trough statistic processing of the values of the ecuations coefficients and values in *(table 2)* and accurate criteria $\sum|\delta_i|$.

The functions (7) and (16), with the coefficients present in( *table 2).*, were represented in (*figure 1).*

The afferent theoretical points of the functional characteristics present the same abscissa (the values of the flow $Q_{0i}$) as the experimental points, but they are displayed on the respective theoretical characteristics

The graphic representation from *(figure 1)* is useful in the correction of the possible errors which can appear at the taking over of the experimental data on the characteristic curves.

Table 2

**The functional coefficients characteristic of the pump NDS_250_200_510 type, at speed rpm $n_0$=1450 and to speed rpm n<n0.**

| | Characteristics | Coefficients | | 1 | 2 | 3 | 4 | 5 | $\sum\|\delta_i\|$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Head (5) | symbol | | $a_{H0}$ | $b_{H0}$ | $c_{H0}$ | - | - | |
| 2 | | value | *M.C.M.M.P.* | -1642.8038 | 184.9798 | 89.5700 | - | - | 11.55749 |
| 3 | | | *M.S.V.A.A.* | -1583.5742 | 176.4054 | 89.7636 | - | - | 10.69400 |
| 4 | Head (36) | symbol | | $A_0$ | $A_1$ | $A_2$ | - | - | - |
| 5 | | value | *M.C.M.M.P.* | 0.00004260 | 0.12757229 | -1642.8038 | - | - | 11.55749 |
| 6 | | | *M.S.V.A.A.* | 0.00004269 | 0.12165888 | -1583.5742 | - | - | 10.69400 |
| 7 | Yield (6) | symbol | | $a_{\eta 0}$ | $b_{\eta 0}$ | $c_{\eta 0}$ | - | - | - |
| 8 | | value | *M.C.M.M.P.* | -45.106036 | 11.444735 | 0.051541 | - | - | 0.19694 |
| 9 | | | *M.S.V.A.A.* | -43.914018 | 11.174156 | 0.065128 | - | - | 0.19230 |
| 10 | Power (7) | symbol | | $a_{N0}$ | $b_{N0}$ | $c_{N0}$ | $d_{N0}$ | $e_{N0}$ | - |
| 11 | | value | *M.C.M.M.P.* | 2055.48508 | 260.06881 | 71.14959 | - | - | 57.86085 |
| 12 | | | *M.S.V.A.A.* | 332.00733 | -36.93252 | -20.18118 | -0.2564697 | -0.001576 | 18.69305 |

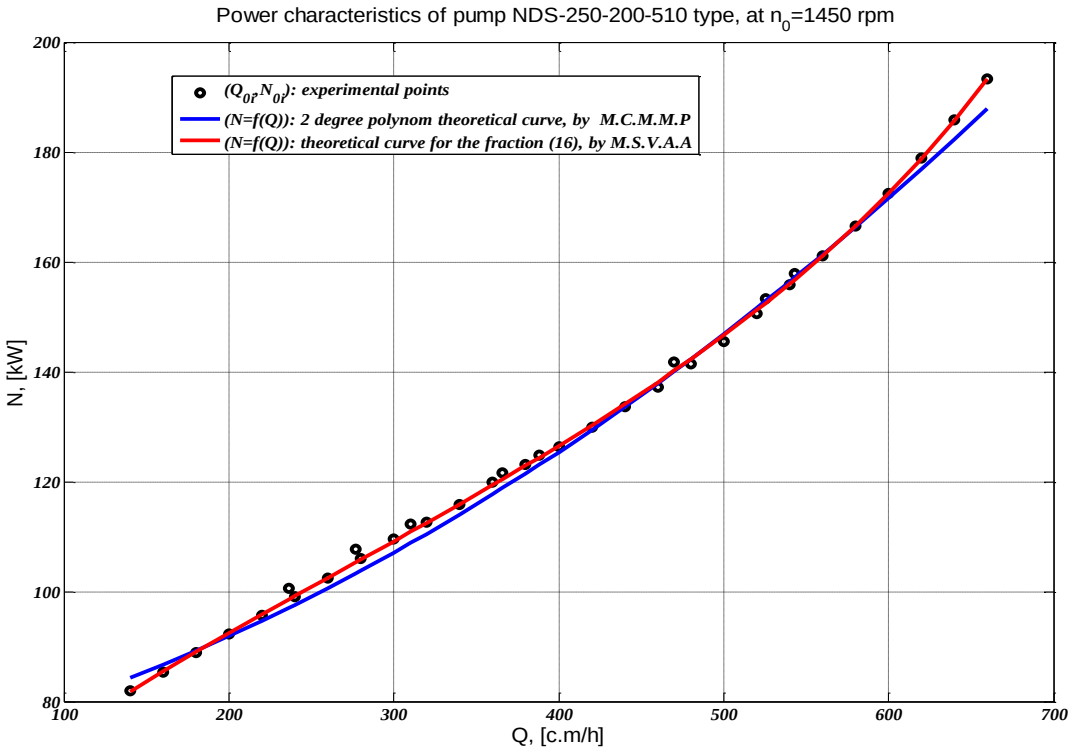


Figure 1 **Power characteristics of experimental and theoretical mission of pump type NDS-250-200-510, at speed $n_0$=1450 r.p.m**

## CONCLUSIONS

Analytical expressions of the variable load speed, deduced by theoretical manner imply the least squares method, which means that the coefficients of a constant speed pump drives in full compliance with similar expressions cited in specialized works.

The analytical expression for the variable speed coefficient values can be entered directly to the constant speed that is not only determined by M.C.M.M.P. but also by other processing methods statistics: M.S.V.A.A., M. M.- M. etc.

Approximate analytical expression for the functional power at constant speed by rational with 5 coefficients proposed in this paper ($\sum|\delta_i| = 18.69305$) is more accurate than second - degree polynomial function, as it is cited in the specialized literature ($\sum|\delta_i| = 57.86085$).

Among the methods of experimental data, the best results were achieved by M.S.V.A.A.

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# THE DYNAMICS OF SOIL MOISTURE AND THE CAPITALIZATION OF RAINFALL WATER BY MAIN FIELD CROPS ON A CLAYEY SOIL

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**Abstract**

The intensity of water uptake by plants depends, besides differences caused by species, crop kind, growing phases, the development of root and soil type, by agricultural practice. The present paper presents the dynamics of soil moisture in 2013-2014 agricultural years in relation with the technology that was applied with the following crops: wheat, corn, sunflower and pasture. After analyzing the evolution of soil moisture with the four crops, respectively 7 variants of soil moisture determination during 2014 year there could be observed soil moisture differences between applied technologies and between crops. For the analyzed area, respectively, on a levigated chernozem that was formed on clays, the capitalization of rainfall water is better by preparing the seedbed through plowing.

**Key words**: moisture, tillage, rainfall

During the last years the evolution of rainfall is changing such way the summers become drier and the meteorological extremes determine high yield losses. In order to diminish such phenomena the scientists research new technologies as well as their applying by farmers.

There are studies and researches on the ensuring of the water requirement for field crops and most of them show that the most important factor is the rainfall. This way, researches performed by Popescu C.V. (2001) in 1996-1998 period, by Pandrea R.C. (2012) in 2008-2010 with wheat, corn and sunflower crops in irrigated regime have shown that rainfall water is the major source of soil water and plant supplying, ranging between 50% to over 90%. There is clear that in order to use rainfall water efficiently there must be applied proper technologies that conduct to a better water keeping by soil, plant supplying by water and minimal evaporation from the soil.

Despite the fact that during previous years the plants suffered because of lack of water in the soil, the 2014 year was very rainy, the rainfall reaching 1,074 mm.

At the first sight these rainfall could be sufficient for the crops, especially wheat.

The main soil feature that influences the water regime is water permeability. in soils with good water permeability the water infiltrates and can be preserved by the soil on a thick depth (loamy soils) while the soils with low water permeability (clayey soils) the soil becomes waterlogged creating anaerobic conditions (Grumeza N., Klepş C., 2005).

## MATERIAL AND METHOD

The researching method consisted in the following the dynamics of soil moisture in 2014 for the main field crops in Braneasa zone, Serbanesti locality, District Olt, Romania.

There was determined the soil moisture on 0-20 cm for the following crops, as follows:

a) Wheat: Gr1 – four tillage by heavy disk harrow, heavy soil, loamy-clayey; the cropped surface was of 87 ha. The previous crop was corn. The seedbed preparation consisted of four tillage by disk harrow during the autumn, on 25th of September. Before last disk harrow tillage there was made the basis fertilization. The drilling was performed between 13-17 October 2013 at a 4-5 cm depth. The harvesting was made at a 14% moisture of the grains, between 8-13 July 2014 obtaining an average yield for all three crop kinds of 6 t/ha.

Gr2 – plowing at 22-25 cm depth plus two tillage by heavy disk harrow, heavy soil, loamy-clayey. The cropped surface was 75 ha. The previous crop was wheat. Between 29 July and 5 august 2013 the entire surface was plowed at a 22-25 depth. At 10-14 September there was made tillage by disk harrow. At 15 October 2013 there was performed the basis fertilization. Three days before drilling there was made one tillage by combinatory and the drilling was made between 29 October and 2 November 2013. The harvesting

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was made at a 14% moisture of grains, between 1-3 august 2014 with an yield of 6.5 t/ha.

b) Corn: Pb1 – plowed at 30 cm depth plus three tillage by combinator, heavy soil, loamy-clayey; cropped surface was of 80 ha. The plowing was made at 30 cm depth between 20-25 november 2013. The previous crop was corn. In the spring the soil was leveled and loosened. The seedbed preparation consisted of two tillage by combinator between 1-3 april 2014. The drilling started at 5 april 2014 with a density of 58,000 grains per hectare, at 70 cm between rows and at 7-8 cm depth. There was performed the preemergent herbicide applying. Because of waterlogging the entire surface was drilled again. The seedbed preparation was made by one tillage by combinator, at 23 april 2014. The drilling was made between 24-26 april 2014 with a plant density of 60,000 grains per hectare. At 20 may there was applied on row fertilization by 220 kg/ha urea and then the mechanical hoeing was made. The harvesting was made at 14 october 2014 obtaining an yield of 6.9 t/ha corn grains with 15% moisture.

Pb2 – plowing at 20-28 cm plus disk harrow and combinator, heavy soil, loamy-clayey. The cropped surface was of 40 ha. The previous crop was wheat. The plowing was performed at 25-28 cm between 28-31 july 2013. In the spring the soil was leveled, loosened yet with remnant wheat plants from fall. The seedbed preparation consisted of one tillage by disk harrow at 24 april 2014 and then a combinator tillage at 28 april 2014. The drilling was performed at between 3-5 may 2014 with a density of 58,000 grains/ha, at 70 cm between rows and 7-8 cm depth. Along with the drilling there was fertilized by 250 kg/ha nitrocalcar (lime mixed with ammonium nitrate). At 5 june 2014 there was performed the mechanical hoeing. Postemergently (3-4 leaves) there was applied the herbicide. The harvesting was performed mechanically at 20 november 2014 with an yield of 5 t/ha at 15.5 % moisture.

c) Sunflower: Fls 1 – plowing at 24-27 cm plus disk harrow and combinator, heavy soil, loamy-clayey. The cropped surface was of 25 ha. The previous crop was wheat. The plowing was performed at 24-27 cm between 5-10 august 2013. In the spring the soil was leveled and loosened yet with remnant wheat plants from fall. On the plowed soil there was applied basis fertilization by 150 kg NPK 18:46:0. The seedbed preparation was performed by disk harrow tillage at 15$^{th}$ of March 2014 and then, at 20th of March there was made tillage by combinator. The drilling was performed at 26-28 march 2014 with a density of 58,000 grains/ha, at 70 cm between rows and 4-5 cm depth. The herbicide was applied preemergently. Between 10-15 may 2014 there was performed the mechanical hoeing and there was fertilized by 250 kg/ha nitrocalcar.

Postemergently (6-7 leaves) there was applied herbicide Pulsar 1.2 l/ha. The harvesting started at 5 september 2014, at 9% moisture of sunflower kernels with an yield of 3.6 t/ha.

Fls 2 – plowing at 24-27 cm plus disk harrow and combinator. The cropped surface was of 20 ha. The previous crop was wheat. The plowing was performed at 24-27 cm between 5-10 august 2013. In the spring the soil was leveled and loosened yet with remnant wheat plants from fall. On the plowed soil there was applied basis fertilization by 150 kg NPK 18:46:0. The seedbed preparation was performed by disk harrow tillage at 10 april 2014 and then, at 15 april 2014 there was made a tillage by combinator. The drilling was performed at 26-28 april 2014 with a density of 58,000 grains/ha, at 70 cm between rows and 4-5 cm depth. The herbicide was applied preemergently. Between 10-15 june 2014 there was performed the mechanical hoeing and there was fertilised by 250 kg/ha nitrocalcar.

Postemergently (6-7 leaves) there was applied herbicide Pulsar 1.2 l/ha. The harvesting started at 12 october 2014, at 10.5 % moisture of sunflower kernels with an yield of 2.8 t/ha.

d) natural pasture – Paj.

The evolution of soil moisture was made by determining the actual soil moisture.

In order to analyze the soil moisture data there is need the knowing of climatic data from meteorological stations Caracal, District Olt and Stolnici, District Arges.

There were analyzed the meteorological data from the two stations because the researched area is between these two stations. There was observed that there no high differences as regard rainfall and temperatures between the two stations. In additions there were taken from Serbanesti hall the rainfall data of 2013-2014 year.

## RESULTS AND DISCUSSIONS

From meteorological data of Braneasa zone, District Olt (*table 1*) there can be noticed that the annual average temperature is 10.5ºC and for the vegetation period it is of 17.4ºC. The lowest average temperatures are recorded in January (-3.1ºC) and February (-0.8ºC) and the highest are recorded in July (22.8ºC) and August (22ºC). From the determinations of average multiannual values there can be noticed that there were recorded extreme values as well, both negative and positive.

The rainfall data during 2013 and 2014 there were taken from Serbanesti hall, District Olt, the multiannual average rainfall was taken from Caracal station, Distrct Olt.

As it can be seen, on the basis of data from 1.a. table, in 2014 the rainfall in Serbanesti – Tufeni area is almost double as compared with the multiannual average, being of 968 mm in 2014, as compared with 512.5 mm the multiannual average.

As regard the rainfall, the multiannual average sum 512.5 mm per year, respectively

326.6 mm within the vegetation period, the monthly repartition of them is being very different. During the vegetation period the rainfall are between 31.3 mm in Septembrie and 69.9 mm in June.

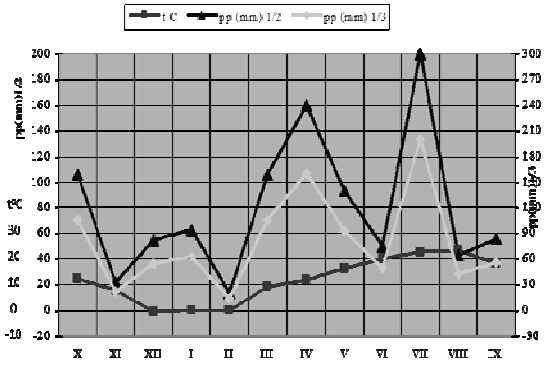


Figure 1 **Climogram for 2013-2014 agricultural year**

The 2013-2014 agricultural years can be characterized as excessively humid (*figure 1*). The average annual temperature was of 11.8ºC and during the vegetation period it was of 17.8ºC (*table 1*). Such way, there was recorded an accentuated warming as compared with the multiannual average. The spring, summer and autumn months of 2013-2014 year had almost equal temperatures with the multiannual ones yet for the winter months these were higher than the multiannual averages.

The rainfall recorded during 2013-2014 agricultural years were much over multiannual average, of 968 mm compared with 512.5 mm, even during the vegetation period (+316.6 mm). The distribution of rainfall during the vegetation period has been much higher compared with the multiannual average (*table 1*).

Table 1

**The average temperatures and rainfall during 2013-2014 agricultural year**

| Months | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brăneasa | X | XI | XII | I | II | III | IV | V | VI | VII | VIII | IX | Annual average | Vegetation period |
| Temperature (ºC) | | | | | | | | | | | | | | |
| 2013 - 2014 | 12.2 | 7.8 | -0.5 | 0.1 | 0.2 | 9.2 | 11.8 | 16.4 | 20 | 22.8 | 23.5 | 18.3 | 11.8 | 17.8 |
| Multiannual | 11.3 | 4.9 | -0.3 | -3.1 | -0.8 | 3.5 | 11.1 | 16.6 | 20.5 | 22.8 | 22 | 17.5 | 10.5 | 17.4 |
| Deviation | 0.9 | 2.9 | -0.2 | -3 | 1 | 5.7 | 0.7 | -0.2 | -0.5 | 0 | 1.5 | 0.8 | 1.3 | 0.4 |
| Rainfall (mm) | | | | | | | | | | | | | | |
| 2013 - 2014 | 106 | 22 | 55 | 63 | 14 | 106 | 160 | 93 | 50 | 200 | 43 | 56 | 968 | 708 |
| Multiannual | 41.2 | 47.3 | 38.3 | 37.8 | 31.5 | 31 | 40.9 | 63.6 | 69.9 | 43.1 | 36.6 | 31.3 | 512.5 | 326.6 |
| Deviation | 64.8 | -25.3 | 16.7 | 25.2 | -17.5 | 75 | 119.1 | 29.4 | -19.9 | 156.9 | 6.4 | 24.7 | 455.5 | 381.4 |

The soils from the studied area are typical for the zone – the levigated chernozem which was formed on clays and are less productive than the chernozem formed on loess material. This soil is acid and this was the reason for applying lime amendments. During rainfall this kind of soil does retain most of the water. Waterlogging condition determine anaerobic reaction within the soil and plants suffer after heavy rains during the summer while in drought conditions this soil cracks and plants, also, suffer.

In *figure 2* there can be observed that the soil moisture was lower around 29 may 2014 and this was the critical phase for winter wheat (blooming, fecundation and grain formation). After harvesting, there can be observed an increase of soil moisture with the winter wheat that was drilled in plowed soil in comparison with the one drilled in disk harrow basis tillage, proving a better water retention in these conditions.

The dynamics of soil moisture with corn crop (*figure 3*) there can be observed an increase of water uptake around 20$^{th}$ of August 2014, when there was recorded the final of the critical phase of corn grains formation yet the hottest period during the corn vegetation.

With the last soil sampling for moisture determination there was observed that with the Pb2 at 20th of November 2014 the amount of water consumption was higher than Pb1 which was taken at 14$^{th}$ of October 2014.

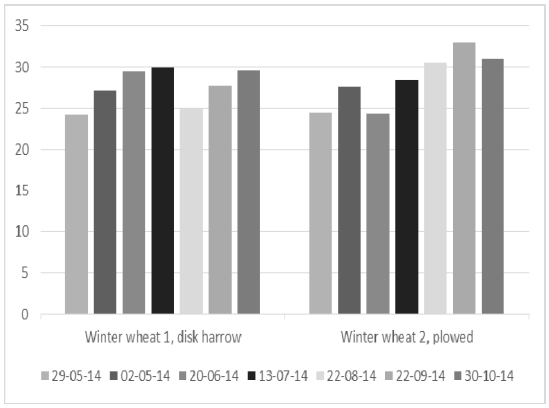


Figure 2 **Dynamics of soil moisture with winter wheat crop**

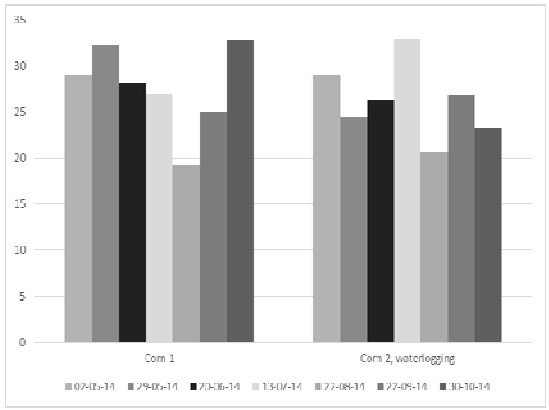


Figure 3 **Dynamics of soil moisture with corn crop**

With sunflower crop (*figure 4*) there can be observed that during the entire vegetation period the plants did not suffer yet around 29th of may 2014 in Fls1 and at 13th July in Fls 2 the soil moisture has increased a lot due to excessive rainfall.

With sunflower crop Fls 1 the soil moisture has decreased during the critical phase of grain formation and this period overlap on the hottest month of the vegetation period.

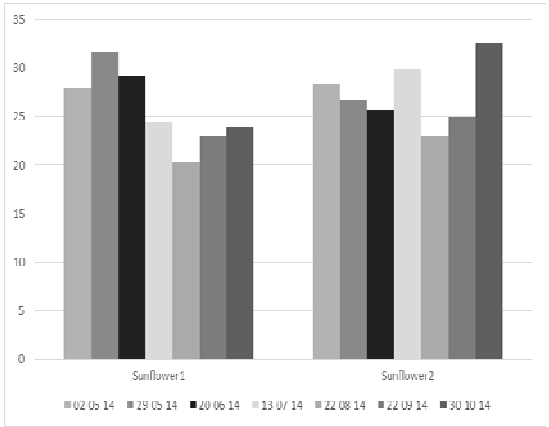


Figure 4 **Dynamics of soil moisture with sunflower**

As regard the dynamics of soil moisture on pasture there can be observed that it complies with the rainfall as well as with the air temperatures.

It is interesting that the lowest values of the soil moisture has been recorded at 22 august and 22 September 2014 on pasture, respectively, 19.77 % and 20.03% as compared with the soil moistures in the other field crops. This fact is due to high air temperatures during august and, especially, September 2014 (*figure 5*).

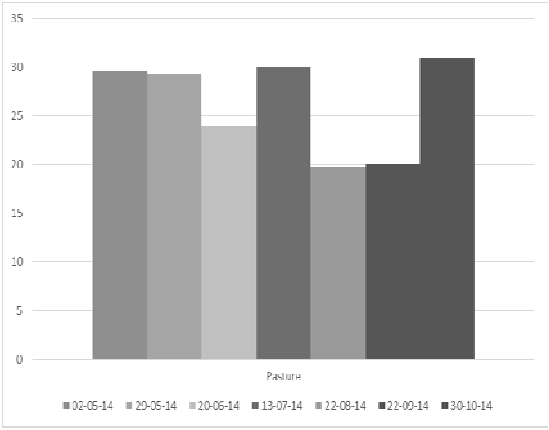


Figure 5 **Dynamics of soil moisture with pasture**

The analysis of the dynamics of soil moisture with four researched crops (table 2 and figure 6) and 7 variants of soil moisture determination, during 2014 reveals the following aspects:

- at the beginning of the vegetation period, when first determination was made, at 2.05.2014, there can be observed that the soil water reserve is close for all 7 soil samples being sufficient and normal for this period;

- with the second determination, at 29.05.2014 there appear differences with crops. With winter wheat crop that was, at this date, at the highest water consumption phase, the lowest soil moisture (24.19% and 24.41%) as compared with the other crops: 32.21% - Pb 1; 31.68% - Fls 1; 29.34% - Paj. The Pb 2 (24.46%) and Fls 2 (26.67%) variants have lower moisture due to the fact that these crops have been drilled much earlier in comparison with Pb1 and Fls 1 and they were much developed and their water consumption was higher;

- with the determination from 20.06 it has to be emphasized the fact that there was recorded a difference between the two winter wheat variants Gr1 (disk harrow) = 29.43% and Gr 2 (plowed) = 24.32% and, in the same time, the yield difference: Gr 1 = 6000 kg/ha, Gr 2 = 6500 kg/ha. This difference is the result of better water supplying.

- at 13.07, after rains, almost all variants recorded high moisture content except Pb1 and Fls

1 which recorded lower values of soil moisture till harvesting as compared with the other variants which proves a better water use and higher yields in comparison with Pb2 and Fls 2.

- the determinations after wheat harvesting indicate that the winter wheat plowed plot (Gr2) has stored more water in comparison with the winter wheat plot that was worked with the disk harrow as basis tillage. This fact proves better results with the plowing rather than disk harrowing as basis tillage for the winter wheat in this region.

Table 2

**The comparative analysis of soil moisture (%) for researched crops**

| Date | Winter wheat 1, disk harrow | Winter wheat 2, plowed | Corn 1 | Corn 2, waterlogging | Sunflower 1 | Sunflower 2 | Pasture | Rainfall Şerbăneşti (mm) |
|---|---|---|---|---|---|---|---|---|
| 2.05.2014 | 27.15 | 27.61 | 29.02 | 28.94 | 27.98 | 28.37 | 29.57 | 160 |
| 29.05.2014 | 24.19 | 24.41 | 32.21 | 24.46 | 31.68 | 26.67 | 29.24 | 93 |
| 20.06.2014 | 29.43 | 24.32 | 28.14 | 26.38 | 29.22 | 25.71 | 24.01 | 50 |
| 13.07.2014 | 29.98 | 28.41 | 26.97 | 32.87 | 24.42 | 29.89 | 30.04 | 200 |
| 22.08.2014 | 24.89 | 30.56 | 19.25 | 20.64 | 20.33 | 23.05 | 19.77 | 43 |
| 22.09.2014 | 27.73 | 32.91 | 25.07 | 26.82 | 22.94 | 24.96 | 20.03 | 56 |
| 30.10.2014 | 29.58 | 31.03 | 32.78 | 23.34 | 23.87 | 32.58 | 31.01 | 54 |

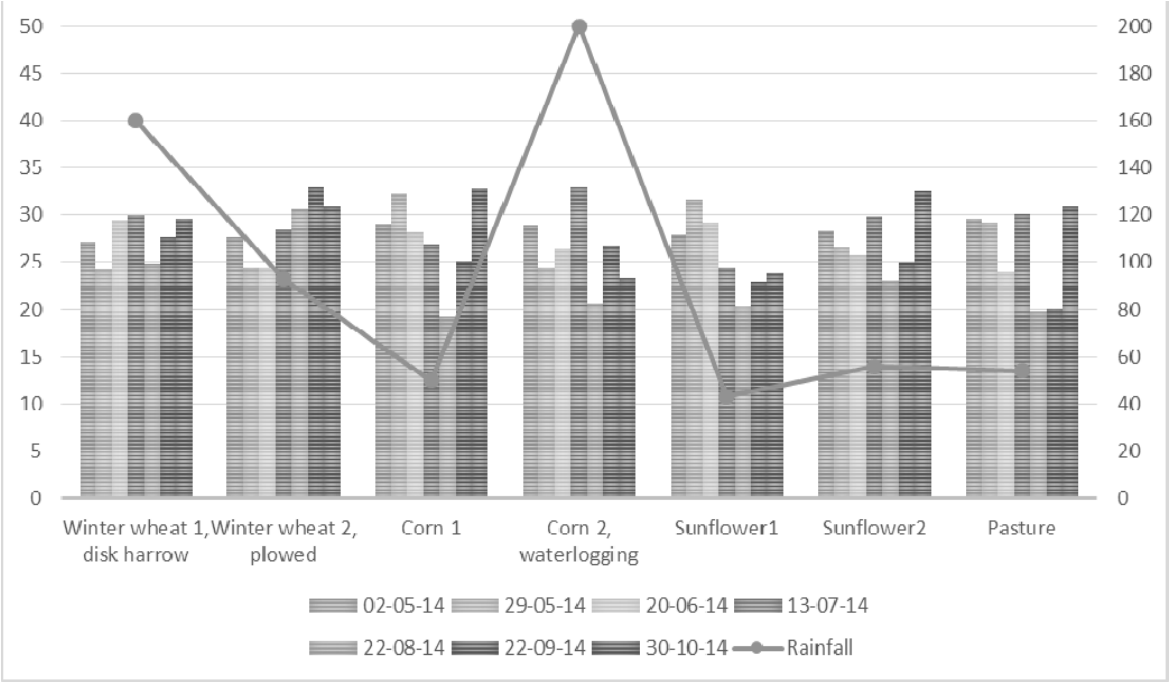


Figure 6 **Dynamics of soil moisture in function of rainfall**

## CONCLUSIONS

The 2014 researching year can be characterized as an excessively humid and hot, recording rainfall of 1,074 mm and, during the vegetation period, approximately 708 mm.

The annual average temperature was of 11.8ºC and, during the vegetation period, of 17.8ºC.

Both rainfall and temperatures that were recorded within the researched area have overpassed the average multiannual values. There was recorded a plus of 455.5 mm rainfall and plus 1.3ºC temperature.

For the analyzed zone, on a clayey soil, the abundant rainfall determines difficulties in doing tillage and hoeing.

High rainfall yet uneven during the vegetation period determine a bad utilization of water by field crops. In order to avoid such situations there has to be identified the most appropriate tillage that determine the best water retention by soil.

For the winter wheat crop within the ear unfolding period till the end of grain formation there were recorded lots of rainfall (1 may-1 june), about 160 liter/$m^2$ which satisfied entirely the crop requirements for water and recording very good yields for this zone.

From the soil moisture data as well as from yield results we can conclude that the best option is to drill winter wheat in plowed land.

Considering the highest water consumption for the sunflower crop in $20^{th}$ of June – $10^{th}$ of August period and analyzing the rainfall within this period, we can conclude that this crop did not suffer being recorded best condition for plant development.

With the case of corn crop, during the critical phase of ear appearing till the end of grain formation (20 July – 25 August) the rainfall have been of approximately 100-150 liters/$m^2$ but the previous rainfall and the even terrain form determined soil waterlogging conditions with Pb2 variant and this fact determined high yield losses.

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# SOIL HEALTH ISSUES OF ARABLE TYPICAL CHERNOZEMS OF MOLDOVA

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**Abstract**

Involvement of soils in agriculture is always associated with changes in natural factors of soil formation and their combination with a complex of agricultural factors. This phenomenon leads to changes, as a rule in the negative direction, in the soil health.

The research was conducted on arable typical chernozems in the North of Moldova. It was established a decline of structure quality in the arable soil in comparison with the grass fallow variant. The content of blocky elements is within 40-60%. The decline in soil structure led to the loss of soil resistance to compaction in the arable layer. The bulk density of recently plowed layer varies between 1.20-1.35 g/cm$^3$, while of the former arable layer is 1.40-1.50 g/cm$^3$. It is clearly pronounced the process of humus loss in the arable chernozems. The average humus content in the layer 0-25 cm reduced by 2.03-2.20% or 33-35 percent in comparison with the soil under grass fallow. As a negative phenomenon was recorded a significant decrease in reserves of nutrients in the soil.

**Key words**: soil structure, humus content, bulk density, soil health

Involvement of soils in agriculture led to significant changes in soil properties. Arable horizon is the most affected by anthropic actions and reflects better all new factors and processes.

Under the influence of agricultural complex of factors has taken place change and combination of elementary soil formation processes: new processes occured, the existing ones were modified, and some were inherited from natural phase of development. New combination of elementary processes in arable soils has been called "contemporary process of soil formation" (Никитин Б.А., 1988). This process has specific characters that take place in all types of soils: the process of accumulation of organic matter slows down; the process of humus formation and accumulation is modified due to different chemical composition of organic residues of crops in comparison with natural vegetation; the amount of nutritive elements removed from soil is much higher than the one remained with organic residues; in arable soils used without application of organic fertilizers or in case of their application in insufficient quantities takes place decrease of humus in the arable layer (Жигэу Г.В., 2008).

At the initial stage the involvement of chernozems into agriculture is associated with the structural-functional reorganization of systems of biogeocenosis. In the result of anthropogenic actions the fallow layer is destroyed and the quantity of organic matter in soil diminishes rapidly (Щеглов Д.И., Брехова Л.И., 2003). So, the maximum quantities of humus are mineralized in the first years of use in agriculture (Albrecht W.A., 1938). The above mentioned changes are located in the upper part of soil profile but further they spread in depth, covering almost the whole profile (Щеглов Д.И., 2003).

Physical properties of chernozems are most exposed to changes under the influence of anthropogenic action. Anthropization of soil formation process has the following basic effects: increasing the bulk density of the soil and structural aggregates; loss of soil structure and crust formation; layering of the soil profile (Жигэу Г.В., 2008).

Soil compaction and losses of humus and structure are interdependent factors of soil degradation. Deterioration of structure and compaction of soils extends over the entire arable land and is conditioned by mechanical destruction of soil structure during circulation of agricultural machinery, grazing and decomposition under the action of microorganisms of humus – the main binder of aggregates (Cerbari V., 2008).

Chernozems are the most widespread and most fertile soils in Moldova, forms and intensity of soil degradation of this soil type it is necessary to study in detail first of all.

The research aim is to assess the qualitative and quantitative changes in typical chernozems under the influence of anthropogenic factor.

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## MATERIAL AND METHOD

The research was conducted in the North of Moldova. The objects of study were typical chernozems used in agriculture for at least 100 years. In order to track changes in soil health induced by human factor we had to compare arable soils with a soil etalon. Taking into account that all soils from the territory of Moldova are presently exploited, most of them were ploughed and involved in agriculture and it is impossible to find an intact chernozem in natural state, we compared arable soils with relative etalons - typical chernozems under grass fallow.

In the research were studied two pairs of soils. One pair was selected on experimental fields of Institute of Practical Science Phytotechny (IPSP), Balti municipality. Here it was studied an arable loamy-clayey typical chernozem, that was compared with a former arable 60 years under grass fallow loamy-clayey typical chernozem. Another pair of soils was found in Rascani district. Here we studied an arable loamy-clayey typical chernozem from the arable lands of Grinauti village. The arable chernozem was compared with a loamy-clayey typical chernozem 60 years under grass fallow from the former field aeroport, east of Drochia city.

In the laboratory were made the next soil analysis: particle-size analysis by pipette method with preparation of soil by Kacinschi method (Вадюнина А.Ф., Корчагина З.А., 1986); hygroscopic coefficient by Nicolaev method (Васильев А.М., 1952); particle density by pycnometer method (Астапов С.В., 1958); soil bulk density by the core method; total porosity by calculation (Вадюнина А.Ф., Корчагина З.А., 1986); compaction degree by calculation (Canarache A., 1990); soil reaction by the potentiometric method; hydrolytic acidity by Kappen method; carbonates by the gasometrical method; total phosphorus by Ginzburg method; humus by Tiurin method (Соколов А.В., 1975); total nitrogen by Kielidali method; mobile phosphorus by Macighin method (Аринушкина Е.В., 1970); mobile potassium by the flame photometric method by Macighin (Соколов А.В., 1975).

## RESULTS AND DISCUSSIONS

It is known that clayey or loamy soils have an optimal structural state at the presence of 70-80% of agronomic valuable aggregates (10-0.25 mm) in soil structure.

The results of dry sieving analysis revealed that soil structure of chernozems under grass fallow is excellent, with predominance of aggregates with size 1-5 mm. Sum of agronomic valuable aggregates is high – 94-87% *(figure 1)*.

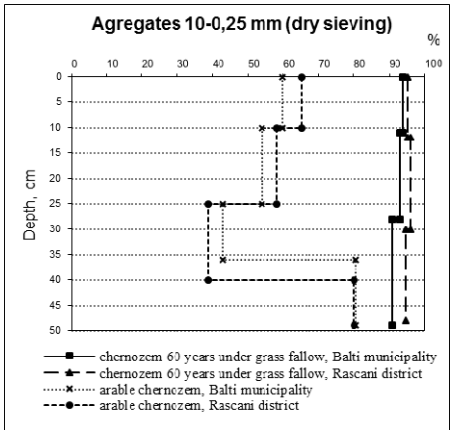


Figure 1 **Sum of agronomic favorable aggregates 10-0.25 mm, dry sieving**

Such structural elements unfavorable for plant growing as clods (>10 mm) and dust (<0.25 mm) makes only 3-10% and 1-4% respectively.

Contrary results were obtained in the case of arable chernozems. Because of intensive use these soils lost natural granular structure. Now the arable layer is highly pulverized that contributed to formation of numerous clods. Structural elements are prismatic or nutty, extremely compacted. In the arable layer (0-25 cm) of chernozems prevail clods – 40-60% *(figure 2)*.

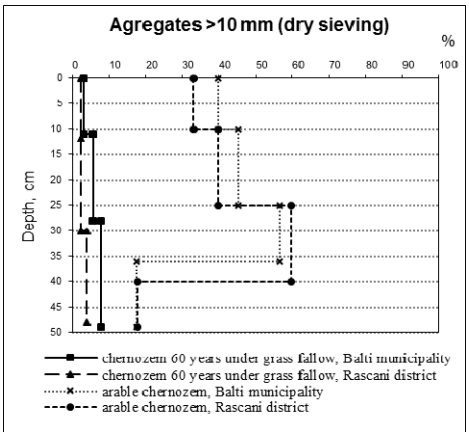


Figure 2 **Aggregates >10 mm, dry sieving**

The next layer (25-35 cm) is characterized by almost monolithic structure. This layer hadn't been worked since '90 years, but it is very compacted because of degraded soil structure as a result of humus loss.

Aggregates hidrostability of chernozems under grass fallow is very high in all studied soil layers. Sum of agronomical favorable aggregates is between 82-94% *(figure 3)*.

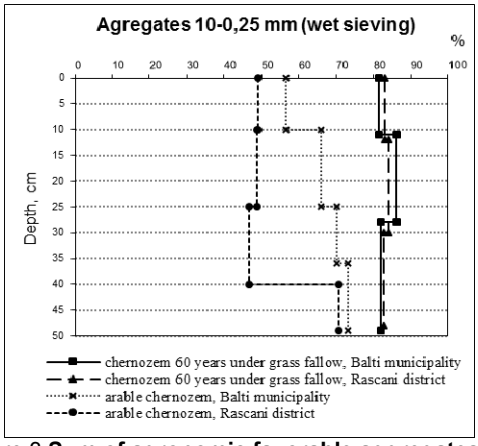


Figure 3 **Sum of agronomic favorable aggregates 10-0.25 mm, wet sieving**

Arable soils near Balti municipality showed an apparently good hydrostability due to strong compaction of aggregates. However the share of fraction <0.25 mm is big enough and makes up 27-53% *(figure 4)*.

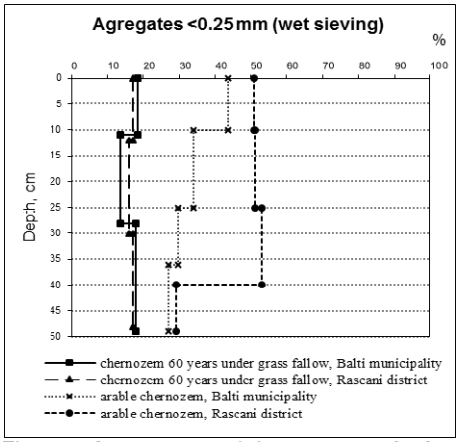


Figure 4 **Aggregates <0.25 mm, wet sieving**

Arable soils from Rascani district have medium hidrostability, which indicates degradation of soil structure. As a result, there is danger of soil compaction and crust formation after rainfall.

As it can be noticed from the *table 1*, bulk density values of arable chernozems are between 1.19-1.34 g/cm$^3$ in ploughed layers 0-10 cm and 10-25 cm. The next layer is strong compacted. Its bulk density values of 1.41-1.46 g/cm$^3$ indicates soil degradation. Bulk density values of Ahţ and Ah horizons of fallow soils are optimal - 1.16-1.35 g/cm$^3$.

The upper 0-10 cm layer of arable soil is loose because it is worked during the growing season, total porosity has medium values. The layer 10-25 cm is more compacted, total porosity is low. The layer 25-35 cm is very compacted with a very low total porosity. Fallow soils are loose and have optimal values of total porosity *(table 1)*.

Because of the use in agriculture essential changes occurred in chemical characteristics of typical chernozems (*table 2*).

There is an increase in the acidity of arable soils – phenomena characteristic for chernozems typical used in agriculture.

The average humus content in arable layers of soils used in agriculture is moderate (4.05-3.81%). Typical chernozems under grass fallow are characterized with high humus content in Ahţ1 horizon, high in Ahţ2 horizon and optimal in Ah horizon. The average humus content in arable soils decreased by 2.24-2.38% of humus in the layer 0-25 cm and 1.65-1.76% of humus in the layer 0-50 cm. Humus losses were respectively 36-37 and 31-32 percent of its initial amount.

Table 1

**Analytical data of physical features of chernozems from the North of Moldova**

| Soil horizon | Depth, cm | Fraction, % <0,01 | Fraction, % <0,001 | Hygroscopic coefficient | Particle density, g/cm$^3$ | Bulk density, g/cm$^3$ | Total porosity, % | Compaction degree |
|---|---|---|---|---|---|---|---|---|
| Arable loamy-clayey typical chernozem, experimental fields of IPSP | | | | | | | | |
| Ahp1 | 0-10 | 62.1 | 39.0 | 7.1 | 2.62 | 1.19 | 54.7 | -4 |
| Ahp1 | 10-25 | 62.6 | 38.6 | 7.1 | 2.62 | 1.34 | 48.9 | 7 |
| Ahp2 | 25-36 | 62.5 | 38.9 | 6.9 | 2.63 | 1.46 | 44.4 | 16 |
| Ah | 36-49 | 62.3 | 38.9 | 6.8 | 2.65 | 1.41 | 47.0 | 11 |
| Loamy-clayey typical chernozem 60 years under grass fallow, experimental fields of IPSP | | | | | | | | |
| Ahpţ1 | 0-11 | 61.2 | 37.1 | 8.0 | 2.62 | 1.16 | 55.6 | -6 |
| Ahpţ2 | 11-28 | 61.8 | 38.7 | 7.8 | 2.63 | 1.29 | 50.7 | 3 |
| Ah | 28-48 | 61.8 | 39.2 | 7.8 | 2.65 | 1.35 | 49.0 | 7 |
| Arable loamy-clayey typical chernozem, Grinauti village, Rascani district | | | | | | | | |
| Ahp1 | 0-10 | 63.3 | 38.3 | 7.8 | 2.62 | 1.21 | 54.0 | -2 |
| Ahp1 | 10-25 | 63.3 | 38.3 | 7.8 | 2.62 | 1.31 | 50.1 | 5 |
| Ahp2 | 25-40 | 63.3 | 38.3 | 7.8 | 2.63 | 1.41 | 46.3 | 12 |
| Ah | 40-49 | 63.1 | 38.0 | 7.7 | 2.69 | 1.39 | 48.2 | 9 |
| Loamy-clayey typical chernozem 60 years under grass fallow, near Drochia city | | | | | | | | |
| Ahţ1 | 0-10 | 60.7 | 36.5 | 8.7 | 2.61 | 1.22 | 53.1 | -4 |
| Ahţ2 | 10-25 | 61.5 | 36.3 | 8.5 | 2.62 | 1.30 | 50.4 | 1 |
| Ah | 25-40 | 62.1 | 36.1 | 8.3 | 2.65 | 1.36 | 48.5 | 5 |

Table 2

**Analytical data of chemical features of chernozems from the North of Moldova**

| Soil horizon | Depth, cm | pH | Hydrolytic acidity | $CaCO_3$, % | Total $P_2O_5$,% | Humus, % | Total N, % | C:N | Mobile $P_2O_5$, mg/100 g soil | Mobile $K_2O$, mg/100 g soil |
|---|---|---|---|---|---|---|---|---|---|---|
| Arable loamy-clayey typical chernozem, experimental fields of IPSP | | | | | | | | | | |
| Ahp1 | 0-25 | 6.3 | 2.4 | 0 | 0.13 | 4.03 | 0.216 | 10.9 | 2.0 | 32.6 |
| Ahp2 | 25-36 | 6.4 | 2.3 | 0 | 0.12 | 3.81 | 0.205 | 10.8 | 1.4 | 23.1 |
| Ah | 36-49 | 6.5 | 1.7 | 0 | 0.10 | 3.01 | 0.172 | 10.1 | 0.9 | 17.5 |
| Loamy-clayey typical chernozem 60 years under grass fallow, experimental fields of IPSP | | | | | | | | | | |
| Ahpţ1 | 0-11 | 6.8 | 1.8 | 0 | 0.16 | 6.70 | 0.320 | 12.2 | 3.0 | 60.0 |
| Ahpţ2 | 11-28 | 6.7 | 1.9 | 0 | 0.13 | 5.94 | 0.290 | 11.9 | 2.1 | 35.6 |
| Ah | 28-48 | 6.8 | 1.7 | 0 | 0.11 | 4.23 | 0.220 | 11.4 | 1.0 | 18.8 |
| Arable loamy-clayey typical chernozem, Grinauti village, Rascani district | | | | | | | | | | |
| Ahp1 | 0-25 | 6.3 | 2.4 | 0 | 0.14 | 4.05 | 0.193 | 12.2 | 1.3 | 30.0 |
| Ahp2 | 25-40 | 6.3 | 2.3 | 0 | 0.13 | 3.94 | 0.188 | 12.1 | 1.2 | 25.0 |
| Ah | 40-49 | 6.5 | 2.0 | 0 | 0.12 | 3.25 | 0.159 | 11.9 | 0.9 | 18.0 |
| Loamy-clayey typical chernozem 60 years under grass fallow, near Drochia city | | | | | | | | | | |
| Ahţ1 | 0-10 | 6.7 | 2.0 | 0 | 0.18 | 7.55 | 0.389 | 11.5 | 2.5 | 49.2 |
| Ahţ2 | 10-25 | 6.8 | 1.7 | 0 | 0.16 | 5.68 | 0.293 | 11.3 | 1.6 | 26.4 |
| Ah | 25-50 | 7.0 | 1.0 | 0 | 0.13 | 4.77 | 0.243 | 11.1 | 0.9 | 17.8 |

Investigated typical chernozems are formed on loess deposits low in phosphorus (0.08-0.06%). There is a bioaccumulation of phosphorus in the soils under grass fallow in Ahţ1 horizons (0.16-0.18%). Total phosphorus content in arable soils is smaller and constitutes 0.13-0.14% upper layer.

Typical chernozems under grass fallow are characterized by moderate content of mobile forms of phosphorus in upper horizons. Arable chernozems have low content of this element.

Soils under grass fallow are characterized by high content of mobile forms of potassium in Ahţ1 horizon, high in Ahţ2 and moderate in Ah horizon.

Content of mobile forms of potassium in arable soils is high in the horizon Ahp1, optimal in Ahp2 horizon and moderate in Ah horizon.

## CONCLUSIONS

The main soil health issues of the studied arable typical chernozems are decline of soil structure quality, negative humus balance and significant decrease in reserves of nutrients. Degradation of structure is caused by low humus content and intensive work with heavy machinery. The decrease in reserves of nutrients in the soil is the result of prolonged use of soils in farming without organic fertilizing of soils.

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# SOIL EROSION AND ITS EFFECTS FROM THE REGION OF THE NEGREA VILLAGE

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**Abstract**

This article shows that the effects of the erosion process on soil characteristics in the investigated region of the Negrea village are varied. It is known that soil erosion is a complex phenomenon, highly spread in various forms. The purposes our researches consist in appreciation of the situation of the danger of erosion in the investigated region and recommend appropriate measures to diminish the negative consequences. The execution of the works on researched territory should be made on the basis of sound scientific projects. Erosion measures of researched soil will be planned within a crop rotation – an elementary necessity of agricultural lands. All humanity must be informed that a centimeter of soil is formed in the best condition of management on a the rock of loess in about 12 years, in terms of agricultural practices normal in about 40 years, and in a somewhat normal (natural) situation soil formation it may take some from 200 to 1000 years. The soil cover in the village Negrea consists of ordinary chernozems of various degrees of erosion and delluvial soils. Methods of conducting of pedological researches in the field and of laboratory testing included: - detailed the soil cover mapping at 1:5000 according to the instructions in force; - location and morphological description of soil profiles, determining morphometric indices of soils, collecting samples of soil for laboratory analysis; - determining the degree of soil erosion degraded of the village Negrea region based on data summary the thickness of humiferous profile with humus content greater than of 1.00%, etc.

**Key words**: agrosistem, crop rotation, landscape, soil erosion, Negrea village

Motto: ”*The soil as a limited resource - is one of the most valuable objects indispensable of humanity.* ” Jean Dorst.

Soil is a complex system within which it carries out a set of processes of transformation and transfer of substances and energy. Most soils reduce their year after year production capacity lose their nutritional elements and organic matter a higher proportion than takes place the process to complete them, which eventually leads to their depletion.

The erosion is the process of detachment and transport of material from the soil surface driven process and influenced by a number of agents and erosive factors. By erosion the soil loses it’s, usually, fertile horizon or loses and the other horizons, suffering a partial or total destruction, with serious implications for its fertility.

Detachment and transportation of material from the surface of the soil on sloping lands are due the greatest extent to water, as in the form of rain drops as well as in the form of dispersed or concentrated currents (Newsletter of ecopedologic monitoring, 1996; Neamtu T., 1996).

Extremely numerous investigations made in this direction have established the degree of change through erosion of the main physico-chemical and hydrophysical indicators of the soil (Voloshchuk M.D., 1978; Zaslavsky M.N., 1966; Sobolev S.S., 1961).

Also the soil is considered as natural resource basic of any agricultural system effectively, productively and sustainably, while being limited and more complex than air and water, representing the essential life support (Berca M., 2008). Throughout time the concept of soil and its functions evolved. Soil properties may evolve over time under the influence of climatic, biological and anthropogenic factors (Florea N., 2003).

Environmental protection in our country represent a matter of national interest in order to preserve the ecological balance, maintain and improve the quality of natural factors, to ensure conditions of living and working ever better present and future generations. Unfortunately, after application of the *Land Law no.18/1991*, returning to the traditional culture in the direction of hill-valley as well as continuous fragmentation of lands has fostered an acceleration of soil erosion.

Most often due to soil erosion, there is a redistribution of the fertile upper horizons of soils

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towards lower areas, having serious consequences on agricultural productivity. Whether the majority of lands located on the hills or on the slopes are affected by surface erosion, on base of the slopes were formed a series of *colluvial* deposits. Most often the transition from the surface of the slopes from the *alluvial* plains is not suddenly, but by means of a connection surface called glacis that have a spread almost generalized.

Preservation and maintenance of natural soil fertility have been and are supported and promoted by researchers and practitioners concidering the current requirements for sustainable agriculture. Deposition sedimentary material (*loess*) held in the meadow area and river terrace (Cerbari V.V. *et al*, 1994, 2010; Ursu A., 2011; Gennadiev A.N. *et al*, 2002).

The erosion of the widespread of soils, such as has been mentioned, is the second peculiarity of the hilly area on the left side of Prut.

Further we present the analysis of information published concerning history of the problem of soils erosion, classification of eroded soils, drawing up anti-erosion measures and diminishing negative consequences (Newsletter of ecopedologic monitoring., 1996). It should be emphasized that any eroded soil is the result of a balance between the pedogenesis permanent process and it's of physical deterioration process by erosion (Cojocaru O.I., 2015). In the case of fallow lands, denudation processes (natural or geological erosion) resulting slow (Cerbari V.V. et al, 2010; Cojocaru O.I., 2014, 2015; Ursu A., 2011) and is formed soils of various degrees of evolving.

## MATERIAL AND METHOD

Soil erosion is a complex phenomenon of destruction and removal of soil and is produced by water that is leaking or the wind. Soil erosion (erosion accelerated) is linked to the anthropogenic factor influence on land fund and now has become the main process of deterioration, degradation and desertification of agricultural lands (Berca M., 2008; Florea N., 2003; Neamtu T., 1996; Soil-forming processes, 2006; Soil processes and spatio-temporal organization of soils, 2006).

The main cause of the spread of large-scale of soil erosion in Republic of Moldova also refers to of region of Prut (Cerbari V.V. *et al*, 2010; Cojocaru O.I., 2014, 2015).

Among those mentioned:

- excessive capitalizing of lands with the inclusion of as arable those with high degree of inclination;
- increased share of hoeing agricultural crops on slopes;
- terraced condition of steep slopes without consideration of the geological and lithology structure of the territory;
- soil tillage and conduct of the technological operations of cultivation of agricultural crops with severe deviations from the general direction of contours;
- the lack of the simplest of erosion control agro- and phytotechnical measures on slopes.

## RESULTS AND DISCUSSIONS

Erosion caused by water is manifested on lands situated on the slopes. Surface leakage on the slope, precipitation water, washed soil in its path and carrying it.

At the core of the fight against erosion must be made mandatory"ecologic limit of the territory" that characterize the limit of the environment auto-generation. The first scholar to shown the existence of eroded soils was the founder of soil science, the renowned Russian scientist Dokuceaev V.V. (Fedotov V.S., 1980; Constantinov I.S., 1987).

The contemporary's researchers of the erosion processes (*Tables 1 and 2*) the Republic of Moldova territory that developed complex anti-erosion measures were: Zaslavskii M.M., Fedotov V.S., Constantinov I.S., Voloşciuk M.D. and others.

Majority of the researchers of the erosion processes were of the opinion that the materials pediology large-scale and detailed of soil coverage local reception basin forms the basis of initial information necessary for successful designing and implementing of complex measures to combat erosion in the case these units of land (Cojocaru O.I., 2015; Florea N., 2003; Neamtu T., 1996; Voloşciuk M.D., 1978).

Table 1

**The classification eroded rich chernozems, under Sobolev S.S. (Sobolev S.S., 1961)**

| The degree of soil erosion | Diagnostic criteria |
|---|---|
| weakly | is washed up to 50 % of the A horizon |
| moderately | is washed more than 50 % or the entire A horizon |
| strongly | is washed partly or wholly B horizon |

Table 2

**The classification the Moldovan rich chernozems, by the degree of erosion, under Zaslavskii M.N. (Zaslavskii M.N., 1966)**

| The degree of soil erosion | The color of the surface horizon | The degree of erosion of genetic horizons | Decreasing the thickness of humus generating profile,% | Decreasing the reserve of humus in the layer 0-50 cm, % |
|---|---|---|---|---|
| weakly | very weak light | less than 50 % of A horizon | less than 30 | less than 20 |
| moderately | moderately light | more than 50 % or the entire A horizon | 30 - 60 | 20 - 50 |
| strongly | light | partially or entirely B horizon | more than 60 | more than 50 |

Over time, damaged lands become sterile, ridden by wheel track cutting and ravines and are therefore removed from agricultural use. The main factors that favor erosion by water are: the relief, precipitations, rocks, vegetation, living organisms, how to use of lands.

*Relief*. The higher the relief is tilted, the faster the water flows and the erosion is stronger, as the length of the slope is greater the more water are gathered from rainfall and therefore its force of destruction is higher. Located on the northern slopes of the hills being less sunny are moistened even more of grass silage and therefore more preserved from erosion than those exposed to the south which furthermore acting and spring runoff caused the from the melting of faster snows.

*Rain fall*. It is a stable aggregate structure and is looser, allowing water infiltration and hence flow on slopes is reduced. On the contrary, soils without structure and less permeable are more easily eroded by water that drains. The rocks as are softer, they cedes to grinding and are therefore faster eroded.

*Vegetation* has an important role in soil protection. The leaves stop water droplets as they do not directly smash the soil; the stems are like obstacles to the water, decreasing the flow velocity and as a result water has more time to infiltrate into the soil; roots fixed the soil and the erosion is reduced. As the vegetation is more concluded with the so much the erosion is reduced.

The way the *land is used* capable of favoring or impede the process of erosion. For example where the soil works are made the direction of the slope, that is to say from the hill in the valley, the water gently flows through the grooves of furrows, or where it destroys vegetation cover is triggered the erosion. On the contrary, the incorrect work as shown, established erosion (Newsletter of ecopedologic monitoring., 1996; Soil-forming processes, 2006; Soil processes and spatio-temporal organization of soils, 2006).

Also, because of the erosion process were investigated leakages of liquid and solid of soil. Leakage of liquid and solid of soil within the different degree of erosion were determined in control plots of land with an area of 3 $m^2$. On these plots were simulated artificial rainfalls of certain intensity with using device portable sprinkler irrigation. The water supply of artificial rain was carried out in the tank with the volume 3,000 liters.

Duration of artificial rain has made for 30 minutes it with an intensity of 2 mm/min. In order to maintain stable over time the flow of 6 l/min the sprinkler irrigation device has been connected to the water control. The amount of water elapsed from the plot was determined by the volumetric method. The amount of washing soil was estimated by determining the turbidity of the samples over 5 minutes in balloons with a volume of 500 $cm^3$ (Cojocaru O.I., 2015).

As a result of unclogging in the layer 0-60 cm of type of soil molic humiferous profile and normal distribution of genetic horizons deep was derogated. Was produced mixing of the material of soil and reversal of horizons, what is quite clearly visible in the investigated recently arable soil profile in the region Negrea village.

Any project of erosion prevention in the framework of river basins should be conceived through research, design and implementation of the measures of erosion prevention in the local reception basins which are a component part independent of all basins of accumulation (Newsletter of ecopedologic monitoring., 1996; Ursu A., 2011; Gennadiev A.N. *et al*, 2002; Cerbari V.V. *et al*, 1994).

According to conducted research in the reception basin lands ”Negrea” from the region Negrea village, in the years 1971-1975 were completely rutted at a depth of 60 cm and used in vineyards and orchards. As a result of soil erosion processes were intensified. However, proper organization compared of the territory and micro-terracing between rows of trees and stumps vines stopped the in some measure the erosion. Acceleration of the processes of soil erosion occurred after the years 1991-1995 when the vineyard plantations and orchards have been in mass grubbed up without being designed and implemented a complex system of protection of arable land used.

As the study of soil cover in the doctoral program theme provides for conducting detailed of pedological mapping of the soil cover of the reception basin ”Negrea”, it was necessary to find a system of classification of sloppy eroded soils. For this purpose has selected a variant of the classification system of eroded soils developed taking into consideration the depth sloppy, derogated layer composition and the genesis horizon under the layer sloppy (Cerbari V.V. *et al*, 1994; Cojocaru O.I., 2014, 2015).

The problem of monitoring of the erosion processes and diminishing their negative impact is primary for agricultural lands in the region of the village of Negrea with relief and soil favorable conditions for showing their extensive (Cerbari V.V. *et al*, 2010; Cojocaru O.I., 2015; Ursu A., 2011).

## CONCLUSIONS

According to existing information the reception basins soils in the region Negrea village is characterized by the following features that influence their condition of quality and production capacity:

- predominance in the granulometric composition of dust coarse and/or fine sand;
- formation of the soil cover in conditions of the erosion processes assessment;
- unclog of soils on the entire territory of the reception basin.

The particulars referred led to the formation within the reception basins of a complex cover of soil.

According to conducted research in the reception basin lands ”Negrea” from the region Negrea village, in the years 1971-1975 were completely rutted at a depth of 60 cm and used in vineyards and orchards.

As a result of unclogging in the layer 0-60 cm of type of soil molic humiferous profile and normal distribution of genetic horizons deep was derogated.

Successful realization of measures to combat of erosion and other soil degradation processes is only possible through the design and implementation of pedo-improvement measures developed based on research of pedological materials on a large scale or detailed.

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# STUDIES REGARDING DESORPTION OF FOOD DYE BY DIFFERENT SOLVENTS

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**Abstract**

In order to elucidate the interactions established between the sorbent and the sorbate desorption studies can be conducted using different polar and non-polar solvents. In the first part of the investigation 20 mg/L of food color Red No. 3 was sorbed on 1g beans hulls/50 mL solution, at room temperature. After the sorption equilibrium was reached, Sulphuric acid (0.2 M), chlorhydric acid (0.2 M), acetic acid (1 M), sodium chloride (1 M), distillate water and distillate water pH 10 (adjusted with NaOH) respectively was used to desorb the dye. Excepting the water with pH 10, where the percentage desorbed is around 17 %, desorption cycle indicated a low amount of dye released in the solution. The efficiency of the sorption-desorption process of 50 mg/L Red No. 3, in three cycles, using 50% acetone, 40% isopropanol, 40% ethanol and distillate water pH 11 (adjusted with NaOH) was conducted in order to evaluate the sorbent reutilization potential. Ethanol (84%) and isopropanol (89%) provided the higher efficiency for dye desorption. Acetone and ethanol keep a constant percentage, around 50-60%. The low amount of dye desorbed reflects a strong interaction between the agro waste surface and the dye molecules, with ion exchange interactions type.

**Key words**: quality indicators, refrigeration, sauces

The increased number of researched have proved that currently sorption is one of the most effective and attractive processes of dye removal from different effluents. The process is relatively inexpensive due to the possibility of applying appropriate renewable adsorbents and the recovery of the compound.

Depending on the dye used and the sites available for adsorption on the material, one or more forces will act in the adsorption process, which influences the possibility to reuse the material.

From the synthetic food colors, the coal-tar/petroleum colors, represent a special class of dyes in whose group enter Red No. 3, a xanthene dye (Apostol L.C., Gavrilescu M., 2013). Acid dye such us Red No. 3 can be lost in effluents in percentage varying from 5 to 20%.

Because of the high dye amount prezented in aqueous efluents, the environment cand be affected even at low concentrations. For the efluents decolorization physical, chemical, and biological processes were investigate. The adsorption process involves several attractive interaction forces such as van der Waals forces, hydrogen bonding, covalent, and ionic bonds (Silva F.C. *et al* 2015). In this context the desorption studies are used:

- to elucidate the nature of adsorption process and to recover the dye.
- to regenerate the sorbents so that it can be used again to adsorb the dye and develop the successful sorption process.

The most common materials used for dye removal is activated carbon. It has been extensively tested, yet relatively high costs of its operation and problems with its regeneration have restricted its large-scale application (Filipkowska U., Rodziewicz J., 2011). The studied alternative are the natural by products because of their properties: inexpensive, abundent and renewable material.

In this research beans were choose for our investigations because of its high grown and consumption East Europe. The massive amount of resulted hulls can be recovered and used as a low-cost sorbent. In order to elucidate the interactions established between the sorbent, beans hulls and the sorbate, Red No. 3, desorption studies were conducted using different organic and inorganic eluents.

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## MATERIALS AND METHODS

Reagents and solvents

The acid dye used in this study, Red No. 3, the inorganic compounds (sulphuric acid, chlorhydric acid, sodium hydroxide, sodium chloride) and organic solvents (acetic acid, acetone, isopropanol, ethanol) were purchased from Sigma–Aldrich.

Sorbent

The agro waste beans hulls, obtain from a local farm, were washed several times with distilled water and dried at 40ºC. The hulls were crushed using a Retsch GM 200 laboratory mill, were sieved and classified. No other chemical or physical treatments were used prior to desorption experiments. The less 3 mm particles size of beans hulls (BH) were used in the experiments study.

Method

Bach desorption studies were conducted in an isothermal shaker (IKA KS 4000 IC) at 150 rpm for 24 h using in 250 mL Erlenmeyer flasks, containing 50 mL of Red No. 3 solution.

The sorption study was performed using 20 and 50 mg/L Red No. 3, respectively, and 1 g sorbent/50 mL. After sorption the solution was removed and analyzed at 524 nm.

After each sorption cycle the sorbents were washed gently with distilled water to remove any excess of dye solution.

For the desorption test different solution were used: acids, bases and organic solvents.

Sulphuric acid (0.2 M), chlorhydric acid (0.2 M), acetic acid (1 M), sodium chloride (1 M), distillate water and distillate water pH 10 (adjusted with NaOH) was used to desorbs 20 mg/L Red No. 3; 50% acetone, 40% isopropanol, 40% ethanol and distillate water pH 11 (adjusted with NaOH), respectively was used to desorbs 50 mg $L^{-1}$ Ery B.

Desorption efficiency was estimated using the Eq. (1):

$$D(\%) = \frac{q_0 - q_d}{q_0} * 100 \quad (1)$$

where $q_o$ is mg of the Red No. 3 sorbet onto BH; $q_d$ is the amount of Red No. 3 in the eluent used for dye desorption.

## RESULTS AND DISCUTIONS

The preliminary study concerning the Red No. 3 desorption was conducted using distillated water as eluent. In the first part of the investigation 20 mg/L of food color Red No. 3 was sorbed on 1g bean hull/50 mL solution, at different temperature. After the equilibrium was reached desorption study was performed at the same temperature as the sorption process. As it can be seen from *figure 1* the temperature has a large influence on the desorption process. Red No. 3 is despot in high amount (0.28 mg/g) at 303 K.

For the first part of the investigation regarding the eluents affinity for dye desorption, the experiments were conducted at room temperature. Sulphuric acid (0.2 M), chlorhydric acid (0.2 M), acetic acid (1 M), sodium chloride (1 M), distillate water and distillate water pH 10 (adjusted with NaOH) respectively was used to desorb the dye. Excepting the water with pH 10, where the percentage desorbed is around 17 %, desorption cycle indicated a low amount of dye released in the solution (*figure 2*).

A second study was conducted using organic solvents. For the test of sorbents regeneration four solutions were chosen to test the efficiency of the sorption-desorption process in three cycle of dye-sorbent.

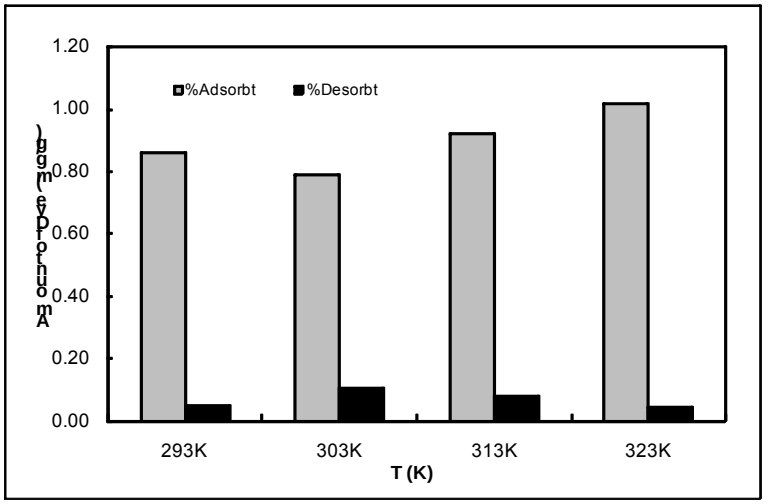


Figure 1 **Amount of Red No. 3 desorpt at different temperature**

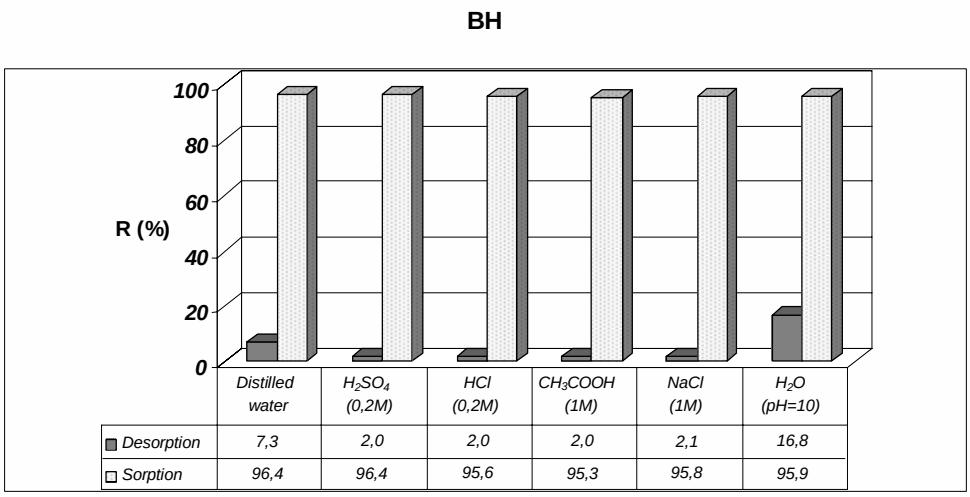


Figure 2 **Desorption percentage for different solution on Red No. 3 desorption**

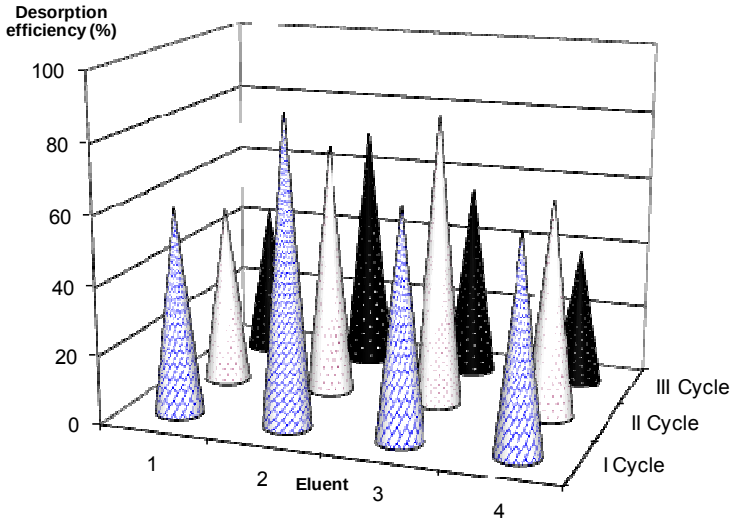


Figure 3 **Efficiency of Red No. 3 desorption using organic solution**
**(1) 50% acetone; (2) 40% isopropanol; (3) 40 % ethanol; (4) $H_2O$ pH 11 (adjusted with NaOH)**

Table 1

Desorption efficincy obtained in different studies for Red No. 3

| Sorbent | Desorption efficincy (%) | Reference |
|---|---|---|
| Pumpkin seeds hulls | 72 | Apostol L.C. *et al* (2016) |
| Chitosan coating on the surface of magnetite | 85 | Eser A. *et al* (2015) |
| Bottom Ash | 94 | Mittal A. *et al* (2006) |
| De-Oiled Soya | 96 | |

The efficiency of the sorption-desorption process of 50 mg/L Red No. 3, in three cycles, using 50% acetone, 40% isopropanol, 40% ethanol and distillate water pH 11 (adjusted with NaOH) was conducted in order to evaluate the sorbent reutilization potential. Ethanol (84%) and isopropanol (89%) provided the higher efficiency for dye desorption. Acetone and wather- pH 11 keep a constant percentage, around 50-60% for the three cycle sorption - desoption process (*figure 3*). The low amount of dye desorbed reflects a strong interaction between the agro waste surface and the dye molecules, with ion exchange interactions type. As a comparison *table 1* presents the

desorption efficincy obtained for Red No. 3 in different studies.

## CONCLUSIONS

In order to elucidate the interactions established between the sorbent, beans hulls and the sorbate, Red No. 3, desorption studies were conducted using different organic and inorganic eluents.

In the first part sulphuric acid (0.2 M), chlorhydric acid (0.2 M), acetic acid (1 M), sodium chloride (1 M), distillate water and distillate water pH 10 (adjusted with NaOH) respectively was used to desorb the dye. Excepting the water with pH 10, where the percentage desorbed was around 17 %, desorption cycle indicated a low amount of dye released in the solution.

In the case of solvents tested ethanol (84%) and isopropanol (89%) provided the higher efficiency for dye desorption. Acetone and wather-pH 11 keep a constant percentage, around 50-60% for the three cycle sorption - desoption process.

The low amount of dye desorbed reflects a strong interaction between the agro waste surface and the dye molecules, with ion exchange interactions type.

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# EFFECT OF BORON FERTILIZATION ON BORON CONCENTRATIONS AND YIELD OF APPLE CULTIVARS GROWN ON DIFFERENT BORON CONTAINING SOILS

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**Abstract**

Study was carried to investigate the effect of soil, leaf and soil + leaf boron applications on leaf B concentration and fruit yield in three different boron containing soils. For this, 4 levels of soil application as 0,100, 300 and 500 g B $da^{-1}$ and 2 levels of leaf application as 0 and 100 mg B $l^{-1}$ were alone and as their combination. Leaf B concentrations and fruit yields in all individual districts increased with the soil and soil x leaf combination. Foliar application had an effect only in one district on leaf boron concentrations but in other districts foliar boron application did affect neither leaf boron concentration nor fruit yield. Depending on the means of soil applications, 12-23 % increase in leaf B concentrations and 11-57% increase in fruit yield were determined. The highest B and yield increases were determined from the lowest soil B containing district with the S3xL1.

**Key words:** Boron application, leaf B, fruit yield

Boron (B) with role of on sugar transport, cell wall synthesis, carbohydrate metabolism, RNA metabolism, respiration, IAA metabolism, phenol metabolism and etc. is one of the important nutrients and B deficiency can occur as different deficiency symptoms. Boron is immobile in phloem. So, B deficiency can result in different fruit disorders affecting fruit storability and quality. Under B deficiency, cell wall structure damage and denaturing, cracking, decaying and softening can be seen in the some fruits and tuber crops (Bergmann W., 1992; Marschner H., 1995). Apple trees require higher amount of B (Shorrocks V.M., 1997). Boron is required for pollen germination and pollen tube growth resulting in fruit setting. Therefore, B fertilization may increase yield, particularly when plants are grown on sandy soil with a low content of available B. The effect of B fertilization of apple trees on fruit quality can change with the several factors such as cultivar, orchard location, rainfall, air temperature. Both low and excessive concentrations of B in apple trees cause poor fruit quality. Apples with a low B concentration have a short storage life because of the high susceptibility to a break down. On the other hand, high B concentration in apples enhances the incidence of internal disorders, particularly water core and internal breakdown. Also, high B concentration in apples could result in increased decay and decreased fruit firmness (Bergmann W., 1992; Wójcik *et al*, 1999).

Boron uptake of the plants is in close relation with some soil, plant and environment factors. Even plants grown on a same soil there can have different characteristics for B using ability (Paull *et al*, 1992; Gupta U. C., 1979). Boron uptake by plants decreases with the increase of pH and lime (Bennet O.L., Mathias E.L., 1973). Soil texture and clay type are other factors effecting plant B nutrition and it is recorded that plants can uptake better B from the coarse texture soils (Singh *et al*, 1976). In regions having more rainfall, coarse texture with low organic matter containing soils don't have sufficient B. But increasing of organic matter in these soils contributes B nutrition of plants (Purves D., McKenzie E.J., 1974.).

In plant production, yield and quality have close relation with plant mineral nutrient concentrations. So it is required to know sufficient levels of nutrients for desired production. Boron is a nutrient that deficiency and toxicity levels are close in the soils. So, keeping the sufficient amount of soil B concentration needs close monitoring.

In this study, it was aimed to investigate the different B application methods on B nutrition and yield of apple grown on different B containing soil.

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## MATERIAL AND METHODS

Study was conducted under 3 different districts (Isparta, Senirkent, Aglasun) having different soil B concentrations in Isparta region. In the region, 2.5 million tones apple production was made per year. The experiments were set up in 2014 using 6-7 years old Red Chief variety grafted on M-9 rootstocks.

Some soil and plant characteristics of experimental orchards in Isparta, Senirken and Aglasun were given in Table 1, Table 2 and Table 3, respectively.

Table 1

**Some soil characteristics and leaf nutrient concentrations for previous year in Isparta orchard**

| Some soil characteristics | | | Previous year leaf nutrient concentrations | |
|---|---|---|---|---|
| pH (1/2.5) | | 8.1 | N (%) | 1.92 |
| EC (1/2.5) | | 0.13 | P (%) | 0.13 |
| OM (%) | | 2.5 | K (%) | 1.92 |
| Texture | | CL | Ca (%) | 3.20 |
| $CaCO_3$ (%) | | 10 | Mg (%) | 0.28 |
| | B | 1.1 | B, ppm | 30 |
| | Fe | 4.8 | Fe, ppm | 169 |
| | Cu | 1.6 | Cu, ppm | 12 |
| | Zn | 0.8 | Zn, ppm | 21 |
| Extractable nutrients | Mn | 10.6 | Mn, ppm | 56 |
| | Ca | 4019 | | |
| | Mg | 423 | | |
| | K | 163 | | |
| | P | 9.58 | | |

Table 2

**Some soil characteristics and leaf nutrient concentrations for previous year in Senirken orchard**

| Some soil characteristics | | | Previous year leaf nutrient concentrations | |
|---|---|---|---|---|
| pH (1/2,5) | | 7.67 | N (%) | 2.3 |
| EC (1/2,5) | | 0.24 | P (%) | 0.22 |
| OM (%) | | 3,4 | K (%) | 2.38 |
| Texture | | C | Ca (%) | 1.32 |
| $CaCO_3$ (%) | | 14 | Mg (%) | 0.31 |
| | B | 0.84 | B ppm | 36.0 |
| | Fe | 2.18 | Fe, ppm | 71.4 |
| | Cu | 3.0 | Cu, ppm | 10.6 |
| | Zn | 2.0 | Zn, ppm | 43.6 |
| Extractable nutrients | Mn | 8.12 | Mn, ppm | 69.6 |
| | Ca | 5607 | | |
| | Mg | 544 | | |
| | K | 902 | | |
| | P | 40 | | |

Table 3

**Some soil chacteristics and leaf nutrient concentrations for previous year in Aglasun orchard**

| Some soil characteristics | | | Previous year leaf nutrient concentrations | |
|---|---|---|---|---|
| pH (1/2,5) | | 7.88 | N (%) | 2.8 |
| EC (1/2,5) | | 0.28 | P (%) | 0.14 |
| OM (%) | | 2.4 | K (%) | 1.43 |
| Texture | | CL | Ca (%) | 1.69 |
| $CaCO_3$ (%) | | 20 | Mg (%) | 0.26 |
| | B | 0.46 | B, ppm | 42.0 |
| | Fe | 3.51 | Fe, ppm | 149 |
| | Cu | 2.41 | Cu, ppm | 12.5 |
| | Zn | 0.89 | Zn, ppm | 50.4 |
| Extractable nutrients | Mn | 3.38 | Mn, ppm | 57.8 |
| | Ca | 7813 | | |
| | Mg | 243 | | |
| | K | 626 | | |
| | P | 21.6 | | |

**Boron fertilization**

Boron fertilizations were made as soil, leaf and soil+leaf applications. For soil applications; 4 levels of B as S0=0, S1=100, S2=300 and S3= 500 g B $da^{-1}$ were applied. For leaf applications, 2 levels of B as L0= 0 and L1= 100 mg B $l^{-1}$ were used. Soil+leaf applications were the combination of soil and leaf (S+L) applications. As B source EDITOT-67 (B: 20.8 %) was used.

The experiments were planned according to randomized parcels with 5 replications and each replication contained 3 trees. All experiments were conducted on 120 trees (4 soil doses x 2 leaf dose x 5 replicates x 3 tree for each replicate). Soil B application was made on November as solution to the active root zone and mixed to the 20-30 cm depth. Foliar applications were made in 3 times as after the harvest, before flowering and fruit set.

**Soil and plant analysis**

In order to determine soil extractable B, 20 g of soil was weighted in to 250 ml flask and 40 ml of 0,01M $CaCl_2$ solution was added. Suspension was boiled for 5 minutes using re-circulated cooling system. Then, solution was cooled until room temperature and filtrated through the blue band filter paper. Boron concentration of filtrate was measured with ICP (Kacar B., 2009). Soil available P, exchangeable K, Ca, Mg and extractable micro elements were determined as described by Olsen *et al*, (1954), Jackson M. L., (1967) and Lindsay W. L., Norvell W.A., (1969). Soil texture was determined using hydrometer (Bouyoucos G.L., 1954) and $CaCO_3$ content was measured with calcimeter (Allison L.E., Moodie C.D. 1965). Soil organic matter was determined based on Walkley A., Black I.A., (1934). Soil pH was measured using pH mater in suspension of soil and water at the rates of 1/ 2.5.

For leaf analysis, leaf samples were collected in July (Jones *et al*, 1991) and brought to the lab. Then, samples were washed, dried at 65±5°C, grounded and wet digested with microwave oven and filled up to 50 ml with ultra-pure water. Boron concentrations in the filtrates were measured with ICP. Total nitrogen was analyzed according to Kjeldahl method. Phosphorus concentrations of samples were determined with a spectrophotometer (Shimadzu UV-1208) at 430 nm according to the vanadomolybdo phosphoric acid method. Potassium, Ca, Mg, Fe, Cu, Zn, and Mn concentrations were determined using atomic absorption spectrophotometer (Kacar B., İnal A., 2008).

For evaluating soil B level, 0.5 mg B $kg^{-1}$ was accepted as critical concentration (Keren R., Bingham F.T., 1985). Sufficient leaf B concentration was accepted as 25-40 mg $kg^{-1}$ (Jones *et al*, 1991). Other classifications were made using the classification chard given in Alpaslan *et al*, (1998) for the soils and given in Jones *et al*, (1991) for he leaves.

## RESULTS AND DISCUSSION

### Effect of B fertilization on leaf B concentrations

Effects of B fertilizations on leaf B concentrations of tree different experiments were given in Table 4. As seen from the mean values, soil applications significantly affected leaf B concentrations in all districts. Increases of leaf B with soil applications in Isparta, Senirkent and Aglasun were 22, 12 and 23 percent respectively.

Also mean B concentrations showed that leaf B fertilization resulted in B increase in Aglasun orchard but in other district, leaf applications did not affect leaf B concentrations. In Isparta district the highest leaf B concentration was measured from the S3xL1 treatment, in Senirkent and Aglasun the highest leaf B concentrations were reached S3xL0 and S3xL1, respectively.

Table 4

**Effects of B applications on leaf B concentration of apple trees**

| Application | Leaf B concentrations (mg $kg^{-1}$) | | |
|---|---|---|---|
| | L0 | L1 | Mean |
| | Isparta experiment | | |
| S0 | 31 b** | 32 b | 31 B* |
| S1 | 30 b | 30 b | 30 B |
| S2 | 35 ab | 38 a | 36 A |
| S3 | 37 a | 39 a | 38 A |
| Mean | 33 | 35 | |
| | Senirken Experiment | | |
| S0 | 34 ab** | 34 ab | 34 B* |
| S1 | 34 ab | 34 ab | 34 B |
| S2 | 33 b | 37 a | 35 B |
| S3 | 38 a | 37 a | 38 A |
| Mean | 35 | 36 | |
| | Ağlasun experiment | | |
| S0 | 42 c** | 52 b | 47 B* |
| S1 | 44 c | 52 b | 48 B |
| S2 | 44 c | 56 ab | 50 AB |
| S3 | 55 ab | 61 a | 58 A |
| Mean | 46 *B**** | 55 *A* | |

*S (P<0.01);**SxL (P<0.01); ***L (P<0.01)

**Effect of B fertilization on yield**

Soil application and soil x leaf interaction significantly affected apple fruit yield in all districts. In this increases, soil applications were more dominant comparing to leaf application. In all areas, the lowest yield was measured from the control treatments, but the dose that the highest yield values were obtained varied with the district. Yield increases from the Isparta, Senirkent and Aglasun were about the 52%, 11% and 57% respectively (*table 5*).

According to the soil analysis, B concentration of Aglasun orchard is under the sufficient level comparing to other orchards in Isparta and Senirkent (Keren R., Bingham F.T., 1985). However, leaf nutrient concentrations in all districts were at about sufficient levels (Jones *et al*, 1991). Looking at the experiment results, it can be seen that increases in leaf B concentration was higher in the orchard (Aglasun) with lower soil B than higher B containing orchards. Also, yield results reflected the same tendency with leaf B concentration and higher yield increase were measured from the orchard having higher leaf B increase. Similar results were found in previous studies implying the same findings (Ganie *et a*., 2013; Wang *et al*, 2012; Baysal G.D., Erdal I., 2015). Looking at the both application methods only in Aglasun experiment foliar B application had a significant effect, However but it was seen that leaf B fertilization did not affect both leaf B concentration and yield in other orchards. From this it can be said that soil application is more efficient (David *et al*, 2005; Meng *et a*., 2014). One of the important finding is that although soil of the Aglasun orchard is lower than other orchards, B concentrations measured in leaf of apples in Aglasun is higher. Looking at this result it can be said that there are some other factors effecting B availability for plant use (Bennet O.L., Mathias E.L., 1973; Purves D., Mc Kenzie E.J., 1974; Singh *et al*, 1976; Gupta U.C., 1976; Poul *et al*, 1992).

Table 5

**Effects of B applications on fruit yield**

| Application | Yield, kg tree$^{-1}$ | | |
|---|---|---|---|
| | L0 | L1 | Mean |
| | Isparta experiment | | |
| S0 | 42 c** | 42 c | 42 C* |
| S1 | 58 ab | 70 a | 64 A |
| S2 | 63 a | 56 b | 59 AB |
| S3 | 55 b | 59 b | 57 B |
| Mean | 55 | 57 | |
| | Senirken experiment | | |
| S0 | 71 b** | 72 b | 71 B* |
| S1 | 74 ab | 72 b | 73 B |
| S2 | 78 a | 81 a | 80 A |
| S3 | 72 ab | 74 ab | 73 B |
| Mean | 35 | 36 | |
| | Ağlasun experiment | | |
| S0 | 46 b** | 48 b | 47 B* |
| S1 | 60 a | 50 b | 55 AB |
| S2 | 75 a | 57 b | 66 A |
| S3 | 64 a | 83 a | 74 A |
| Mean | 61 | 60 | |

*S (P<0.01);**SxL (P<0.01)

## CONCLUSIONS

Soil, leaf and applications and their combination (soil+leaf) significantly increased the leaf B concentrations and fruit yields regardless of the regions. But the most effective application type and the application doses varied with the region.

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# THE STUDY ON THE POSSIBILITY OF THE SOIL SUCTION SIMULATION STUDY OF SOILS FROM BREAZU AND DANCU AREAS THROUGH THE SOIL PARAMETER ESTIMATOR SOFTWARE

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**Abstract**

To determine the soil suction is needed a previously analysis of the retention capacity (storage). In achieving this paper aims to present a method to study the retention of two types of soils taken from Breazu and Dancu study areas, at four harvesting depths (0-20 cm, 20-40 cm, 40-60 cm and 60-80 cm) through the simulation technique implemented with the help of SOIL PARAMETER ESTIMATOR software who needed a data series of bulk density - previously determined for each harvest depth. Following the introduction of data entry, the software generated a total of eight suction curves, one for each depth, corresponding to study areas mentioned above.

**Key words:** Soil Parameter Estimator, suction curves, bulk density

Soil structure put a direct influence on the aerohidric and thermal regime of soils and ensuring optimal conditions for seed germination, plant sunrise and root system development, as well as certain mechanical properties may make the necessity and effectiveness of future technological worksAccording to studies conducted by some researchers in this field we can affirm that retention of soil that still bears his name and soil suction necessitated always special attention because of the importance it has when you wish determination of a multitude of hydrophysical who may have a significant impact on soil fertility.

Besides the soil structure another basic physics of the pedologic foundation is represented by soil texture.

Texture is one of the most important soil properties which depend on the nature of soil parent material and evolution of soil formation processes (Rogobete G., 1993).The role of texture presents some aspects including: texture put a large influence on solification process, a coarse texture allows a more intense leaching, a broader development of the profile, but a fine texture opposes leaching accented create profiles shorter horizons better differentiated and stimulates the accumulation of humus, texture determines and/or greatly influence soil properties. (Filipov F., Lupaşcu Gh., 2003).

In general (Canarache, 1990) a rough textured can cause the following: high permeability to water and air, small capacity of water retention, low containing of humus and nutrients, underrepresented colloidal complex, compared to the fine type of texture when she in turn displays some advantages and disadvantages for examples: low permeability for water and air, high water retention capacity, greater compactness, high humus content and nutrients, complex colloidal well developed, potential fertility (Lăcătuşu R., 2000).

## MATERIAL AND METHOD

All research was conducted on soil samples disturbed (stored in labeled bags) and undisturbed harvested (collected by the method of metallic cylinders with a volume of 100 $cm^3$) shown in *figure 1.a and b*)

All samples was collected at 4 depth (0-20 cm, 20-40 cm, 40-60 cm and 60-80 cm) from two locations – Breazu and Dancu (Dumitru., 2009).

Physical properties were analyzed in the laboratory with the following methods: soil bulk density (oven drying method *figure* 2 a ), texture (pipetting method performed using Eijkelkamp Pipette Apparatus and other tools *figure* 2 b)

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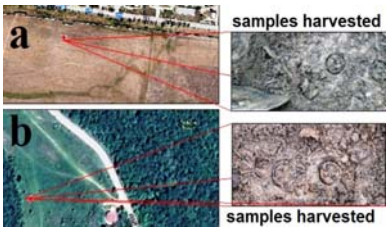


Figure 1 **Presentation of the location study**
**a) zone of Dancu sampling soil, b) zone of Breazu sampling soil**


Figure 2 **Equipment used to analyze the physical properties:**
**a) drying machine b) Eijkelkamp Pipette Apparatus and other tools used for determination of soil texture**

Besides the equipment shown in Figure 2 in determining the soil suction was applied Soil Parameter Estimator program.

Soil Parameter Estimator program has generated a diagram of soil texture for simple operation which needs data about percentages of clay, dust, sand and soil bulk density.

The textures in the chart on the left is situated clay that grows from the bottom to the top (*figure 3*).

On the right is the dust which ascends and it in turn from top to bottom.

Soil texture classes include a number of textural subclasses of environmental features analyzed with this program, such as sand, clay, clay-sandy soil and clay (*figure 3*).

The bulk density should record a value of less than 2.65 g/cm$^3$ (2.65 g /cm$^3$ density solids meaning).

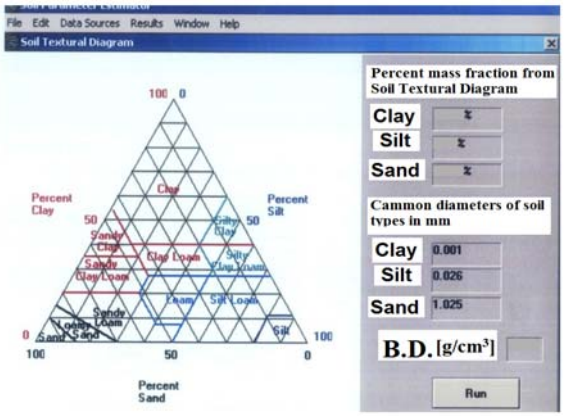


Figure 3 **The interface of Soil Parameter Estimator program**

## RESULTS AND DISCUSSIONS

Following the introduction of the program Soil Parameter Estimator (*figure 3*) of apparent densities for each soil samples yielded a total of 8 curves suction that can be used to determine indices hydro, being of particular significance when desired highlighting water content in the soil.

In *table 1* are presents the results obtained after applying the research methods of the physical properties of soils harvested on the four depth from areas studied.

After the program was able to provide us with the 8 suction curves was chosen thresholds suction arranged ordinate axis then was relizat through a line parallel to the abscissa determined the intersection point located on the curve of

suction.

After finding the suction point on the curve was lowered a direct perpendicular to the abscissa and finally determined water content.

In *tables 2* and *3* are presented the water contents obtained from suction curves generated by the Soil Parameter Estimator program.

Table 1

**Physical Properties of Soils for Breazu and Dancu**

| Sample | D.A. [g/cm$^3$] | Clay [%] | Silt [%] | Sand [%] |
|---|---|---|---|---|
| B 0-20 cm | 1.22 | 21 | 29 | 50 |
| B 20-40 cm | 1.45 | 24 | 31 | 45 |
| B 40-60 cm | 1.56 | 26 | 45 | 29 |
| B 60-80 cm | 1.59 | 28 | 64 | 8 |
| D 0-20 cm | 1.08 | 8 | 29 | 63 |
| D 20-40 cm | 1.18 | 19 | 41 | 40 |
| D 40-60 cm | 1.38 | 7 | 34 | 59 |
| D 60-80 cm | 1.43 | 3 | 52 | 45 |

In *Figure 4* is shown the soil suction curve of B 0-20 cm which on extracted the dates mentioned in *table 2*. For the other curves was proceeded in the same mode.

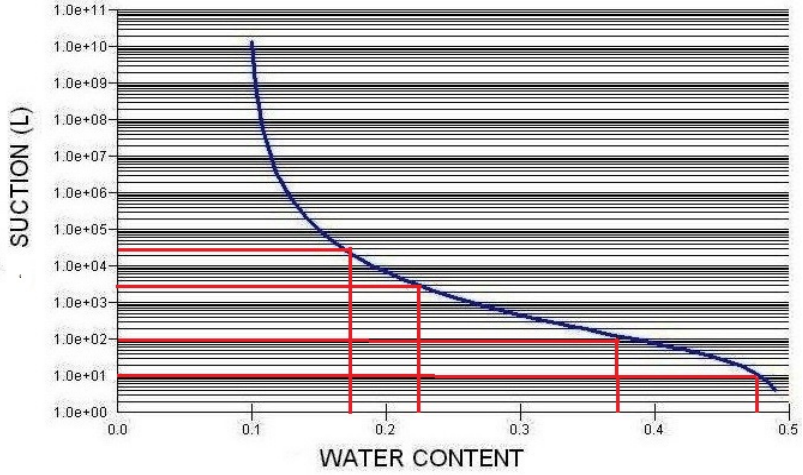


Figure 4 **Suction curves genereted by the Soil Parameter Estimator program for B 0-20 cm and presentation the method of water contents extraction values**

Table 2

**Values of water content θ (%) of all suction thresholds for soil of Breazu site - simulated dates**

| pF (kPa) | θ (%) B 0-20 cm | θ (%) B 20-40 cm | θ (%) B 40-60 cm | θ (%) B 60-80 cm |
|---|---|---|---|---|
| 0 | 50.11 | 46 | 44 | 36 |
| 0.4 | 49 | 45 | 43 | 35 |
| 1 | 48 | 44 | 41 | 34 |
| 1.5 | 43 | 41 | 39.5 | 32 |
| 1.8 | 40.5 | 38 | 38 | 30.5 |
| 2 | 38.5 | 36 | 37 | 29.5 |
| 2.3 | 31 | 32 | 33 | 25 |
| 2.7 | 28.4 | 29 | 31 | 24 |
| 3 | 26.9 | 26 | 28 | 23 |
| 3.4 | 21.8 | 23 | 23.5 | 20.5 |
| 4.2 | 17 | 16 | 19 | 17.5 |

Table 3

In the results interpreting will be discussed only a few suction thresholds namely: minimum - 0 pF, minimum-intermediate - 1 pF, medium - pF 2 intermediate medium - pF 3, maximum - pF4.2.

After a simple analysis of data from tables 2 and 3, we see that the minimum threshold of B 0-20 cm soil recorded lower values than the soil sample taken from the same depth of Dancu, this can be argued by densities higher bulk density of B 0-20 cm soil than D 0-20 cm which did nothing to reduce water storage areas.

If the minimum threshold intermediate was observed the same situation but this time with a value increasing with 15% approximately this cause was identical with the minimum threshold.

At pF 2 and pF 3 the things have changed, this time the soil from the Breazu site has managed to earn higher values of θ (%) because if we realize

a correlation of data from Table 1 we notice that the soil of the site's Breazu holds most significant clay, silt and sand content which was unevenly distributed over the entire section studied (0-80 cm) although the values of D.A. were higher as the Dancu soil.

Table 3

**Values of water content θ (%) of all suction thresholds for soil of Dancu site - simulated dates**

| pF (kPa) | θ (%) D 0-20 cm | θ (%) D 20-40 cm | θ (%) D 40-60 cm | θ (%) D 60-80 cm |
|---|---|---|---|---|
| 0 | 60 | 51 | 47 | 45.2 |
| 0.4 | 54 | 50 | 45 | 44.2 |
| 1 | 48.5 | 48 | 42.5 | 42.4 |
| 1.5 | 34.5 | 43 | 34 | 34.4 |
| 1.8 | 32 | 41 | 30 | 30 |
| 2 | 28.6 | 39 | 27.14 | 28.8 |
| 2.3 | 20 | 31 | 20 | 20.8 |
| 2.7 | 18 | 28 | 17.18 | 17.6 |
| 3 | 17 | 26 | 15.6 | 16.6 |
| 3.4 | 12 | 21.5 | 11.25 | 12 |
| 4.2 | 6 | 17.5 | 7.5 | 6.2 |

In the case of the minimum threshold of D 20-40 cm the soil recorded a higher content than B 20-40 cm soil sample but in other situations Brezu presented more storage capacity than Dancu soil samples collected from the same depths.

## CONCLUSIONS

Making an overall analysis we can mention the following:

Following the introduction of data relating to bulk density have resulted in a a number of 8 curves suction whose data are shown in *table 2 and 3*, which in some cases have ranged from a different depth and location to another.

The program used in this study has managed to provide more precise data that could create a favorable image to retention capacity of soil for each separately type.

A soil with a balanced distribution of the sand, silt and clay contents will ensure a higher content of water that ultimately promote the development and maintenance of conditions vital development both flora and fauna soil - considered one of the most important environmental components.

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# RESEARCH ON THE INFLUENCE OF SOIL PARTICLES SHAPE ON THE HYDRAULIC CONDUCTIVITY OF SOILS FROM BREAZU STUDY AREA

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**Abstract**

The present study wants to highlight the influence of the relationship between soil particles characteristics (shape, size and surface area texture) and hydraulic conductivity (saturated and unsaturated).
The study of this relationship wants to note any change that may occur in the hydrological regime of soils in researched areas. Determination of the soil particles characteristics was achieved by: a) size analysis and b) SEM microscopic analysis type. Determination of soil hydraulic conductivity was performed by laboratory methods: the constant-head method (Ks) and the falling head method (Kθ).

**Key words:** hydraulic conductivity, particle size analysis, microscopic analysis

The study of the influence of the shape and characteristics of corresponding to soil particles on hydraulic conductivity is an important factor in determining the variation rate of percolation of chemical compounds that once you get in rural unsaturated and saturated represent a real threat for the groundwater quality that at today represents one of the most primordial sources of pure water without the human factor to intervene in order to purification for daily consumption.

Soils in general are composed of mineral fragments with different sizes which have most often hydrological regimes differ according to a number particularities such as shape, size and the size of constituent elements. For this reason the determination of these traits requires a complex analysis based on a comparison with a particle witness some ellipticity (Santamarina J.C. *et al*, 2001).

On this occasion we remember that in specialty literature the particles of irregular shape (compared to those with regular shape) occurs in three main staircase of sphericity (Wadell, 1932 Krumbein W.C., 1941; Powers, 1953; Krumbein and Sloss, 1963; Barrett, 1980). Sphericity can be quantitated as the ratio between the diameter of the largest and lowest scores within the district. Roundness is measured as the average radius of curvature of the surface in relation to the maximum radius of the sphere which can be entered in particle. Refers to the characteristics of surface roughness that can be much smaller than the particle diameter (Santamarina. J.C. *et al*, 2003). In the present study the peculiarities analysis which was above mentioned was performed using SEM technique to use as a pillar research the digital image analysis have been provided.

The digital analysis image facilitating the systematic evaluation of the mathematics descriptors that take account of particle shape, including Fourier analysis, used hybrid techniques to achieve an analysis on level fraction (Meloy, 1977; Clark, 1987; Hyslip and Vallejo, 1997, Bowman *et al*, 2001).

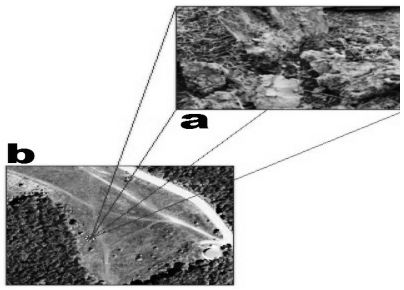


Figure 1 **Presentation of the Breazu location study a) samples harvested, b) zone of sampling soil**

## MATERIAL AND METHOD

All research was conducted on soil samples disturbed one for each depth (stored in labeled bags) and undisturbed harvested one for each depth from Breazu study area (*figure 1 b*) (collected by the method of metallic cylinders with a volume of 100 $cm^3$) shown in *figure 1 a.*

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Soil particles morphology analyses were achieved by: a) size analysis (*figure 2. a*) and b) SEM (Scanning Electron Microscope) microscopic type. Microscopic research was performed using scanning electron microscope Quanta 200, manufactured by FEI COMPANY. All samples (total samples = 24, 6 for each depth) were analyzed in Low Vacuum, approximately 60 Pa to 20 Kv shown in *figure 2. b*).

The analysis of hydraulic characteristics of soil samples was achieved by the laboratory methods, for hydraulic conductivity was the constant-head method($K_s$) (Lungu. 2013) give us in *figure 3* a) and the falling head method ($K_\theta$) (Stanciu and Lungu. 2006) presented in *figure 3 b*).

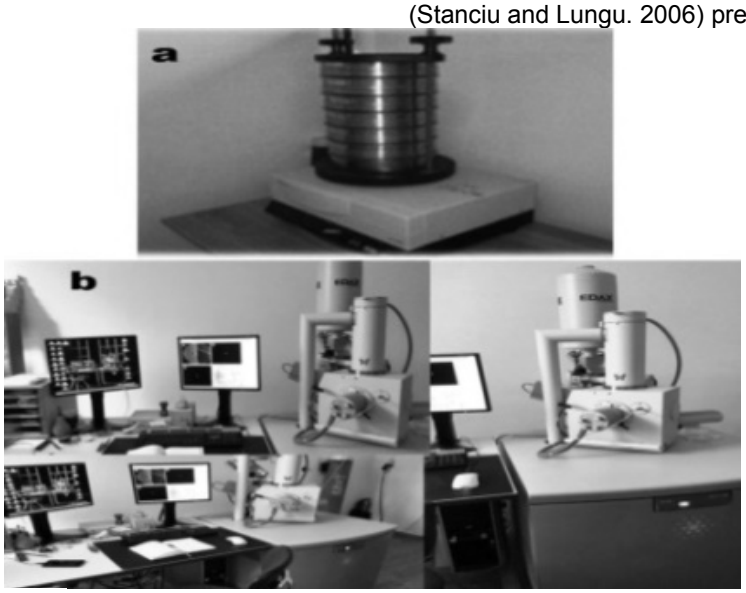


Figure 2 **Equipment used to analyze the morphology of mineral particles: a) shaker electromagnetic; b) equipment used in microscopic analysis SEM**

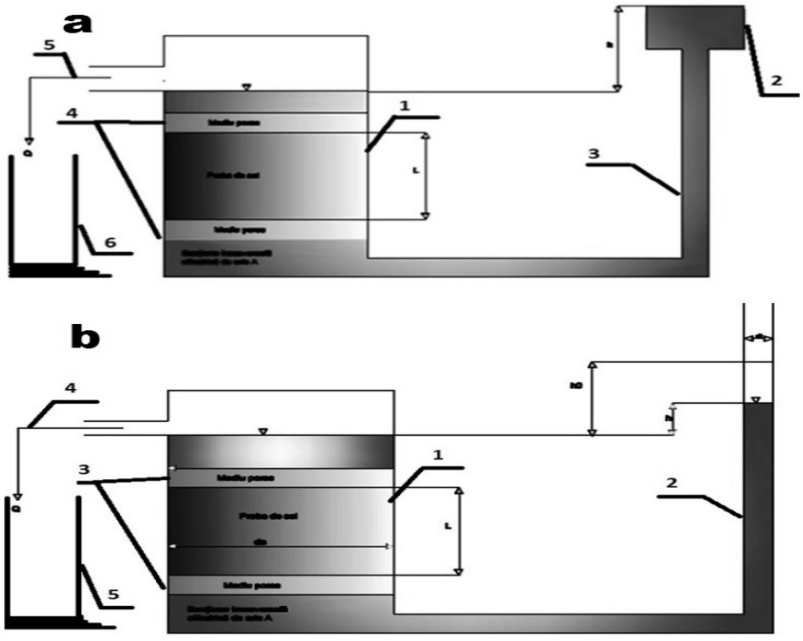


Figure 3 **Equipment used in the study of hydraulic conductivity a) constant-head method; 1: cylindrical soil sample, 2 reservoir:, 3: contact tube 4: poroase- plates., 5: surcharge , 6: graduated cylinder b) falling head method: 1: cylindrical soil sample, 2 graduated contact tube, 3: poroase- plates, 4: surcharge, 5: graduated cylinder**

In the study of the influence of soil particle shape on soil permeability was applied a new method characterized by a framing soil particles in a series of geometric figures whose perimeters were represented by magenta in *figure 4*. From the research of SEM images carried out at very high resolutions was made a classification of surface texture of soil particles with a very high importance when determining the desired action on the morphological properties of soil hydraulic properties analyzed *(tables 2 and figure 5)*.

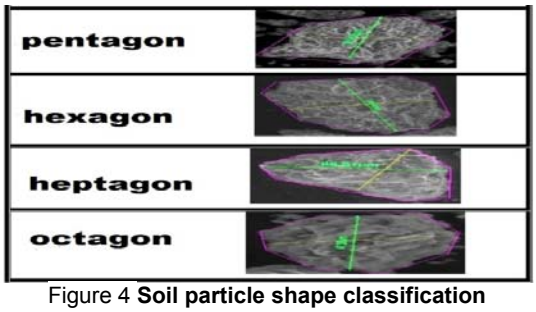


Figure 4 **Soil particle shape classification**

Determining the change of soil hydraulic properties in the Breazu area, only maximum and minimum of two types of pores were taken into account: maximum macro pores surface and minimum surface of nanopores.

To determine relationship between morphological characteristics that belong to particles with different dimensions which are in direct relation to pore system and hydraulic conductivity unsaturated was taken into account only one type of pores – macropores considering that it has a greater carrying capacity than the nanopore. Nanopores were being used for determining the saturated hydraulic conductivity because they have a much lower transmission capacity.

The highest values of K(θ) were attributed to the macro pores and lowest values of Ks have been distributed to the nanopores according to the argument mentioned above. This relationship for first depth is shown in *figure 6,* and for other depths was similary preceded.

**Calculation process**

Hydraulic conductivity Ks on vertical direction of the water flow is calculated from the relationship (King, L. G., 1965)*:*

Unsaturated hydraulic conductivity values $K_{(\theta)}$ were determined with relation (Dumitru E., 2009).

$$K_s = \frac{V * L}{T * A * h}$$

where:

V- volume of water collected;
L - length of the soil sample;
T - time for the collection volume of water (the excess);
A –cross sectional area of the sample.

$$K_{(\theta)} = \frac{a * L}{T * A} \cdot \ln\left(\frac{h_1}{h_2}\right)$$

where:
a - the cross section of graduated tube;
L - length of the soil sample;
T - time for the collection volume of water (the excess);
A –cross sectional area of the sample;
$h_1$ and $h_2$ -height of water column after a time T.

## RESULTS AND DISCUSSIONS

In *Table 1* are shows the values of morphological characteristics of soil mineral particles on study section and in table 1 and fig. 4 are mentioned the values of unsaturated, saturated hydraulic conductivity and SEM analysis results will be presented in which will be presented in the morphological characteristics soil mineral fragments for example: 1 mm, 250 µm and < 63 µm to 0-20 cm and 60-80 cm depths - the shape of fragment, the size and the particle surface area (done with AutoCAD 2007) and for other depths was similary.

Table 1

**Particle size distribution of Breazu site**

| µm | B 0-20 cm (%) | B 20-40 cm (%) | B 40-60 cm (%) | B 60-80 cm (%) |
|---|---|---|---|---|
| < 63 | 9 | 5 | 7.5 | 6,5 |
| 63 | 10 | 4 | 7 | 9 |
| 125 | 6 | 3 | 5 | 7 |
| 250 | 10.5 | 6 | 7.5 | 11.5 |
| 500 | 19 | 19 | 17 | 19 |
| 1000 | 45.5 | 63 | 56 | 47 |

Table 2

**Values of K (θ) and K s depending, on the morphological characteristics of soil particles to B 20-60 cm Breazu site**

| Breazu | Fraction size | Surface texture S.T. | The pore size P.s. (mm) | Particle size P. S. (mm) | The shape of particle | K (θ) at 15 ° C |
|---|---|---|---|---|---|---|
| B 20-40 cm | 1mm | middle | 0.41 | 3.14 | hexagon | 0.05577 |
| B 20-40 cm | 500 µm | finely - middle | 0.406 | 1.55 | hexagon | 0.01977 |
| B 20-40 cm | 250 µm | middle - coarse | 0.11 | 0.087 | pentagon | 0.01057 |
| B 20-40 cm | 125 µm | coarse | 0.045 | 0.19 | octagon | 0.0071 |
| B 20-40 cm | 63 µm | coarse | 0.026 | 0.1 | heptagon | 0.00566 |
| B 20-40 cm | < 63 µm | coarse | 0.009 | 0.03 | heptagon | 0.0043 |
| B 40-60 cm | 1mm | finely | 0.864 | 4.06 | heptagon | 0.09296 |
| B 40-60 cm | 500 µm | finely - middle | 0.825 | 1.96 | pentagon | 0.02966 |
| B 40-60 cm | 250 µm | finely - middle | 0.176 | 0.676 | pentagon | 0.02266 |
| B 40-60 cm | 125 µm | finely - middle | 0.046 | 0.255 | hexagon | 0.01549 |
| B 40-60 cm | 63 µm | middle - coarse | 0.033 | 0.127 | hexagon | 0.01363 |
| B 40-60 cm | < 63 µm | coarse | 0.007 | 0.02 | pentagon | 0.01213 |
| Breazu | Fraction size | Surface texture S.T. | The pore size P.s. (mm) | Particle size P. S. (mm) | The shape of particle | K s at 15 ° C |
| B 20-40 cm | 1mm | middle | 0.019 | 3.14 | hexagon | 0.00084 |
| B 20-40 cm | 500 µm | finely - middle | 0.014 | 1.55 | hexagon | 0.00062 |
| B 20-40 cm | 250 µm | middle - coarse | 0.003 | 0.087 | pentagon | 0.00049 |
| B 20-40 cm | 125 µm | coarse | 0.001 | 0.19 | octagon | 0.00044 |
| B 20-40 cm | 63 µm | coarse | 0.0024 | 0.1 | heptagon | 0.00039 |
| B 20-40 cm | < 63 µm | coarse | 0.0011 | 0.03 | heptagon | 0.00038 |
| B 40-60 cm | 1mm | finely | 0.07 | 4.06 | heptagon | 0.00132 |
| B 40-60 cm | 500 µm | finely - middle | 0.002 | 1.96 | pentagon | 0.00123 |
| B 40-60 cm | 250 µm | finely - middle | 0.006 | 0.676 | pentagon | 0.00105 |
| B 40-60 cm | 125 µm | finely - middle | 0.002 | 0.255 | hexagon | 0.00093 |
| B 40-60 cm | 63 µm | middle - coarse | 0.001 | 0.127 | hexagon | 0.00083 |
| B 40-60 cm | < 63 µm | coarse | 0.0009 | 0.02 | pentagon | 0.00093 |

As shown in *tables 2 and figures 6* can easily notice the downward trend in the process of infiltration intensity correlated with the morphological characteristics of particles (particle shape, particle size, size fraction, specific surface texture, pore size) soil types that make up the three sites .

The particle size of soil samples taken from the three study areas has declined in direct proportion to the characteristic interval of fragment size distribution analysis (1m - <63 µm).After analyzing the data in *Table 1 and 2* and the graphs shown in Figures 6 it can be seen the variation of K (θ) in raport to form in the case of mineral fragments of B 0-20 cm, consisting of particles with diameters of 1 mm, 250 µm, 125 µm and 63 µm with pentagonal outline followed by the group of 500 µm particles and <63 µm with hexagonal appearance, had the largest carrying capacity of the four depths.

Other features should not be overlooked such as particle size and surface texture which ranged in size fraction to another. If we refer to the type of surface texture of mineral fragments we notice the presence of texture, coarse in the case the particles in the range of particle size 250 µm - <63 µm which in turn will present a negative trend in terms of speed transit fluid at the level of the particle surface of the ground, characterized by a resistance to flow due to the roughness.

The average value of unsaturated hydraulic conductivity for Breazu site was detected in the B 40-60 cm sample composed of 1mm fractions of heptagonal shape, particles of 500 µm, 250 µm and < 63 µm of pentagonal and 125 µm and corpuscles 63 µm which had a hexagonal layout. In this case of the particle surface roughness of the ground was totally different from referred to above situation as it was mainly segment completion grading curve ranged between 1 mm and 125 µm.

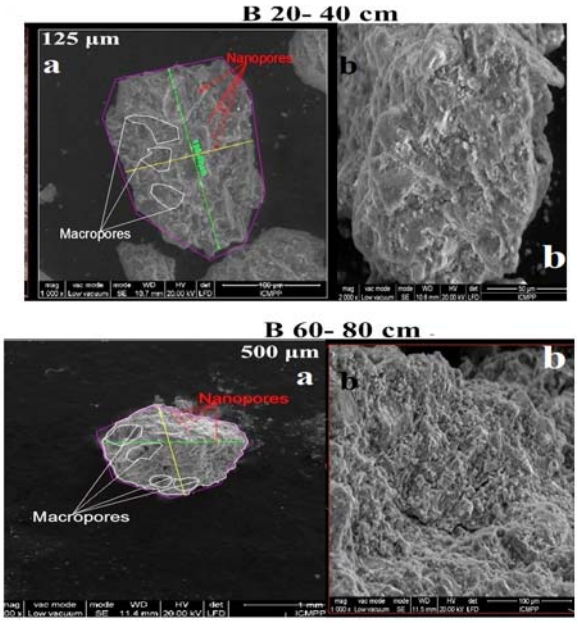


Figure 5 **Morphological characteristics of soil mineral particles on study section a) shape of particles b) surface texture**

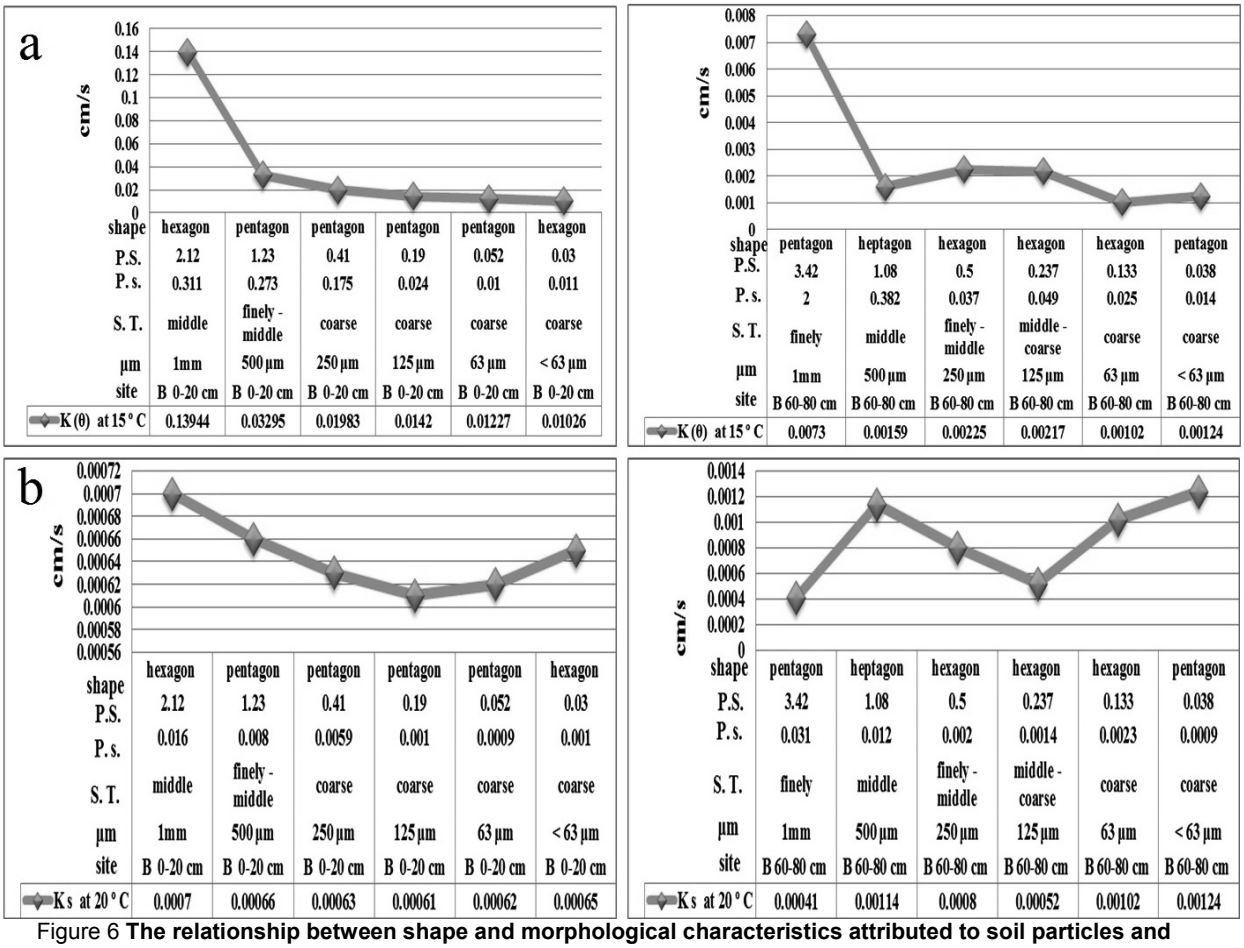


Figure 6 **The relationship between shape and morphological characteristics attributed to soil particles and hydraulic conductivity for Breazu 0-20 cm and Breazu 60-80 cm a) unsaturated hydraulic conductivity b) saturated hydraulic conductivity**

The lowest permeability was observed in B 60-80 cm soil (*noted in figure 6. b*) presented a composition almost similar previous case but if the previous case heptagonal shaped particles have represented the majority in this case of soil type predominates particles with pentagonal shape 1

mm and < 63 μm followed by particles with diameters between 250 μm and 63 μm (9%) surrounded by a perimeter composed of 6 sides and finally fragments of 500 μm with a heptagon form.

In this case, the skeleton elements had a complex texture characterized by morphological variation of this almost the whole range.

The soil sample particles of different shapes, which corresponded to the four forms (pentagon, hexagon, heptagon and octagon) was B 20-40 cm.

Particle surface of the sample extracted from the second harvest threshold noted the existence of a middle-type textures the two extremes (fine-middle and middle coarse).

If we will realize a parallel between the two conductivities will notice the huge gap between values that justified the fluctuation of morphological parameters of particles by different particle size fractions.

The soil from the Breazu site presented among the lowest values of Ks the lowest being observed as in the case of K (θ) - B 60-80 cm sample (observed in *figure 6. a*).

Average capacity transport was notified in section formed in the B 0-20 cm and B 20-40 cm depths (*seen in table 2*).

Filtration process with the highest intensity was observed in soil located at the B 40-60 cm harvesting stage compared to the previous situation characterized by infiltration into the soil before the most powerful B 0-20 cm (*seen in figure 6. b*).

## CONCLUSIONS

The distribution of shape and morphological characteristics of soil particles on study section greatly influenced hydric regime of soil from the Breazu site.

When we are referring to the soil we relate at a homogeneous formation composed by well-structured aggregates which are formed to particles with different diameters, sizes and shapes.

The primary characteristics of particles mentioned above are taken in to account when we want to determine the transport mode of all fluids types.

The results of the SEM analysis type help us in making accuracy determination of possible relationship between morphological characteristics representative for each particle and the most important hydraulic properties of the soil with a major impact on water regime corresponding with the each type of soil.

This paper has centered on how the variation of certain of shape and basical characteristics of particles shows the possibility of changing the regime for the various fluids when you want to determine the main particularities of agricultural soils. Soils used for farming activities often after intensive exploitation for satisfying the needs of the last rings of the food chain are in long process of decay with a knowingly subject.

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# RESEARCH ON THE INFLUENCE OF SOIL PARTICLES SHAPE ON THE RETENTION CAPACITY OF SOILS FROM DANCU STUDY AREA

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**Abstract**

This paper wants to remarked the impact of the relationship between soil particles characteristics (shape, size and pores surface) and retention capacity (soil suction).
The analized of this relation wishes to observe and to notice any change that may occur in the hydrological regime of soils in researched areas. Checking of the soil particles characteristics was obtained by: a) particle size analysis and b) SEM analysis type. Research the soil suction was accomplished using the sandbox, sand/kaolin box and pressure membrane apparatus.

**Key words:** water regime, particle size analysis, microscopic analysis

According to classical literature soil suction has required always a special attention because of the importance it has when you want to determine soil fertility as a soil with a balanced distribution of the sand, silt and clay contents will encourage the development and maintenance of conditions vital to develop both flora and fauna as solului- considered as one of the most important environmental components.

The study of the influence of the shape and characteristics of corresponding to soil particles on soil suction is an important factor in determining the variation of retention rate of chemical compounds that once you get in rural unsaturated and saturated represent a real threat for the groundwater quality that at today represents one of the most primordial sources of pure water without the human factor to intervene in order to purification for daily consumption.

Soils in general are composed of mineral fragments with different sizes which have most often hydrological regimes differ according to a number particularities such as shape, size and the size of constituent elements. For this reason the determination of these traits requires a complex analysis based on a comparison with a particle witness some ellipticity (Santamarina J.C. *et al*, 2001).

On this occasion we remember that in specialty literature the particles of irregular shape (compared to those with regular shape) occurs in three main staircase of sphericity (Wadell 1932 Krumbein W.C., 1941; Powers, 1953; Krumbein and Sloss, 1963; Barrett, 1980).

Sphericity can be quantitated as the ratio between the diameter of the largest and lowest scores within the district. Roundness is measured as the average radius of curvature of the surface in relation to the maximum radius of the sphere which can be entered in particle. Refers to the characteristics of surface roughness that can be much smaller than the particle diameter (Santamarina J.C. *et al*, 2003).

In the present study the peculiarities analysis which was above mentioned was performed using SEM technique to use as a pillar research the digital image analysis have been provided.

The digital analysis image facilitating the systematic evaluation of the mathematics descriptors that take account of particle shape, including Fourier analysis, used hybrid techniques to achieve an analysis on level fraction (Meloy, 1977; Clark, 1987; Hyslip and Vallejo, 1997; Bowman *et al*, 2001).

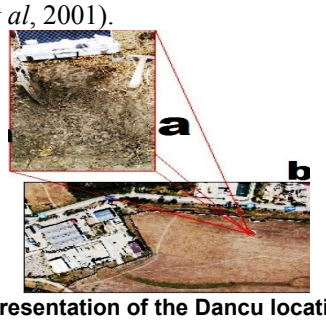


Figure 1 **Presentation of the Dancu location study a) samples harvested, b) zone of sampling soil**

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## MATERIAL AND METHOD

All research was conducted on soil samples disturbed one for each depth (stored in labeled bags) and undisturbed harvested one for each depth from Dancu study area (*figure 1 b*) (collected by the method of metallic cylinders with a volume of 100 $cm^3$) shown in *figure 1 a.*

Soil particles morphology analyses were achieved by: a) size analysis (*figure 2.1 a*) and b) SEM (Scanning Electron Microscope) microscopic type.

Microscopic research was performed using scanning electron microscope Quanta 200, manufactured by FEI COMPANY. All samples (total samples = 24, 6 for each depth) were analyzed in Low Vacuum, approximately 60 Pa to 20 Kv shown in *figure 2.1 b*).

Suction was determined on a value range between pF 0 and pF 4.2 using experimental plant comprising: sandbox (pF 0 – pF 1.8) remarked in *figure 2.2 a*), sand/kaolin box pF 2 – pF 2.7) shown in *figure 2.2b*), and the pressure membrane apparatus (pF 3 –pF 4.2) noticed in *figure* 2.2 c) (Dumitru. 2006).


Figure 2 **The tools used in research:**
**1: equipment used to analyze the morphology of mineral particles: a) shaker electromagnetic; b) equipment used in microscopic analysis SEM; 2: all equipment used in the study of hydraulic properties a) sandbox; b) sand/ kaolin box; c) pressure membrane apparatus**

Determination of soil particle shape was achieved after analyzing SEM images provided by Quanta 200 scanning electron microscope, manufactured by FEI. The research focuses on particle shape classification categories particulate form by form factor he mentioned in other studies conducted on the subject.

Last aspect taken into calculation of soil particle shape analysis was rapotul size between the largest and smallest - determined using Autocad and microscope mentioned above. In this case study considered valid only ends particles compared to the second stage which took into account only the dimensions that microscope has been determined according to the focused area (*figure 4*).

In 2011 Stanisław Ż. is those achieved a study on the influence of particle shape on soil hydraulic propreties. For example, if the granules have the shape of a sphere having a d diameter, where b = d, and A = 6. The value of the shape factor is also 6, where the particle has the shape of a cube of side b and a cylinder with a base diameter B and height b. However, if the particles are oblong and the flattened, the value of A is raised.

In our study we did not find out the desired the A shape factor value, but only the particles in the classification of certain types listed in *figures 3 and Table. 3*. In the present study it was observed these and other forms such as: irregular shape.

In analyzing of this relationship between the morphological characteristics associated particles of different fractions directly related to pore system that lies across the surface of their ability to note the water of mineral particles to focus only on two categories of pores (macropores and nanopores shown in *figure 5*).

Suction lowest (pF 0 - pF 2.0) thresholds were associated with macropores because they can store a higher amount compared to nanopores that can retain water volume much smaller at higher pF values (pF 2.3 - pF 4.2). This relationship between that particularites of soil fragments and soil suction is presented in *figures 6.*

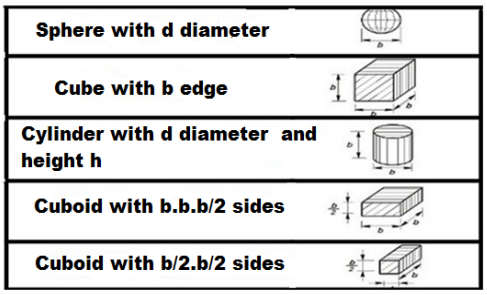


Figure 3 **Form factor A for various forms of particle adapted after Stanisław Ż., 2011**

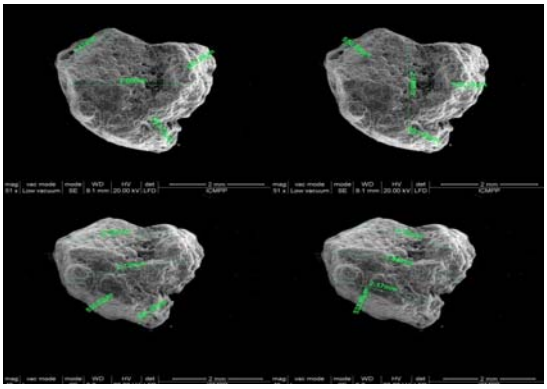

Figure 4 **SEM image at 51 x of 1mm soil particle corresponding D 0-20 cm - A shape factor**

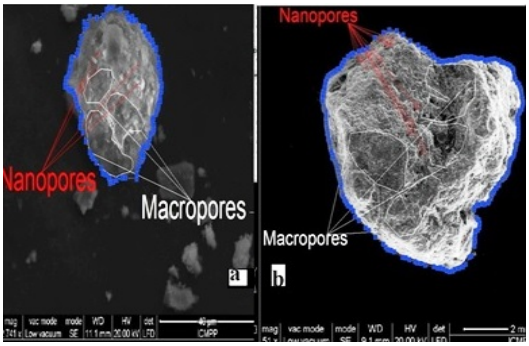


Figure 5 **SEM image at 2741 and 51 x - morphological particularities of mineral fragments from Dancu 0-20 cm a: particle < 63 µm - distribution of soil particle pore surface. b) particle 1 mm - distribution of soil particle pore surface**

## CALCULATION PROCESS

The dates of water retention curve in the soil were obtained using the relation 5 (Ahuja L.R., 1998):

$$W = \frac{weiht\ of\ soil\ water \cdot 100\ \%}{weigt\ of\ soil} \quad (3)$$

$$\rho_d = \frac{\text{dry soil weight (without ring.canvas)}}{\text{weight of soil}} \quad (4)$$

$$\theta = W \cdot \rho_d \quad (5)$$

where:
θ - volumetric water content;
W - soil humidity;
$\rho_d$ - bulk soil density.

## RESULTS AND DISCUSSIONS

In *Table 1* are shows the values of size mineral particles on study section and in *Table 2* are mentioned the of θ (%) water content at all suction thresholds for soil to Dancu site and SEM analysis results will be presented in (*Tables 3*) which will be presented in the morphological characteristics soil mineral fragments for example: 1 mm, 250 µm and 63 µm to 0-20 cm and 60-80 cm depths - the shape of fragment, the size and the particle surface area (done with AutoCAD 2007) and for other depths was similary.

Table 1

**Particle size distribution of Dancu site**

| µm | D 0-20 cm (%) | D 20-40 cm (%) | D 40-60 cm (%) | D 60-80 cm (%) |
|---|---|---|---|---|
| 63 | 6.5 | 4.5 | 7 | 13 |
| 125 | 9.5 | 7 | 11 | 20 |
| 250 | 15 | 12 | 18 | 25 |
| 500 | 44 | 45.5 | 36 | 42 |
| 1000 | 100 | 100 | 100 | 100 |

Table 2

**The values of θ (%) water content at all suction thresholds for soil to Dancu site**

| pF (kPa) | θ (%) D 0-20 cm | θ (%) D 20-40 cm | θ (%) D 40-60 cm | θ (%) D 60-80 cm |
|---|---|---|---|---|
| 0 | 52.21238938 | 45.16129032 | 48.33333333 | 42.70833333 |
| 0.4 | 51.32743363 | 43.68340944 | 47.5 | 40.625 |
| 1 | 50.44247788 | 43.5483871 | 45.83333333 | 37.5 |
| 1.5 | 48.67256637 | 41.93548387 | 45 | 35.41666667 |
| 1.8 | 47.36842105 | 41.12903226 | 42.5 | 33.33333333 |
| 2 | 46.90265487 | 39.51612903 | 35.86156112 | 30.33333333 |
| 2.3 | 46.49122807 | 36.14916286 | 27.90868925 | 27.42342342 |
| 2.7 | 44.73684211 | 33.77703827 | 26.11940299 | 24.78832117 |
| 3 | 37.57225434 | 33.59375 | 25.37313433 | 20.05839416 |
| 3.4 | 30.1300578 | 32.8125 | 23.88059701 | 16.59854015 |
| 4.2 | 15.39017341 | 31.25 | 12.22385862 | 8.454608455 |

Table 3

**Results of the morphological analysis for particles of different size fractions with macropores and nanopores system for Dancu site**

| Dancu | Fraction size | The pore surface (max) P.S. ($mm^2$) | The type of pores | A shape factor |
|---|---|---|---|---|
| D 20-40 cm | 1mm | 1.037 | Macropores | irregular shape |
| D 20-40 cm | 500 µm | 0.251 | Macropores | cuboid with b.b.b/2 sides |
| D 20-40 cm | 250 µm | 0.008 | Macropores | cuboid with -b.b/2.b/2 sides |
| D 20-40 cm | 125 µm | 0.0011 | Macropores | cuboid with -b.b.b/2 sides |
| D 20-40 cm | 63 µm | 0.00028 | Macropores | cuboid with - b.b.b/2 sides |
| D 20-40 cm | < 63 µm | 0.00009 | Macropores | sphere with d diameter |
| D 40-60 cm | 1mm | 0.762 | Macropores | irregular shape |
| D 40-60 cm | 500 µm | 0.738 | Macropores | irregular shape |
| D 40-60 cm | 250 µm | 0.346 | Macropores | cuboid with -b.b.b/2 sides |
| D 40-60 cm | 125 µm | 0.0014 | Macropores | cube with b side |
| D 40-60 cm | 63 µm | 0.00058 | Macropores | cuboid with b.b.b/2 sides |
| D 40-60 cm | < 63 µm | 0.00026 | Macropores | cuboid -b.b/2.b/2 sides |
| Dancu | Fraction size | The pore surface (min) P.S. ($mm^2$) | The type of pores | A shape factor |
| D 20-40 cm | 1mm | 0.0012 | Nanopores | irregular shape |
| D 20-40 cm | 500 µm | 11.389 | Nanopores | cuboid with b.b.b/2 sides |
| D 20-40 cm | 250 µm | 5.544 | Nanopores | cuboid with -b.b/2.b/2 sides |
| D 20-40 cm | 125 µm | 0.0711 | Nanopores | cuboid with -b.b.b/2 sides |
| D 20-40 cm | 63 µm | 0.015 | Nanopores | cuboid with - b.b.b/2 sides |
| D 20-40 cm | < 63 µm | 0.0058 | Nanopores | sphere with d diameter |
| D 40-60 cm | 1mm | 0.0019 | Nanopores | irregular shape |
| D 40-60 cm | 500 µm | 8.442 | Nanopores | irregular shape |
| D 40-60 cm | 250 µm | 6.147 | Nanopores | cuboid with -b.b.b/2 sides |
| D 40-60 cm | 125 µm | 0.086 | Nanopores | cube with b side |
| D 40-60 cm | 63 µm | 0.0012 | Nanopores | cuboid with -b.b.b/2 sides |

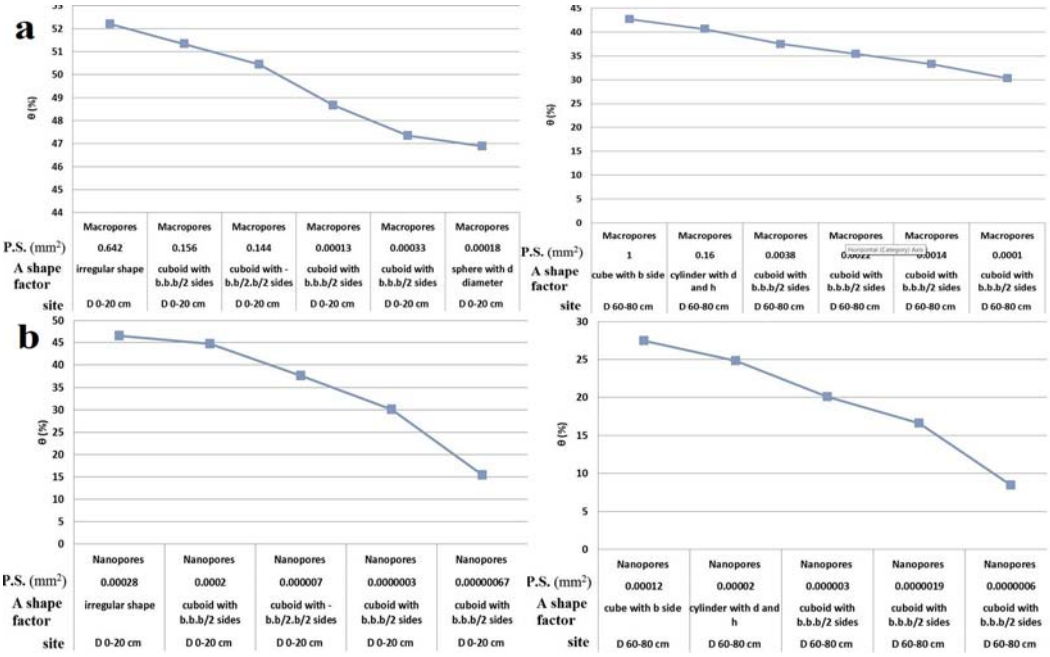


Figure 6 **The relationship between morphological characteristic of particle at different particle size fractions and soil suction for D 0-20 cm and D 60-80 cm a) macropores; b) nanopores**

The results of size analysis can highlight a variation of the percentages corresponding to each particle size fractions in direct proportion with increasing depth of soil sampling analysis.

Following the analysis of SEM type, we can achieve an overview on the morphological characteristics of soil particles for each particle size. The morphological characteristics of soil particles ranged in depth from six different particle.

The particles that make up soil from the Dancu site have highlighted some aspects of the shape factor A. The soil sample D 0-20 cm was composed of particles following form: ~ 50%, cuboid with bbb /2 side and irregular shape and cuboid withside bb/2 b/2, D 20-40 cm - b cube with b side, ~ 50% cuboid with bbb/2 side and spherical particles. Regarding soil sample D 40-60 cm (*table 3*) was observed a relatively uniform distribution of A shape factor for all six particle size fractions. D 60-80 cm (*figure 6. a*) holds a sizeable percentage of particles shaped like a cuboid with b.b.b/2 sides ~ 50%, cube with b edge (side) and cylinder with d diameter and h height.

Soil samples collected from the Dancu area the first level of suction exhibited a range of values of the water content were particularly the location and depth to the other but not in direct proportion to the increase in depth.

It noted a lower content in soil sample as compared to the depth D 20,...,40 cm D 40,...,60 cm. The highest value 52.21% was obtained in the first depths, has the highest total porosity compared to the lowest found in soil D 60,...,80 cm.

The highest rate was determined on soil samples collected from the first depth, and the lowest rate was observed in soils extracted from a depth of D 60,...,80 cm. If things change value of pF 4.2, suction does not change from depth to another depth as if pF 2, but shows varying values depending on soil type, so the lowest values of $\theta$ water content 34.25% were observed at D 20,...,40 cm soil.

The maximum was observed in D 0,...,20 cm soil, and the medium in D 40,...,60 cm.

When you looked at the relationship between morphological characteristics of the soil particles at various dimensions and soil suction was considered only two kinds of pores (macropores and nanopores)

**If it notices a decrease in the macropores water contents with decreasing values of morphological characteristics of mineral fragments.**

Regarding the situation nanopores, it could highlight a change in the form of suction of curves for the four depths. The curve shapes change according to the size of each particle fraction retention, different size and surface (*figure 6. b*).

**Water contents fell as the two types of pore surface began to decrease depending on size fraction. As with hydraulic conductivity**

**this relationship has changed from a depth to another.**

## CONCLUSIONS

The distribution of shape and morphological characteristics of soil particles on study section greatly influenced hydric regime of soil from the Dancu site. When we are referring to the soil we relate at a homogeneous formation composed by well-structured aggregates which are formed to particles with different diameters, sizes and shapes.

The primary characteristics of particles mentioned above are taken in to account when we want to determine the transport mode of all fluids types.

The SEM analysis type help us in making accuracy determination of possible relationship between morphological characteristics (parameters) representative for each particle and the most important hydraulic properties of the soil with a major impact on water regime corresponding with the each type of soil from that four depth.

This paper has centered on how the variation of certain of shape and basical characteristics of particles shows the possibility of changing the storage regime for the various fluids when you want to determine the main particularities of agricultural soils.

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# THE INFLUENCE OF THE COMPACTION PROCESS ON THE OSCILATION OF SOIL HYDROPHYSICAL PROPERTIES FROM TATARASI AREA

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**Abstract**

The present work wants to highlight the influence it has compacting process on the variation of hydrophysical.properties of three types of soil.
In resolving this hostile soil phenomenon this paper tries to noting the main effects exerted by the compaction process on the hydrophysical.properties distribution in time and space by applying laboratory methods for determining the physical and hydraulic properties of soils from Tatarasi study area. Principal physical characteristics were determined: soil density, soil bulk density, texture and soil porosity.
Hydraulic properties analyzed in order to mark the variation of water regime were: hydraulic conductivity (saturated and unsaturated) and soil suction.
All these basic aspects of soil were analyzed using laboratory methods widely applied all around the world.

**Key words:** compaction process, soil physical aspects, soil hydraulic properties

In general the soil compaction is one of the main causes of the phenomenon of negative character entitled destruction from degradation.

From the multitude of effects due to the emergence and further development of the compaction process reduced the hydraulic conductivity and soil water but should not be neglected increasing the water retention (soil suction).

In terms of hydraulic soil is a porous medium which is reflected in complex structure its rather complicated system of canals and trails variable called soil pores that support the movement of fluids through them. In this regard it was found that for the transport of water and chemical compounds in the soil is necessary to have two environments: solid medium (soil matrix) and a stream of water moving through the pores of the soil (Stătescu and Pavel, 2011).

During the process pierce soil by fluid, his permeability is altered. Thus, based on dry ground, in the first instance, the permeability is high and then decreases rapidly, until the soil is saturated with water. Since then, the amount of water that enters the soil becomes constant. Water entering for unsaturated soil is made by infiltration (I.C.P.A., 1980).

## MATERIAL AND METHOD

All research was conducted on soil samples disturbed one for each depth (stored in labeled bags) and undisturbed harvested one for each depth from Tatarasi study area (*figure 1 b*) (collected by the method of metallic cylinders with a volume of 100 $cm^3$) shown in *figure 1 a*

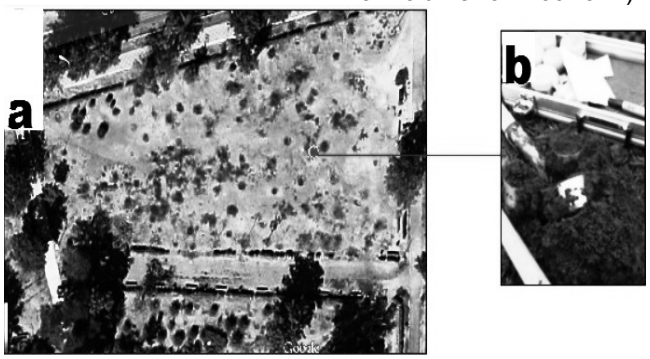


Figure 1 **Presentation of the Breazu location study a) zone of sampling soil, b) samples harvested**

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Physical properties were analyzed in the laboratory with the following methods: soil density and soil bulk density (oven drying method and pycnometer method *figure* 1. c), texture (pipetting method performed using Eijkelkamp Pipette Apparatus *figure* 1 b) and size distribution (*figure* 1. a)

The analysis of hydraulic characteristics of soil samples was achieved by the laboratory methods, for hydraulic conductivity was the constant-head method ($K_s$) (Lungu., 2013) give us in *figure* 2. 2 d) and the falling head method ($K_\theta$) (Stanciu & Lungu, 2006) presented in *figure* 2. 2 e.

Suction was determined on a value range between pF 0 and pF 4.2 using experimental plant comprising: sandbox (pF 0 – pF 1.8) remarked in *figure* 2. 2 a), sand/kaolin box pF 2 – pF 2.7) shown in *figure* 2 2 b), and the pressure membrane apparatus (pF 3 –pF 4.2) noticed in *figure* 2. 2 c) (Dumitru., 2009)

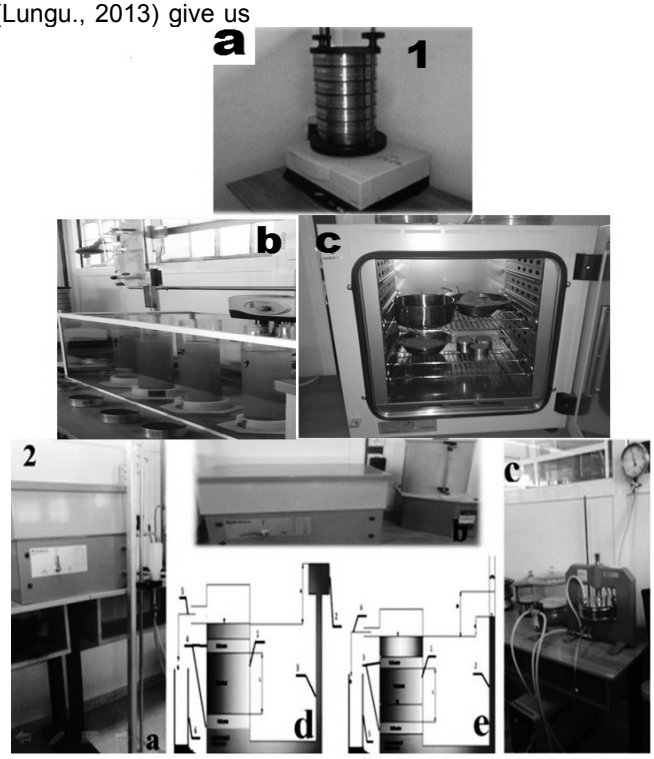


**Figure 2. The techniques used in research: 1: equipment used to analyze the physical properties: a) shaker electromagnetic; b) Eijkelkamp Pipette Apparatus c) drying machine 2: all equipment used in the study of hydraulic properties a) sandbox; b) sand/ kaolin box; c) pressure membrane apparatus; d) constant-head method; e) falling head method**

## CALCULATION PROCESS

Soil density. is calculated with eq. 1 *(*Filipov & Lupaşcu., 2003)

$$D = \frac{m_2 - m_0}{m_1 + m_2 - m_0 - m_3} \cdot \rho_1 \qquad (1)$$

where:
$D$ - soil density, [g/cm$^3$];
$m_0$ – mass of empty pycnometer;
[g], $m_1$ – mass of pycnometer with liquid;
[g], $m_2$ – mass of pycnometer with soil, [g];
$m_3$ – mass of pycnometer with soil and liquid, [g];
$\rho_1$ – liquid density, [g/cm$^3$].

Soil bulk density is calculated from the relationship (2) (Rogobete., 1993)

$$DA = \frac{m_2 - m_1}{V_t} \ (g/cm^3) \qquad (2)$$

where:
$m_1$ is the mass of empty cylinder gol [g];
$m_2$ – mass of cylinder with dry soil at 105°C [g];
$V_t$ – the total volume of the soil sample from cylinder [cm$^3$].

Soil porosity is calculated with (King., 1965):

$$PT = \left(\frac{V_p}{V_t}\right) \cdot 100 = \left(1 - \frac{DA}{D}\right) \cdot 100 \qquad (3)$$

where:
PT is the total porosity [%];
$V_p$ – pore volume [cm$^3$];
$V_s$ – the volume of the solid part of the soil [cm$^3$];
D – soil density [g/cm$^3$];
DA- the bulk density of the soil [g/cm$^3$].

Hydraulic conductivity $K_s$ on vertical direction of the water flow is calculated from the relationship *(4)* (King., 1965):

$$K_S = \frac{V * L}{T * A * h} \qquad (4)$$

where:

V- volume of water collected;
L - length of the soil sample;
T - time for the collection volume of water (the excess);
A –cross sectional area of the sample.

Unsaturated hydraulic conductivity values $K_{(\theta)}$ were determined with (King., 1965):

$$K_{(\theta)} = \frac{a * L}{T * A} \cdot \ln\left(\frac{h_1}{h_2}\right) \quad (5)$$

where:
a - the cross section of graduated tube;
L - length of the soil sample;
T - time for the collection volume of water (the excess);
A –cross sectional area of the sample;
$h_1$ and $h_2$ -height of water column after a time T.

The dates of water retention curve in the soil were obtained using the relation 8 (Ahuja., 1998):

$$W = \frac{\text{Weight of soil water} \times 100\%}{\text{Weight of soil}} \quad (6)$$

$$\rho_d = \frac{\text{dry soil weight (without ring.canvas)}}{\text{weight of soil}} \quad (7)$$

$$\theta = W \cdot \rho_d \quad (8)$$

where:
$\theta$ is the volumetric water content [%];
$W$ – soil humidity [%];
$\rho_d$ – soil bulk density[g/cm$^3$].

## RESULTS AND DISCUSSIONS

In Table 1 and 2 are presents the results obtained after applying the research methods of the physical properties of soils harvested on the four depth from area studied.

Table 1

**Size distribution of Tatarasi study area**

| µm | T 0-20 cm (%) | T 20-40 cm (%) | T 40-60 cm (%) | T 60-80 cm (%) |
|---|---|---|---|---|
| 63 | 7 | 8 | 10 | 20,5 |
| 125 | 10 | 11 | 15 | 30,5 |
| 250 | 16,5 | 17 | 24 | 44,5 |
| 500 | 35,5 | 36 | 45 | 67,5 |
| 1000 | 100 | 100 | 100 | 100 |

Table 2

**Physical and hydraulic properties of soils for Tatarasi**

| Sample | D.A. (g/cm3) | D (g/cm3) | P.T. (%) | Clay (%) | Silt (%) | Sand (%) | $K_{(\theta)}$ (cm/s) | $K_s$ (cm/s) |
|---|---|---|---|---|---|---|---|---|
| T 0-20 cm | 1.06 | 2.12 | 50 | 4 | 79 | 17 | 0.016085 | 0.02221 |
| T 20-40 cm | 1.13 | 2.2 | 48.7 | 9 | 60 | 31 | 0.020119 | 0.016124 |
| T 40-60 cm | 1.22 | 2.25 | 45.77 | 13 | 30 | 57 | 0.020171 | 0.016561 |
| T 60-80 cm | 1.31 | 2.35 | 44.3 | 14 | 57 | 29 | 0.016361 | 0.000133 |

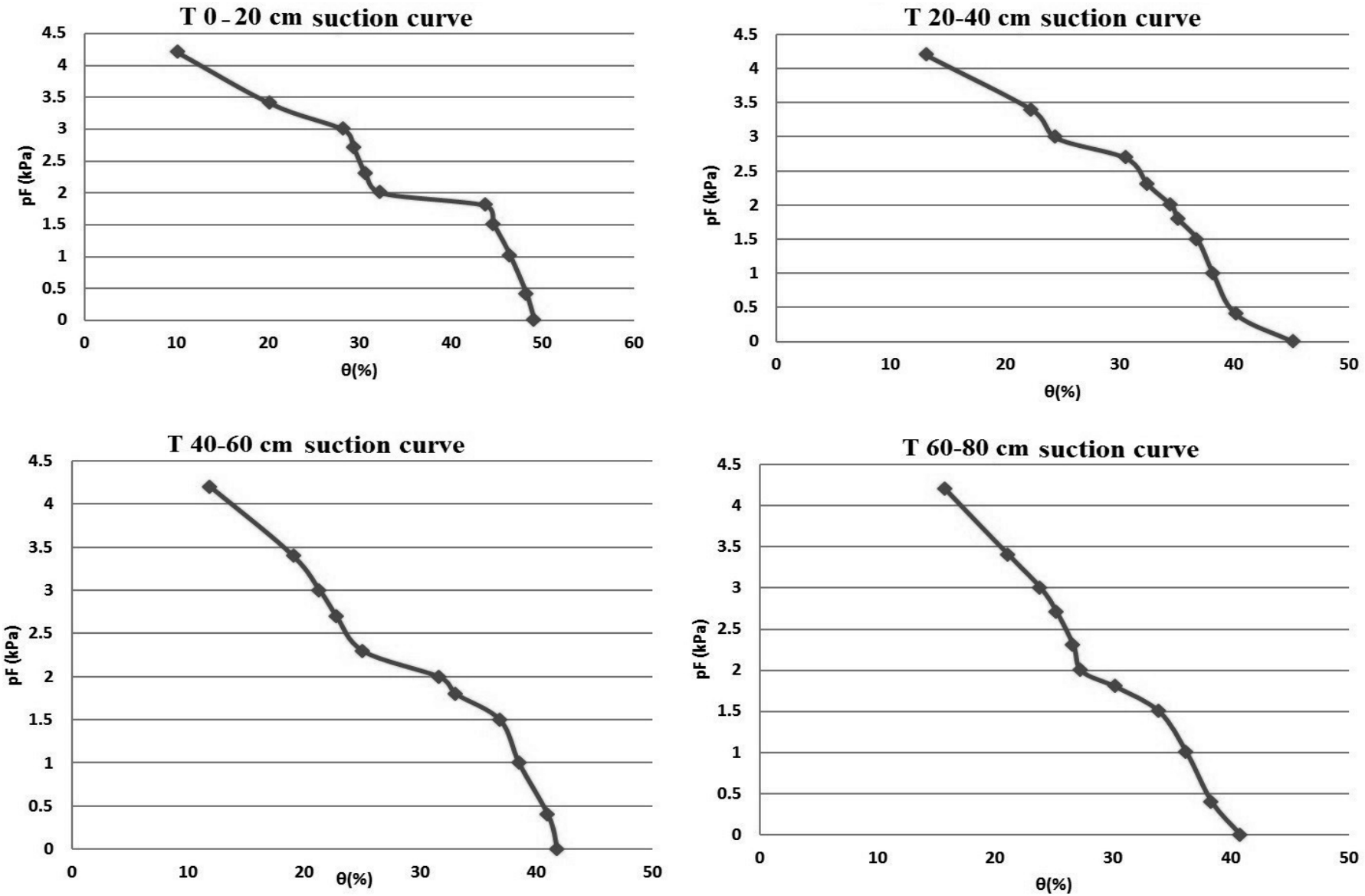


Figure 3 **The suction curves of Tatarasi study area**

For Tatarasi area we mention that aspect: soil density was generally lower than the other two areas because this type of soil presented a bit different mineralogical composition.

Compared to the density and bulk density of the soil, porosity decreased concomitantly with the enhancement the density of the two types.

The lowest values were noted in the case of last depth, they ranged from 44,3%.

The mean values of total porosity on the three areas have been highlighted in the type of soil collected from second harvested level, the latter being in the range of 48.7%-37.5% compared to the maximum percentages found in soil samples taken from T 0-20 cm. All these variations in the values of total porosity is attributable to the content of sand, silt and clay varied according to depth and location.

Preliminary data obtained (table 2) from the $K_{(\theta)}$ and K s analysis showed a speed of transport which gradually varied from a depth to another depending on the physical properties (density, bulk density, texture etc) of the environment in which there is process of infiltration.

This change in flow regime can be justified by the increase of both types of density (density (ρ) and bulk density (DA)) which exerted a great influence on the total porosity (PT) limiting access of water in soil pores (routes drain).

Unsaturated hydraulic conductivity (*table 2*) research conducted on soil samples collected from the study site Tatarasi have revealed that in the first depths (T 0-20 cm) value $K_s$ (0.0222 cm/s) was higher than the $K_{(\theta)}$ (0.0160 cm/s).

The $K_{(\theta)}$ values for soil samples collected from depths of T 20-40 cm, T 40-60 cm and T 60-80 cm fluctuated in line with the change in physical properties.

About saturated hydraulic conductivity (*table 2)* we can remarked as: the Tatarasi perimeter showed similar values but compared with other situations, the relationship between the physical and hydraulic properties variation was constant on all four depths

In *figure 3*, is presents the results obtained after applying the research methods of the hydraulic properties (soil suction) of soils in the three areas studied.

The soil of Tatarasi site is a special case because he merged the two situations described above.

In the pressure range pF 0- pF1,8 the percentage values have been fluctuated constantly on the soil surface to the 80 cm depth and generally taking into account the possible shrinkage of the porous mass arising from the rise of the compaction process.

Between pF 2 and pF 4.2 percentages have fluctuated over the four depths of study, we also highlight the next issue - where T 20-40 cm was observed the highest percentage (32.43%) compared to the other three steps whose values which are evidenced in the graph of *figure 3.*

At pF 4.2 the soil of Tataraşi site could retain a water content between 15.74% and 10.14%. In this case the highest value was observed at T 60-80 cm followed by T 20-40 cm 13.10%, T 40-60 cm had a water content of 11.9% and finally the lowest value was detected in T 0-20 cm soil sample.

## CONCLUSIONS

Making an overall analysis we can mention the following:

The compaction process greatly influenced the distribution in time and space of hydrophysical properties in entire section study depending on the site geology and the action of natural and anthropogenic factors.

The physical properties varied from one area to another one - in the case of soil in the Tatarasi area can be discussed by a slump by natural origin which in the presence of a higher content of clay, silt and sand generated a number of effects worse.

Soil compaction in Tatarasi zone said the word when saturated hydraulic conductivity was determined at the 60-80 cm depth, mainly due to the rearrangement of particles of soil compaction caused by anthropogenic origin fed continuously usefully land of the studied site.

By point of view of the soils storage capacity analyzed can easily observe its variation that can be substantiated by the distribution of physical properties that changed simultaneously with migration percentages of clay, silt and sand on 0-80 cm section for each type of analyzed soil.

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# THE EFFECT OF AQUASORB ON SOME SOIL PHYSICAL PROPERTIES UNDER PEDOCLIMATICAL CONDITIONS OF THE MOLDAVIAN PLAIN

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**Abstract**

Several series of tests were carried out to study the influence of a hydrogel (Aquasorb) on some soil physical properties (bulk density, total porosity, and moisture and water soil reserve) for maize and soybean crops. Aquasorb operates in absorption-desorption cycles of water and nutrients and has efficiency in soil up to five years. The experiment is a bifactorial one, AxB type, being placed in randomized multilevel blocks method, with three replications. The aimed factors of the experiment were the crop and the hydrogel dose. There were three variants: $V_1$ (control) untreated, variant $V_2$ - were administered doses of 15 kg ha$^{-1}$ of Aquasorb and variant $V_3$ - were applied 30 kg ha$^{-1}$. The hydrogel was administered in the spring, before seedbed preparation at 15 cm depth, being incorporated with a disk harrow. The results showed that there was a direct interaction between the dose of hydrogel and the analysed parameters, the differences being statistically significant. The evaluation of the results was done according to the official methodology of pedological studies proposed by ICPA (Research Institute for Soil Science and Agrochemistry, Bucharest). For the bulk density, the values have outlined that for the control variant ($V_1$) the soil may be framed as "weak loose" (BD between 1.19-1.31 g cm$^{-3}$) and the treated variants can be considered as "poorly compacted" (BD between 1.32 to 1.45 g cm$^{-3}$). The hydrogel administration improved the soil moisture, the values ranging between 0.6% and 1% for the maize crop and between 0.8 and 1% for soybean.

**Key words**: hydrogel, Aquasorb, physical indicators, maize, soybean.

In Romania, the agricultural yields periodically are affected around 30-50% depending on the magnitude of extreme weather phenomena. Thereby, 64% of the agricultural area is significantly influenced by long period of drought, which decreases the agricultural sector efficiency (Hurduzeu G. *et al*, 2014, Mateescu E., Alexandru D., 2010, Galeş D.C. *et al*, 2016). In Romania and abroad, the research towards the agricultural tillage systems have been orientated in the direction of finding ways to lead to the soil structure improvement, to reduce the soil compaction and to improve the hydrological and air regime (Răus L. *et al*, 2016). Another problem detected in the NE Region of Romania is the uneven distribution of the rainfall during the growing stages which determines agro-technical issues such as water retention in the soil. One of the modern solutions to such hindrance may be the use of some hydrogels such as Aquasorb. This is a copolymer of acrylamide and potassium acrylate that has the ability to function in absorption-desorption cycles of water and nutrients and to release them progressively to the plants according to their requirements. This has effectiveness in soil up to five years which determines lower costs with irrigation (Agaba H *et al*, 2011) and a better utilisation of water in agriculture. Aquasorb proved its effectiveness especially in arid and semi-arid areas, increasing the water retention capacity in the soil and decreasing the cumulative infiltration and evaporation rate (Hayat R. Ali, S., 2004). Yang-Ren et al, 2007 showed that the hydrogel's efficiency varies with soil structure, the salts and fertilizers concentration as well as the plant breed. Hydrogels application may stabilize the soil structure, increase the erosion resistance and the infiltration rate and may decrease the surface drain (Sojka R.E. *et al*, 2007, Jihoon Kang *et al*, 2015, Sepaskhah A.R., Shahabizad V., 2010, Assaf Inbar *et al*, 2015).

## MATERIAL AND METHOD

There was organized a bifactorial experiment, AxB type, using the randomized blocks method, with three replicates. The experimental factors were represented by crop and Aquasorb dose. The crops used in experiment were maize and soybean. The Aquasorb dose was applied in 3 variants: $V_1$ - untreated variant considered as control, $V_2$ - variant treated with 15 kg ha$^{-1}$ of Aquasorb and $V_3$ - variant treated with 30

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kg $ha^{-1}$ of hydrogel. The Aquasorb was administered in spring, prior seedbed preparation by incorporating it with a disk harrow at 15 cm depth.

The experiment was set to the Ezareni Farm within the "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine" Iaşi (47°5' - 47°10' N latitude, 27°28' - 27°33' E longitude). The pedoclimatic conditions were specific for the Moldavian Plateau (Romania). The field had a slope of 3-4%, being a clay-loamy cambic chernozem, formed on loess deposits, with a medium to good fertility (medium content of N and $P_2O$ and good content of $K_2O$), with a low acid pH and a humus content of 2.5-3.0% *(table 1).*

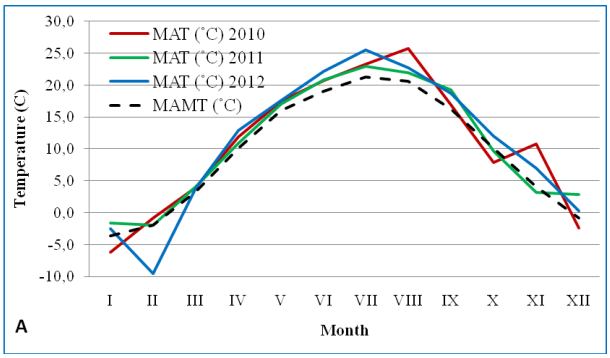
Table 1

**Chemical properties of cambic chernozem from Ezareni Farm**
(0-40 cm soil profile)

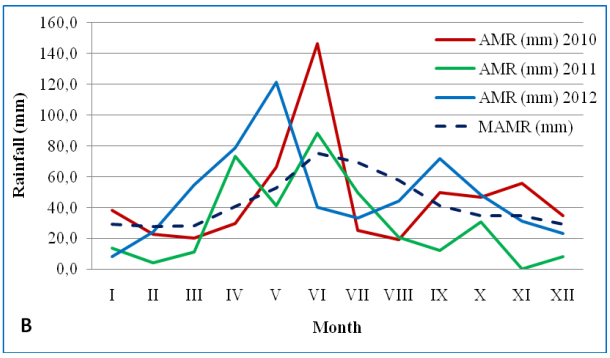
| Crop | Depth (cm) | pH | Humus % | Total N % | P AL mg/kg | K AL mg/kg |
|---|---|---|---|---|---|---|
| Maize | 0-10 | 6.32 | 2.88 | 0.11 | 34.00 | 174.0 |
| | 10-20 | 6.40 | 2.88 | 0.10 | 23.00 | 171.0 |
| | 20-30 | 6.51 | 2.76 | 0.09 | 19.00 | 166.0 |
| | 30-40 | 6.51 | 1.50 | 0.07 | 6.00 | 149.0 |
| **Average 0-40 cm** | | **6,44** | **2.51** | **0.09** | **20.50** | **165.0** |
| Soybean | 0-10 | 6.27 | 3.54 | 0.10 | 27.00 | 195.0 |
| | 10-20 | 6.29 | 2.94 | 0.11 | 27.00 | 192.0 |
| | 20-30 | 6.40 | 3.18 | 0.10 | 18.00 | 167.0 |
| | 30-40 | 6.72 | 2.70 | 0.08 | 8.00 | 155.0 |
| **Average 0-40 cm** | | **6,42** | **3.09** | **0.10** | **20.00** | **177.3** |

The climatic conditions of the experiment were characterised by an average multiannual temperature of 9.6°C and an average multiannual rainfall of 517.8 mm.

The climatic conditions during the experimentation are presented in *figure 1* (A-temperature, B- rainfall).




MAT - Multi-annual temperature
MAMT - Multi-annual mean temperature




AMR - Average monthly rainfall
MAMR - Multi-annual average rainfall

Figure 1 **Climatic factors characterisation for 2010-2012 *(A – air temperature, B – rainfall)***

The used technologies were accordingly with the crop type, respectively maize and soybean (Muntean L.S. *et al*, 2003).

In order to determine the main physical characteristics, there were collected undisturbed soil-cores in 100 $cm^3$ metallic cylinders using an Eijkelkamp kit *(figure 2).*

Figure 2 **Eijkelkamp kit**

The soil samples were taken from each variant, at 0-10 cm, 10-20 cm and 20-30 cm depth.

The main hydro-physical soil indexes were determined using the classical analysis methods (Rusu T., et al 2007, Canarache A., 1990).

The bulk density (BD) was determined by dividing the weight *(W)* of the soil dried in the oven to the total volume ($V_t$) of the sample (1).

$$BD = \frac{W}{Vt} \quad (1)$$

The total porosity (TP) was determined using the formula (2):

$$TP = \left(1 - \frac{BD}{D}\right) \times 100 \quad (2)$$

where, *TP* – total porosity of the soil volume, in %; *BD* – bulk density, in g $cm^{-3}$;
*D* – density, in g $cm^{-3}$ (for most of the soils the values ranged between 2.65- 2.68 g $cm^{-3}$ for the ploughed layer and 2.70- 2.72 g $cm^{-3}$ for the one beneath the ploughed layer).

In order to determine the *soil moisture (U,%)* soil samples were collected from different layers: 0-5 cm, 5-10 cm, 10-15 cm, 15-20 cm, 20-25 cm and 25-30 cm, in aluminum vials, which were dried in the oven. The soil moisture was calculated by dividing the evaporated water at the soil sample weight (3):

$$U\% = \frac{W_w x 100}{W_{ds}} \quad (3)$$

where, *U%* - soil moisture (%); $W_w$ – evaporated water from the sample (g); $W_{ds}$ – dried soil weight (g).

The water reserve was calculated as water layer, in mm (4), *(Dumitru Elisabeta Dumitru, et al 2009):*

$$L_{wr} = W_g \times BD \times h \times 0.1 \quad (4)$$

where, $L_{wr}$ – water reserve as water layer (mm); $W_g$ – gravimetric moisture (g); *BD* – bulk density (g $cm^{-3}$); *h* – the thickness of the considered soil layer (cm); 0.1 – coefficient resulted from transformation of $m^3$ x $ha^{-1}$ in mm.

## RESULTS AND DISSCUSSION

### *Bulk density (BD)*

The values of the bulk density presented in table 2 are average values calculated for depth (0-30 cm) and main vegetation stages (sowing, during vegetation and harvest). The statistical analysis of the average values of the bulk density highlighted significant differences between the treated variants and the control, for both crops *(table 2A).*

Table 2

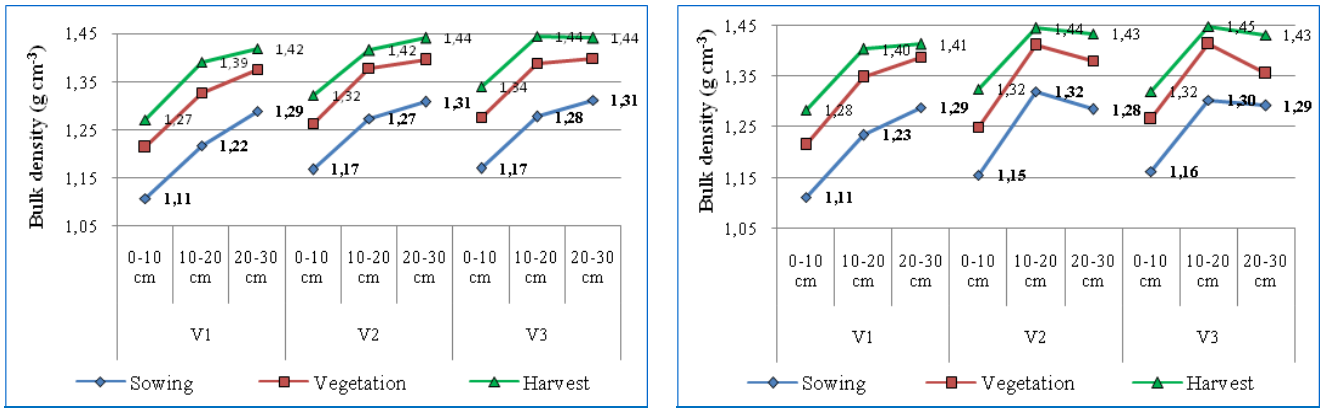
**The influence of Aquasorb on some soil hydro-physical characteristics for maize and soybean crops**
(Average values for years, variants, depth (0-30 cm) and growing stages)

| Type of determination | Variant | Maize | | | | Soybean | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | UM | Compared to control | | Significance | UM | Compared to control | | Significance |
| | | | % | Differences (UM) | | | % | Differences (UM) | |
| A. Bulk density (g $cm^{-3}$) | $V_1$ | 1.29±0.00 | 100.00 | 0.00 | Control | 1.30±0.00 | 100.00 | 0.00 | Control |
| | $V_2$ | 1.33±0.02 | 103.10 | 0.04 | xx | 1.33±0.01 | 102.31 | 0.03 | xx |
| | $V_3$ | 1.34±0.01 | 103.88 | 0.05 | xxx | 1.33±0.00 | 102.31 | 0.03 | xx |
| | | LSD 5% = 0.013 g $cm^{-3}$; LSD 1% = 0.022 g $cm^{-3}$; LSD 0.1% = 0.041 g $cm^{-3}$; | | | | LSD 5% = 0.012 g $cm^{-3}$; LSD 1% = 0.022 g $cm^{-3}$; LSD 0.1% = 0.037 g $cm^{-3}$; | | | |
| B. Total porosity (% v/v) | $V_1$ | 51.61±0.18 | 100.00 | 0.00 | Control | 51.30±0.15 | 100.00 | 0.00 | Control |
| | $V_2$ | 50.13±0.79 | 97.14 | -1.48 | ooo | 49.97±0.43 | 97.41 | -1.33 | ooo |
| | $V_3$ | 49.78±0.46 | 96.45 | -1.83 | ooo | 49.89±0.31 | 97.25 | -1.41 | ooo |
| | | LSD 5% = 0.3 % v/v; LSD 1% = 0.5 % v/v; LSD 0.1% = 1.0 % v/v; | | | | LSD 5% = 0.3 % v/v; LSD 1% = 0.5 % v/v; LSD 0.1% = 1.0 % v/v; | | | |
| C. Soil moisture (%) | $V_1$ | 15.8±0.26 | 100.0 | 0.0 | Control | 15.8±0.21 | 100.0 | 0.0 | Control |
| | $V_2$ | 16.4±0.11 | 103.8 | 0.6 | x | 16.6±0.12 | 105.1 | 0.8 | xx |
| | $V_3$ | 16.8±0.07 | 106.3 | 1.0 | xx | 16.8±0.04 | 106.3 | 1.0 | xxx |
| | | LSD 5% = 0.4 %; LSD 1% = 0.7 %; LSD 0.1% = 1.3 %; | | | | LSD 5% = 0.3 %; LSD 1% = 0.5 %; LSD 0.1% = 0.9 %; | | | |
| D. Water content (mm) | $V_1$ | 61.4±5.78 | 100.0 | 0.0 | Control | 61.7±6.14 | 100.0 | 0.0 | Control |
| | $V_2$ | 65.7±5.15 | 107.0 | 4.3 | xxx | 66.4±5.87 | 107.6 | 4.7 | xxx |
| | $V_3$ | 67.7±6.61 | 110.3 | 6.3 | xxx | 67.1±6.30 | 108.8 | 5.4 | xxx |
| | | LSD 5% = 1.3 mm; LSD 1% = 2.0 mm; LSD 0.1% = 3.3 mm; | | | | LSD 5% = 1.9 mm; LSD 1% = 2.9 mm; LSD 0.1% = 4.7 mm; | | | |

Note: x- significant, xx – distinctly significant, xxx – very significant, o – negative significant, oo – negative distinctly significant, ooo – negative very significant, LSD – Least Significant Difference. $V_1$ – Control (untreated), $V_2$ - 15 kg $ha^{-1}$ Aquasorb, $V_3$ - 30 kg $ha^{-1}$ Aquasorb.

According to the methodology proposed by I.C.P.A. (Florea N., et al 1987), the bulk density results showed that the control variant was "weak loose" (BD varies between 1.19-1.31 g $cm^{-3}$) and the treated variants were "poorly compacted" (BD varies between 1.32-1.45 g $cm^{-3}$).

The plant radix was normally developed for both treated and untreated variants due to the fact that bulk density had values lower than 1.40 g $cm^{-3}$, being well known that those values are considered optimal for plant growth and development in a soil with clay loam texture. The *figure 3* shows the bulk density variation during the growing stages also on the 0-30 cm soil layer.



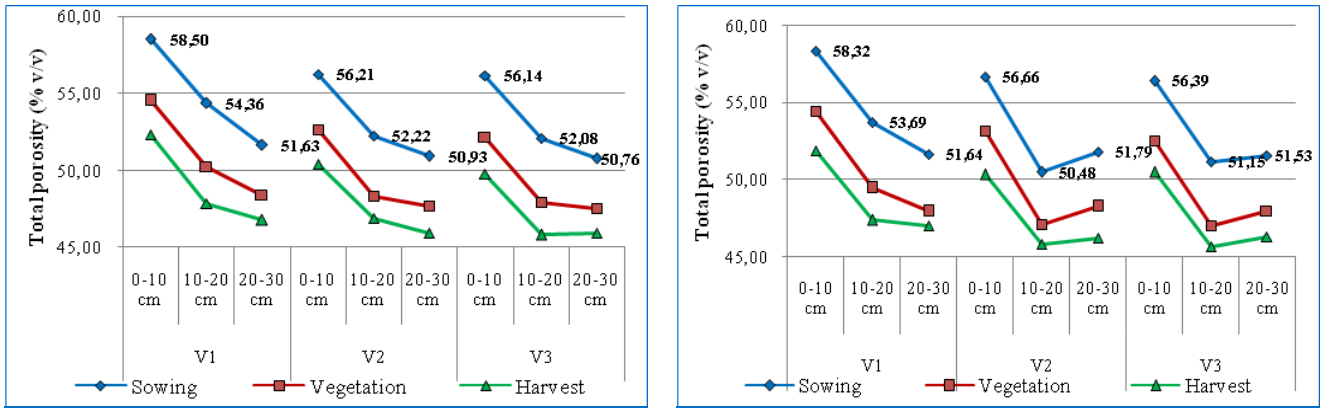

Maize Soybean

Figure 3 **The Bulk density evolution on depth and growing stages - average values 2010-2012**
$V_1$ – Control, $V_2$ – 15 kg $ha^{-1}$ Aquasorb, $V_3$ – 30 kg $ha^{-1}$ Aquasorb

***Total porosity (TP)***

TP has a special importance for the whole soil dynamics. To total porosity has a similar role to the solid phase because through the soils pores circulate all its organic and mineral components and which determine the analysing and interpreting of this indicator to be done depending on other important soil qualities such as, texture. Thus, a correct interpretation of this indicator according with the official methodology of pedological studies, is differentiated whereas the same values of total porosity may have different levels of favorability for plants depending on soil texture. It is appreciated that the ploughed layer is well done when the total porosity values range between 48 and 55% from which 2/3 are represented by capillary pores that retain water and 1/3 by non-capillary pores that retain air (Rusu T. et al, 2007).

Averages values of TP *(table 2B)* on depth and growing stages showed that the hydrogel influenced the differentiated mode in which the soil "placed" itself under the influence of technological works executed during the growing periods, the rainfalls as well as of the own soil weight. In the hydrogel action zone were recorded higher variations compared with the ones from 20-30 cm depth layer due to the indirect influence of the soil moisture.




Maize Soybean

Figure 4 **Total porosity evolution on depth and growing stages - average values 2010-2012**
$V_1$ – Control, $V_2$ – 15 kg $ha^{-1}$ Aquasorb, $V_3$ – 30 kg $ha^{-1}$ Aquasorb.

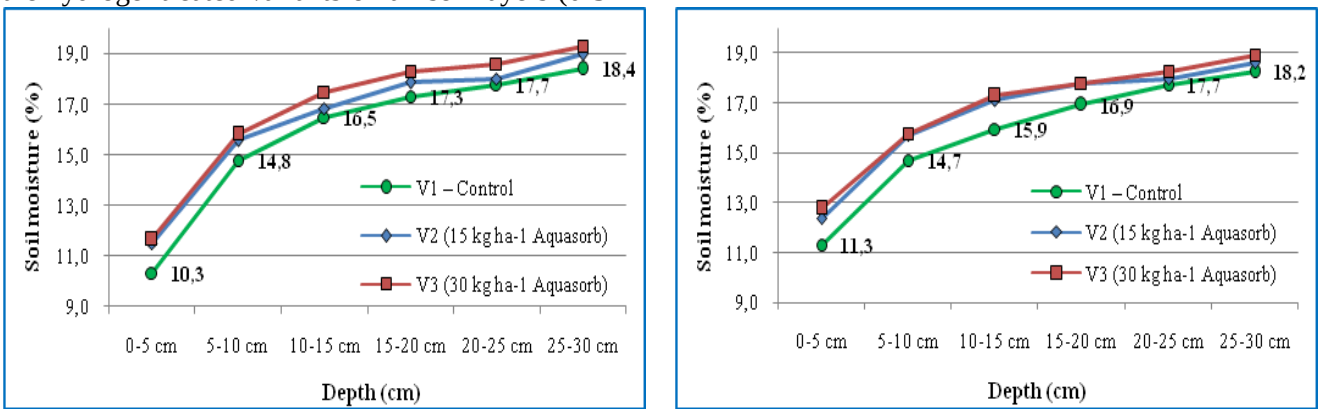
The results interpretation according to the official methodology of pedological studies, frame the soil from the polymer treated variants and the control variant in the "weak loose" class at sowing and in "weak compacted" class during vegetation and harvesting *(figure 4).* However, for the polymer treated variants the framing is done to a lower class limit compared with control variant.

***Soil moisture***

The data analysis (on depth and vegetation stages) showed that the hydrogel had a direct influence on soil moisture average values, with

statistical differences noticed for both crops *(table 2C).* There were registered higher soil moisture values with 0.6-1.0% for maize culture and with 0.8-1.0% for soybean crop while to the control variant the soil moisture was in average 15.8% for both crops *(table 2).* Soil moisture was higher for the hydrogel treated variants on all soil layers (0-5 cm, 5-10 cm, 10-15 cm, 15-20 cm, 20-25 cm and 25-30 cm) in both crops *(figure 5).*

The results explain the hydrogel property to control water movement through the soil by easily retaining (blocking) the moisture and releasing it, afterwards, to the plants (Galeș D.C. et al, 2016).

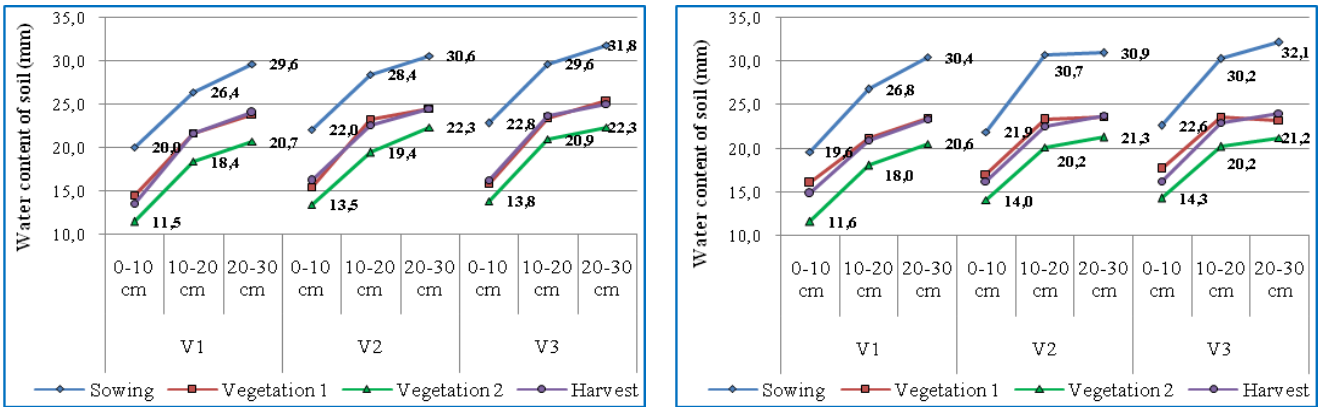



Maize Soybean

Figure 5 **Soil moisture evolution on depth - average values 2010-2012**

***Soil water reserve***

Soil water reserve was positively influenced by the hydrogel treatment. Thus, differences were registered between the hydrogel treated variants and the control, which ranged according with the applied Aquasorb doses between 4.3-6.3 mm for maize crop and 4.7- 5.4 mm for soybean. For the control variant, the soil water reserve varied between 61.4 mm for maize and 61.7 mm for soybean *(table 2D).* In general, soil water reserve may vary with the rainfall during the vegetation stages. Thus, for both crops were noticed higher amplitudes of soil water reserve variation after sowing and quite lower values during the driest periods of the year. For the treated variants, Aquasorb created a higher water reserve in the soil, after the spring rainfall *(figure 6).*




Maize Soybean

Figure 6 **The water reserve evolution on depth and growing stages - average values 2010-2012**
$V_1$ – Control, $V_2$ – 15 kg ha$^{-1}$ Aquasorb, $V_3$ – 30 kg ha$^{-1}$ Aquasorb

This generated water accumulation and the possibility of releasing it to the plants, according to their necessities. These results confirms prior researches (Nevenka Đurović, et al, 2012, Galeş D.C., et al, 2012, 2011, *Bhat N.R, et al, 2006,* El-Hady O.A. *et al*, 2002, Jahangir A.K. and Asadkazemi J., 2006, Nazarli H. and Zardashti M.R., 2010, Allahdadi I. *et al*, 2005, Lee Sang Soo *et al*, 2015), which supports the Aquasorb capacity of releasing water to the plants.

## CONCLUSION

Applying the Aquasorb hydrogel had a direct influence on the analysed parameters, determining the increase of the bulk density, soil moisture and soil water reserve and the decrease of the total porosity.

The obtained results lead us to say that the Aquasorb has prospects to be successfully used in

cultivation technologies at least for maize and soybean and possibly for other crops.

Also, that can be regarded as one of the measures to combat the negative effects of drought of average intensity or the uneven distribution of rainfall during the plant growing stages.

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# THE EFFECT OF AQUASORB ON SOME MORPHO-PHYSIOLOGICAL PARAMETERS OF THE PLANTS UNDER THE PEDOCLIMATICAL CONDITIONS FROM MOLDAVIAN PLATEAU

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**Abstract**

The study aimed to outline the influence of hydrogel (Aquasorb) on some morpho-physiological parameters of the plants (number of grains per cob pods per plant, average height and chlorophyll content in leaves) for maize and soybean crops. Aquasorb is a copolymer of acrylamide and potassium acrylate that has the ability to absorb water and to release it progressively in the plant according to their needs. The experiment was bifactorial, AxB type, being located under the pedoclimatic conditions of the Moldavian Plateau from Ezareni Farm (47°5'- 47°10' N lat. 27°28'-27°33' E long.). The experimental field had a slope of 3-4 % with a clay-loamy texture of cambic chernozem soil. The soil had a medium content of N and P and good content of K, slightly acid pH and 2.5 – 3.0 % humus content. The experimented factors were the crop (maize and soybean) and hydrogel doses with three graduations ($V_1$- control variant, not treated; $V_2$- soil was treated with 15 kg $ha^{-1}$ Aquasorb; $V_3$ – soil was treated with 30 kg $ha^{-1}$ Aquasorb). The hydrogel was incorporated with a disk harrow at 15 cm depth, during seedbed preparation, in spring. The results outlined that the plants height registered large differences on treated variants compared with the control one especially at 30 days after their sprung up, which shows that the hydrogel provide a good start in plant vegetation and implicitly many advantages in the fight against weeding. The average content of chlorophyll in leaves was increased in hydrogel treated variants; depending on the Aquasorb dose. The values varied between 1.5 to 2.9 CCI (chlorophyll content index) for maize and between 1.2-1.9 CCI for soybean.

**Key words**: hydrogel, Aquasorb, morpho- physiological parameters, maize, soybean

In Romania, almost 64% of agricultural areas are more or less affected by long droughts periods and in consecutive years (Ulea E. *et al,* 2012; Hurduzeu G. *et. al,* 2014; Mateescu E., Alexandru D., 2010). Using hydrogel for soil conditioning, a part of the area affected by degradation processes such as, drought may be restored and returned to the agricultural circuit. Auasorb is a hydrogel, a copolymer of acrylamide and potassium acrylate. The hydrogel has the ability to function in absorption-desorption cycles of water and nutrients, releasing them to the plants accordingly with their requirements (Hany El-Hamshary 2007; An Li, *et al,* 2005; Farrell C. *et al,* 2013; Sepaskhah A.R., Bazrafshan-Jahromi A.R., 2006) and it has efficiency in soil for 5 years.

The water was available for longer periods in soils treated with hydrogel compared with untreated being noticed a decrease in irrigation frequency and lowering the irrigation costs implicitly (Sharma J., 2004; Agaba H *et. al,* 2011). Allahdadi I. *et al,* 2005 notified that the hydrogel application in an amount of 4g $kg^{-1}$ of soil decrease the water requirements to 66% compared with the control lot.

The polyacrylamide improves soil hydro-physical properties determining an increased soil resistance to water and wind erosion and to the structural damages due to the soil tillage. The soil pores diameter and also water evaporation decreased, resulting an increased amount of available soil water. Also, it was noticed a lower pH and a higher nitrogen content in the sandy soil treated with polyacrylamide (El-Hady O.A., Abd El-Kader A.A., 2009).

The processes of germination, plant growth, nutrients takeover, efficient water and fertilizers utilisation rate have significantly increased when sandy soils were treated with hydrogels (Ouchi S. *et al,* 1990; Nus J.E., 1992; Smagin A.V., Sadovrikova N.B., 1995; Nadler A. *et al,* 1996; El-Hady O.A. *et al,* 2001, 2002, 2003, 2006; Callaghan T.V. *et al,* 1988).

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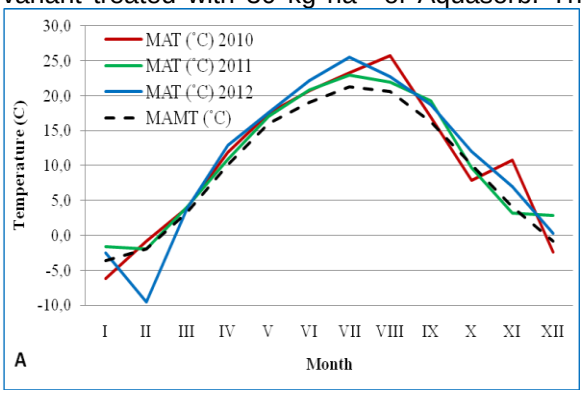
This study aims to bring new data regarding the possibilities to increase the productivity of agricultural land exposed to risk factors such as, drought which is manifested widespread and could be framed in the global climate change.

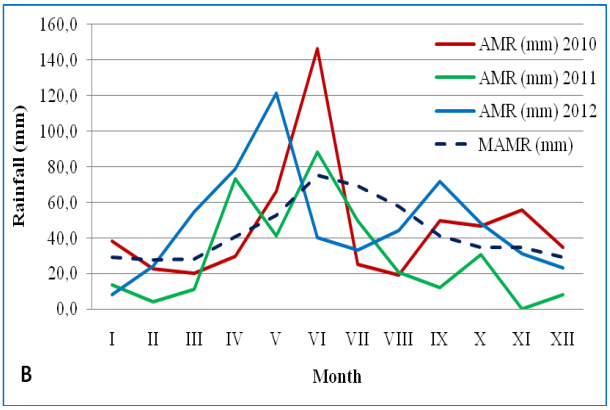
## MATERIAL AND METHOD

The experiment was bifactorial, of AxB type, using the randomized blocks method, with three replicates. The experimental factors were represented by crop (maize and soybean) and Aquasorb doses. The hydrogel doses were applied in 3 variants: $V_1$ - untreated variant, $V_2$ – variant treated with 15 kg $ha^{-1}$ of Aquasorb and $V_3$ variant treated with 30 kg $ha^{-1}$ of Aquasorb. The Aquasorb was administered in spring, before seedbed preparation during disk harrowing, at 15 cm depth.

The study was carried out under the pedo-climatic conditions of the Moldavian Plateau, to the Ezareni Farm, which belongs to “Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine”, Iași. The terrain has a slope of 3-4 %, the soil being a cambic chernozem, with medium to good fertility (medium content of nitrogen and phosphorus and good content of potassium), with 2.5 – 3.0% humus and low acid pH. In *figure 1* (A - temperature, B - rainfall) are presented the climatic conditions throughout the study.




MAT - Multi-annual temperature
MAMT - Multi-annual average temperature




AMR - Average monthly rainfall
MAMR - Multi-annual average rainfall

Figure 1 **Characterization of climatic factors for 2010-2012**
***(A – air temperature, B – rainfall)***

The used technology was specific for the analyzed crops, respectively maize and soybean. The fertilizers were administered at a dose of 60 kg $ha^{-1}$ $P_2O_5$ + 40 kg $ha^{-1}$ N prior seedbed preparation and 20 kg $ha^{-1}$ N during vegetation to the first mechanical weeding for maize. For the soybean crop the total amount of nitrogen was administered before seedbed preparation. The seedbed was prepared on the sowing day, using the kompaktor cultivator. The seeding was performed with SPC 4 Planter + U650 for maize and with SPC 6 Planter +U650 for soybean crop. There were used Pioneer cultivars for both crops respectively, PR38A24 for maize and PR91M10 for soybean. Soybean was sown when the soil temperature was minimum of 7-8˚C, corresponding to average daily temperatures of 14-15˚C, at a rate of 90 kg $ha^{-1}$. The sowing was done in strips of three rows at 45 cm, with 60 cm between them, to 4-5 cm depth. The maize was sown when the soil temperature has reached 10°C, at a depth of 8-10 cm and 70 cm between rows, ensuring the maximum density recommended by the producer for non-irrigated crops - 65000 plants $ha^{-1}$. During the vegetation stage weeding operations were done mechanically and manually. For weed control were also used chemical measures such as, preemergent herbicide treatment with Dual Gold 960 EC (1.0 l $ha^{-1}$), for controling annual monocotyledonous and some dicotyledonous weeds (*Setaria sp., Echinochloa sp., Digitaria sp., Amaranthus sp., Chenopodium sp., Hibiscus sp.*). During the growing stage were used Basagran (2.0 l $ha^{-1}$) insert in soybean and Dicopur D (1.0 l $ha^{-1}$) for maize crop.

There were determined the average number of grains per cob (maize) and pods per plant (soybean), the average plant height and the chlorophyll content. In order to determine the average plant height, measurements were carried out as follows, after 30 days from sowing, during the vegetation stage and at harvesting. The samples were taken in three replications with 15 plants each for both crops. Plant height was determined with a standard meter-stick measuring from the soil surface to the highest point of the plant (Freemanet et al, 2007, Hager, 2010).

For the maize crop, three replicate determinations were done in order to count the number of grains per 15 cobs. Similarly, the number of pods per soybean plant was determined by counting 15 plants, with three replicate determinations. The counting was done with a Sadkiewicz electronic seed counter (Liu *et al*, 2011).

*The leaf chlorophyll content* was measured using the CCM 200 plus device from *Opti-Science (figure 2)*.

It is a device used for measurements in the field and does the precise, reliable and easy determination of the leaf chlorophyll content. It can store up to 4000 measurements, made with a detector with two photo-diodes and absorbance detector. The determinations were carried out approximately after 30 days from sowing, in early and late July, to the upper, middle and lower part of the plants, to highlight the Aquasorb influence on the plant development. The data had been stored on the internal memory, and after being downloaded on the PC, and at the end were processed using ANOVA and the F test.

Figure 2 **Device for determining the chlorophyll content of leaves (http://www.envcoglobal.com)**

## RESULTS AND DISSCUSSION

*Grains per cob / pods per plant*

The average number of grains per cob and pods per plant respectively, were directly influenced by the hydrogel treatment. Thus, all variants registered significantly differences (*table 1*). For the control variant, the average number of grains per cob was 508.4 (*table 1*) and for the Aquasorb treated variants were obtained results higher with 10.4 grains and 18.9, respectively depending on the applied hydrogel dose. The same trend was noticed to soybean crop. The average number of pods per plant was 21.2 to the control variant and for the hydrogel treated one, the values raged between 22.7 and 24.0 pods.

The differences between all variants are due to the hydric stress periods which have a negative influence on plants growth and development. Its negative effects were partially attenuated by applying Aquasorb. The hydrogel has an important role in delaying the critical points when negative effects are triggered due to the hydric stress.

A higher number of pods per plant and grains per cob assured a higher crops productivity; similar results were presented insert by other researchers (Dorraji *et al*, 2010; Yang *et al*, 2014).

Table 1

**The influence of Aquasorb on productivity elements**

| Variant | Maize (Grains per cob) | | | | Soybean (Pods per plant) | | | |
|---|---|---|---|---|---|---|---|---|
| | Grains per cob | Compared to control | | Significance | Pods per plant | Compared to control | | Significance |
| | | % | Differences (grains) | | | % | Differences (pods) | |
| $V_1$ – Control (untreated) | 508.4±52.40 | 100.00 | 0.0 | Control | 21.2±1.37 | 100.00 | 0.0 | Control |
| $V_2$ (15 kg ha$^{-1}$ Aquasorb) | 518.8±48.04 | 102.0 | 10.4 | x | 22.7±1.81 | 107.1 | 1.5 | x |
| $V_3$ (30 kg ha$^{-1}$ Aquasorb) | 527.3±48.79 | 103.7 | 18.9 | xx | 24.0±0.71 | 113.2 | 2.8 | xxx |
| | LSD 5% = 9.4 grains | LSD 1% = 13.4 grains | | LSD 0.1% = 19.4 grains | LSD 5% = 1.2 pods/pl | LSD 1% = 1.7 pods/pl | | LSD 0.1% = 2.5 pods/pl |

Note: x – significant, xx – distinctly significant, xxx – very significant, LSD – Least Significant Difference

*Average plant height*

The data analysis for both crops, showed that applying the hydrogel had a positive influence on plants average height in the vegetation stages when this parameter was determined (*table 2*). Similar results were obtained in research done on tomato and cucumber crop by El-Hady O.A. *et al*, 2001, 2002, 2003, 2006; Gales D.C., *et al*, 2016. The Aquasorb treatment offers many advantages to plants against the weeding especially in the first development stages, knowing that those are the most critical ones for the analyzed crops. Each vegetation stage analysis highlights that the Aquasorb positive effect on plants height is shown immediately after the plants rising, that being the plant critical point against weeding (*table 2*). Thus, for the maize crop, the variant treated with 30 kg ha$^{-1}$, the plants were higher than the control variant with 5.8% at approximatively 30 days from sowing, with 1.6% during the vegetation and with 2.5% to harvesting (*table 2*). The same trend was noticed to the soybean crop, the values obtained being higher with 14.7% after plant rising, with 4.2% during vegetation and 5.5 % to harvesting than the control variant (*table 2*).

Table 2

**The influence of the Aquasorb on the average plant height in maize and soybean crop**
(average values 2010-2012)

| Growing stages | Variant | Maize Plant height | | | | Soybean Plant height | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | cm | Compared to control | | Significance | cm | Compared to control | | Significance |
| | | | % | Differences (cm) | | | % | Differences (cm) | |
| Sowing | $V_1$ | 44.8±1.83 | 100.0 | 0.0 | Control | 15.5±0.45 | 100.0 | 0.0 | Control |
| | $V_2$ | 45.6±1.37 | 101.8 | 0.8 | NS | 16.8±0.45 | 107.8 | 1.2 | xxx |
| | $V_3$ | 47.4±2.04 | 105.8 | 2.6 | xx | 17.8±0.66 | 114.7 | 2.3 | xxx |
| | | LSD 5% = 1,7 cm | LSD 1% = 2.4 cm | | LSD 0.1% = 3.5 cm | LSD 5% = 0.6 cm | LSD 1% = 0.8 cm | | LSD 0.1% = 1.2 cm |
| Vegetation | $V_1$ | 239.7±3.20 | 100.0 | 0.0 | Control | 73.9±1.13 | 100.0 | 0.0 | Control |
| | $V_2$ | 242.2±3.10 | 101.0 | 2.5 | NS | 76.6±0.61 | 103.6 | 2.7 | xx |
| | $V_3$ | 243.6±4.24 | 101.6 | 3.9 | NS | 77.0±1.28 | 104.2 | 3.1 | xxx |
| | | LSD 5% = 4,9 cm | LSD 1% = 7.0 cm | | LSD 0.1% = 10.1 cm | LSD 5% = 1.4 cm | LSD 1% = 1.9 cm | | LSD 0.1% = 2.8 cm |
| Harvest | $V_1$ | 236.5±1.90 | 100.0 | 0.0 | Control | 86.2±1.05 | 100.0 | 0.0 | Control |
| | $V_2$ | 243.3±2.08 | 102.9 | 6.8 | xxx | 88.8±1.15 | 103.0 | 2.6 | xx |
| | $V_3$ | 242.3±2.58 | 102.5 | 5.8 | xxx | 90.9±0.90 | 105.5 | 4.7 | xxx |
| | | LSD 5% = 2.8 cm | LSD 1% = 3.9 cm | | LSD 0.1% = 5.7 cm | LSD 5% = 1.3 cm | LSD 1% = 1.9 cm | | LSD 0.1% = 2.7 cm |

Note: xx – distinctly significant, xxx – very significant, NS – insignificant, LSD – Least significant difference, $V_1$ – Control (untreated), $V_2$ - 15 kg ha$^{-1}$ Aquasorb, $V_3$ - 30 kg ha$^{-1}$ Aquasorb

.

*The chlorophyll content in leaves*

The photosynthesis is influenced by internal and external factors. Cristea M. et al, 2004 appreciates that external factors are represented by light and lighting interval, $CO_2$ concentration, temperature, water, relative air humidity, mineral matter and oxygen. The internal factors are species, leaf structure, leaf age, chlorophyll content and accumulation of assimilates in the leaves. The chlorophyll formation is the most important physiological process which determines and characterises the plant accommodation reaction to various factors action such as, temperature, light, salt concentration of the soil solution, the atmospheric humidity and soil moisture.

Chlorophyll content in leaves was influenced by the hydrogel treatment for both crops. The noticed differences varied between 1.5- 2.9 CCI for maize crop, depending on the Aquasorb doses. To the control variant, the chlorophyll content in leaves was in average 47.3 CCI (*table 3*).

Table 3

**The influence of Aquasorb on the chlorophyll content in maize and soybean leaves**
(average values 2010-2012)

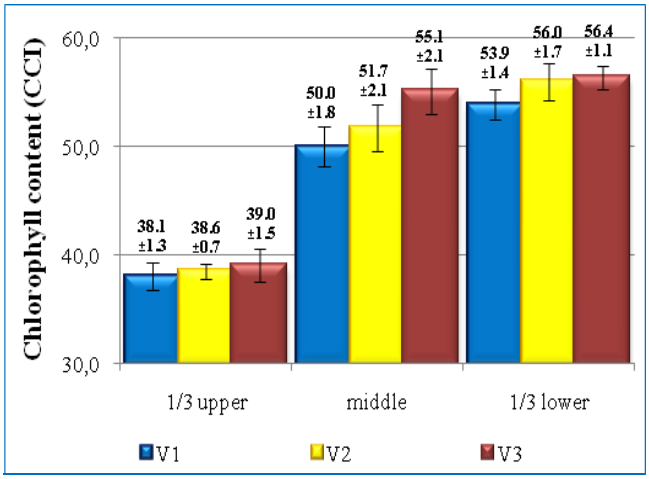
| Variant | Maize chlorophyll content | | | | Soybean chlorophyll content | | | |
|---|---|---|---|---|---|---|---|---|
| | CCI | Compared to control | | Significance | CCI | Compared to control | | Significance |
| | | % | Differences (CCI) | | | % | Differences (CCI) | |
| $V_1$ – Control (untreated) | 47.3±1.37 | 100.00 | 0.0 | Control | 24.3±0.64 | 100.00 | 0.0 | Control |
| $V_2$ (15 kg ha$^{-1}$ Aquasorb) | 48.8±1.10 | 103.17 | 1.5 | x | 25.5±0.61 | 104.94 | 1.2 | x |
| $V_3$ (30 kg ha$^{-1}$ Aquasorb) | 50.2±0.86 | 106.13 | 2.9 | xx | 26.2±0.67 | 107.82 | 1.9 | xxx |
| | LSD 5% = 1.5 CCI | LSD 1% = 2.1 CCI | | LSD 0.1% = 3.0 CCI | LSD 5% = 0.9 CCI | LSD 1% = 1.3 CCI | | LSD 0.1% = 1.8 CCI |

Note: x – significant, xx – distinctly significant, xxx – very significant, LSD – Least significant difference.

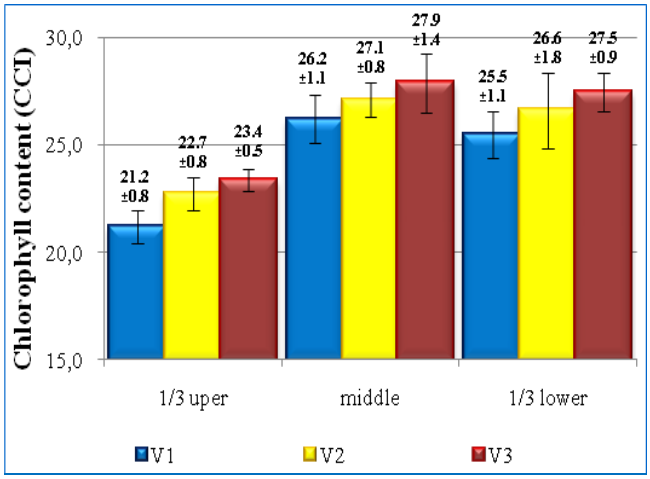
The same results were noticed to soybean crop. Differences were registered between the hydrogel treated variants and the control, being higher with 1.2 CCI for $V_2$ and 1.9 CCI for $V_3$. The chlorophyll average content for the control variant was 24.3 CCI (*table 3*). The chlorophyll content in leaves varied throughout the plant. Thus, for the maize crop was noticed that the chlorophyll content was maximum in the lower part of the plant, medium in the middle and minimum to the upper part (*figure 3*). For the soybean crop, the chlorophyll content was maximum in the middle part, medium in the lower plant part and minimum in the superior part of the

plant. This differentiation is due more to plant morphology and not because of the hydrogel influence in plants growth and development. But, the interest lays in the differences noticed to the treated variants compared to control one; the chlorophyll content was maximum in the upper third of the plant, medium in the lower third and minimum in the plant median part (*figure 3*).

During the research was noticed that the chlorophyll content in leaves increased along with the plant growth, the maximum being obtained after blooming. In this vegetation stage were also recorded the highest differences in chlorophyll content between treated and untreated variants.




Maize




Soybean

Figure 3 **Chlorophyll content in maize and soybean leaves (average values on years and growing stage)**
$V_1$ – Control, $V_2$ – 15 kg $ha^{-1}$ Aquasorb, $V_3$ – 30 kg $ha^{-1}$ Aquasorb.

## CONCLUSION

The results obtained so far show that the Aquasorb influences the plant growth and development in all growing stages, a more significant influence being noticed during the periods in which the rainfall had a relative uneven distribution. During those periods, the plants from the treated variants had suffered less due to the hydric stress because the applied hydrogel created a water reserve which assured an easy transition over hydric stress periods or even its avoidance when the water reserve was not used entirely.

Using the hydrogel Aquasorb in crop technology can be seen as a technical solution that helps to reduce the costs using more efficiently the water where the irrigation systems are installed and also may be considered as an "insurance policy" against some undesirable phenomena such as medium intensity droughts.

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# IS PROLINE ACCUMULATION UNDER WATER DEFICIT REVERSIBLE IN COTTON?

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**Abstract**

Proline is an amino acid which is used in biosynthesis of proteins is widely accepted as a biochemical indicator for various stress environment and species. In order to assessed the function of proline we aimed to determine if proline accumulation in cotton leaves under water deficit condition is reversible or not. For this purpose, a pot experiment was conducted under fully controlled growth chamber. Cotton plants (*Gossypium hirsutum* L.) subjected to well water (WW), water deficit (WD) and water deficit/re-watering (WDR) treatments 8 weeks after sowing. Canopy Temperature Depression (CTD) and transpiration decreased with stress treatment and rapidly recovered with re-watering whereas SPAD value didn't clearly respond to water treatments. Leaf area and dry weight of plants significantly decreased under both stress treatment while root and stem dry weights didn't change. The highest water use efficiency was found under WDR treatment. Proline content of leaves was similar under WW and WD treatments whereas it was markedly higher in WDR treatment.

**Key words**: proline, cotton, water deficit, SPAD, CTD.

Water scarcity is one of the major limiting factors for crop development and yield. The anticipated demand in additional water supplies for agricultural production will lead to increase water scarcity in near future. Thus, irrigated crop production such as cotton system needs a better management to increase water use efficiency. Deficit irrigation receives remarkable attention to keep productivity while minimizing water use. But it requires better understanding of how cotton response to limited water in soil. Proline is an amino acid which is used in biosynthesis of proteins is widely accepted as a biochemical indicator for various stress environment and species. However, its role in stress conditions is still under discussion. In order to assessed the function of proline we aimed to determine if proline accumulation in cotton leaves under water deficit condition is reversible or not.

## MATERIAL AND METHOD

A pot experiment was carried out in a fully controlled growth chamber in Ege University Faculty of Agriculture Department of Field Crops. Four Seeds of the Turkish cotton cultivar MAYP06 (*Gossypium hirsutum* L.) were sown to PVC pots filled with commercial garden soil and sand (3:1). The size of the pots was 10 cm height and 10 cm diameter. Three seedlings were eliminated from each pot after emerging. A total of 11.8 mg nitrogen, 11.8 mg potassium and 11.8 mg were added each pot at the beginning of the experiment. Light was supplied from 8:00 a.m. to 6:00 p.m. and light intensity at plant level was at least 300 µmol $m^{-2}s^{-1}$. Relative moisture content of the growth chamber was kept around 40-50%. The water content of soil was maintained 60 % of WHC (Water Holding Capacity) until onset of treatments 28 days after sowing (DAS).

Three soil moister contents were applied for 10 days after onset of treatments. The soil moister content was kept 60 % in well-watered treatment (WW) whereas drought treatment (DD) was applied via withholding watering. In re-watering treatment (DW), drought subjected plants were irrigated 24 hours before end of treatments. Then all plants were harvested 38 DAS.

SPAD values using with SPAD 502 Plus Chlorophyll Meter® and Canopy Temperature Depression (CTD) using with Infrared Thermometer IR-77L® were measured daily. Transpiration of single plants was determined through difference weighing every other day. Plants were separated to leaf, stem and root parts. Leaves were scanned by digital scanner and leaf

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area was determined via Photoshop CS6® software. All plant parts were own dried at 60℃ for 75 hours. Then dry weights are measured. Prolin content of leaves were determined according to Bates et.al. (1973) using with UV/VIS spectrophotometer (Carry 50®).

## RESULTS AND DISCUSSIONS

Transpiration of cotton plants decreased 4 days after drought treatment started (*figure 1*). And a slight increase was observed after re-watering plants in DW treatment. Average water uses were 18.5, 6.0 and 3.7 g/day in WW, DW and DD treatments respectively. SPAD values of the plants grown all treatments steadily increased (Figure 1). However there were not significant differences between the treatments. CTD initiated to decrease 8 days after drought application in DW and DD treatments whereas not clearly changed in WW treatment (*figure 1*). A slight increase in CTD was recorded due to re-watering plants in DW treatment.

CTD values had similar trend with transpiration during treatments. However, the effect of drought observed in CTD 4 days following the transpiration. Higher CTD values in higher transpiring plants were also reported by Belko *et al* (2012). Sharma and Kumar (2014) emphasized relation between CTD, leaf water potential and transpiration rate of wheat plants under drought conditions.

Leaf dry weight of cotton plants decreased while stem and root dry weight did not change due to drought treatments (*figure 2*). Leaf area also reduced due to drought stress in DW and DD treatments (*figure 2*). However, re-watering plants subjected to drought did not significant effect on both leaf dry weight and leaf area.

Karademir *et al* (2012) reported 30% percent decrease in leaf area of drought affected cotton plants which is similar to our findings. Our results also indicated inverse relation between leaf area and SPAD value (Data is not shown). We earlier observed increasing SPAD value while leaf area was decreasing due to limited water application in cotton plants (Çakaloğulları, 2015). This invers relation can be attributed tighten leaf tissues via water loss and increased chlorophyll pigments in unit leaf area.

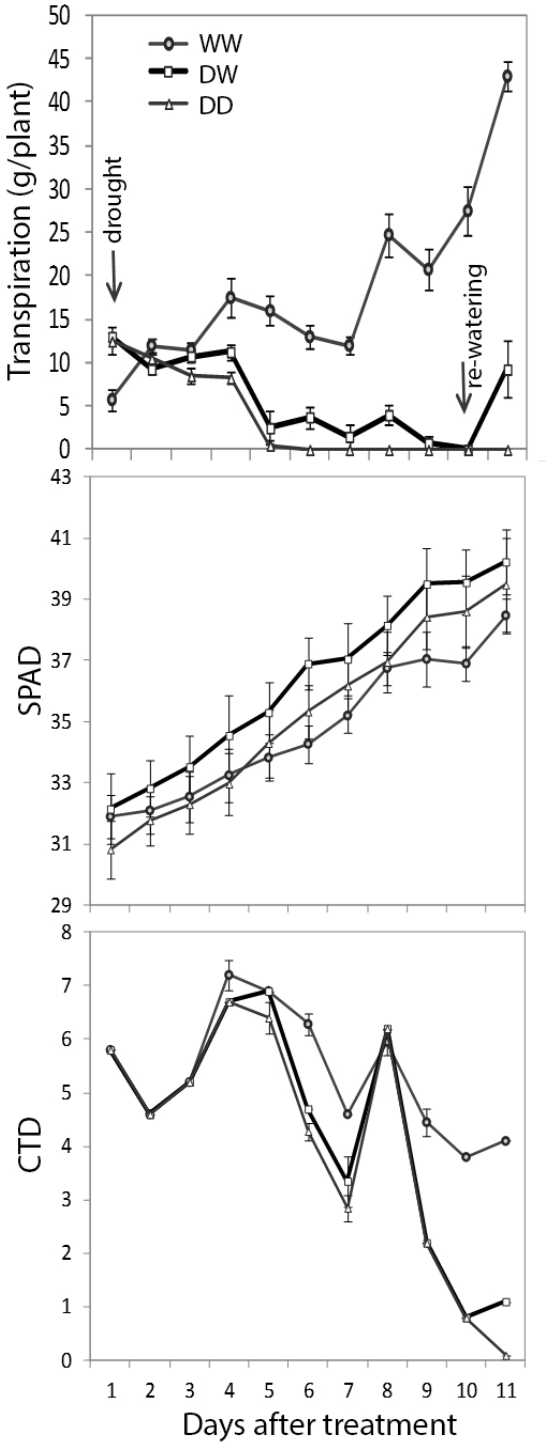


Figure 1 **Daily transpiration amount, SPAD values and Canopy Temperature Depression (CTD) values of cotton plants under well-water (WW), drought (DD) and re-watering (DW) treatments**

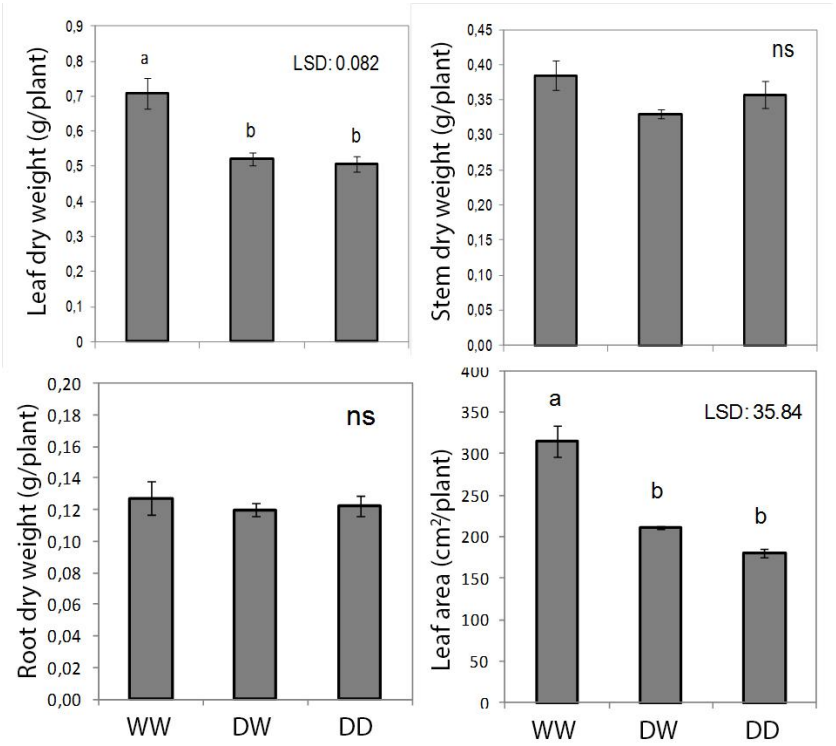


Figure 2 **Leaf, stem and root dry weights and leaf area of cotton plants under well-water (WW), drought (DD) and re-watering (DW) treatments**

Proline content of leaves drastically increased in DD treatment (*figure 3*). However similar proline accumulation was found in WW and DW treatments. Increasing proline content has been previously reported in drought subjected wheat (Tatar, Gevrek, 2008), cotton (Ferreira *et al*, 1979), maize (Ilahi, Dörffling, 1982) and faba bean (Siddiqui *et al*, 2015) plants. Lower proline accumulation in re-watered plants, in the present study, revealed this biochemical response

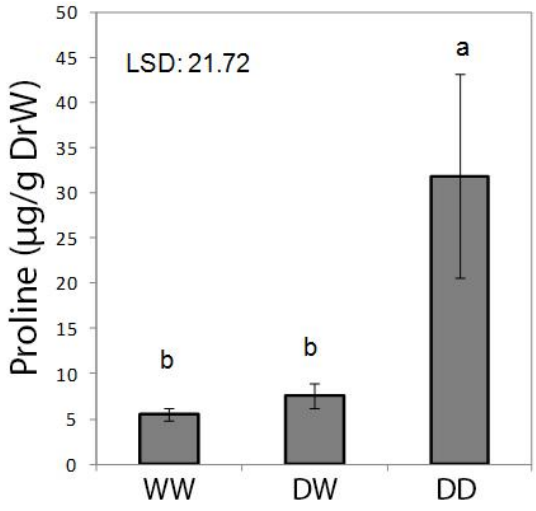


Figure 3 **Proline content of cotton plants under well-water (WW), drought (DD) and re-watering (DW) treatments**

of cotton plant was reversible. This reversible response via proline biosynthesis may play crucial role in adjustment of cellular state and acclimation of cotton plants to drought conditions.

## CONCLUSIONS

In conclusion, we may suggest that both stress treatment caused decrease in CTD and transpiration than inhibited dry matter production of cotton plants. Proline accumulation drastically increased with drought stress but it immediately reversed after re-watering cotton plants.

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# THE USE OF ADVANCED HYDRAULIC TOOLS TO OBTAIN FLOOD HAZARD MAPS

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**Abstract**

The aim of this paper is to obtain a hazard map using hydraulic modeling tools. Floods are some of the natural phenomena that have deeply marked human society, being some of the most widespread disasters around the world and also the largest producer of damage and casualties. Flood events cannot be avoided, but they can be managed, and their effects can be reduced by measures and actions to help mitigate the risks associated with these phenomena. To study these phenomena or prediction of their evolution in time, we need physical or mathematical models that reproduce them with accuracy as fine. A very useful tool for the study of phenomena related to free surface water runoff is represented by hydraulic modeling. Currently, hydraulic modeling is successfully applied worldwide, both in scientific research and in engineering.

**Key words**: water management, flood hazard map, hydraulic modeling.

To allow us to defend against extreme events and reduce potential damage caused by these, specialists from different fields are trying to devise and improve different calculation methods, tools, software, by means of which could predict in advance any disaster intervening in time to remove them or diminish the total amplitude. Floods represent a great danger to society, especially in the current context of climate change. To reduce the damage caused by them, at international level was decided the preparation of flood hazard and risk maps, based on them different decisions can be take about the actions and work that must be undertaken in order to not have losses. These maps can be drawn based on classical engineering calculations, also by using modern hydraulic calculation software.

This paper presents drawing of a hazard maps using modern software and the comparison of modeled results with the flooding strip observed during the floods phenomenon.

## MATERIAL AND METHOD

To draw the hazard map specialized software as WMS and HEC-RAS have been used. WMS is hydrologic and hydraulic analysis software. It was developed by the Research Laboratory for Environmental Modeling - Brigham Young University, in cooperation with the US Army Corps of Engineers - Station Experiments for Waterway. WMS is organized into eight modules. Each module is associated with a particular object type. While modeling only one module can become active (Brigham Young University, 2002; Hraniciuc T., 2011).

WMS interface for hydraulic modeling uses HEC-RAS software. HEC-RAS model can be run both in steady state and unsteady movement and the results are used to delimit the expansion of the flooded areas, also can run animations of flood wave transit.

The mathematical equations underlying modeling are the Saint-Venant equations in one-dimensional system:

• One-dimensional system:

Continuity equation (1): $$\frac{\partial \zeta}{\partial t} + \frac{\partial (uh)}{\partial x} = 0$$

Momentum equation (2): $$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + g\frac{\partial \zeta}{\partial x} + c_f \frac{u|u|}{h} = 0$$

where: y - the water local depth; A - the cross section area; B - the width of the water surface; *Z* - water level (compared to baseline), defined as: $\zeta = h + z_b(m)$ ; *h* - the local water depth (m); $z_b$ – thalweg local level (m); *u* - flow velocity (m/s) and $c_f$ - the coefficient of friction (dimensionless).

The main steps required for drawing the hazard map are (http://www.aquaveo.com; http://www.emrl.byu.edu/wms.html):

- Define a stream centerline and bank stations;
- Define cross section locations;
- Automatically cut cross sections and derive Manning's roughness values from elevation and ground material data;
- Export cross sections to the HEC-RAS model;

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- Run the hydraulic model and read the water elevations back into WMS;
- Read water surface elevation data from a hydraulic model or manually input known water surface elevations;
- Create flood extents and flood depth maps using digital terrain data and water surface elevation data points.

Case study. The case study has been made on the Jijia River, and one tributaries i.e. Buhai river. Jijia river is located in the north-east of Romania *(figure 1)*.


Figure 1 **Research location**

The first step to make a HEC-RAS model is creating a conceptual model that defines the river with its tributaries, the river cross sections position, the banks location and related land use. The conceptual model will be used later to create a schematic network with the location of the rivers cross sections in the hydraulic module (Giurma I. *et al*, 2009).

The cross sections will be extracted automatically by the program WMS, if this will have an available contour plan in electronic format. In WMS the plan contour can be obtained if a network of scatter associated with the corresponding rates i.e. a TIN (Triangulated Irregular Networks) is provided.

Thus, we have digitized the contour plan at 1: 5000 scale, resulting the network scatter *(figure 2)* based on which we achieve the TIN in plan *(figure 3)*, i.e. 3D visualization *(figure 4)*.

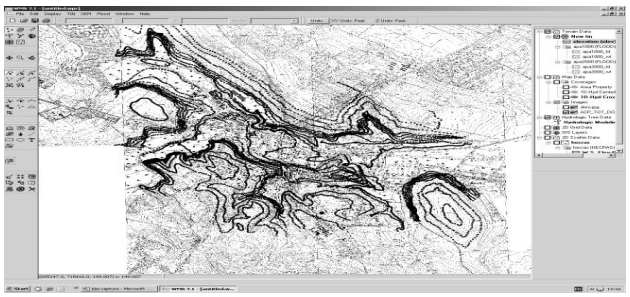

Figure 2 **Scatter network after contour**

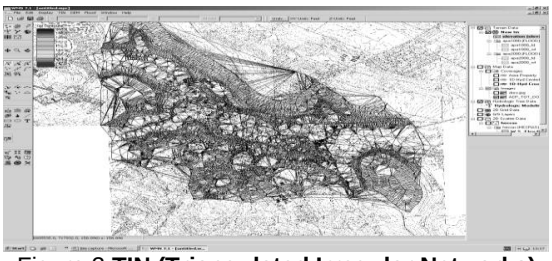

Figure 3 **TIN (Triangulated Irregular Networks)**

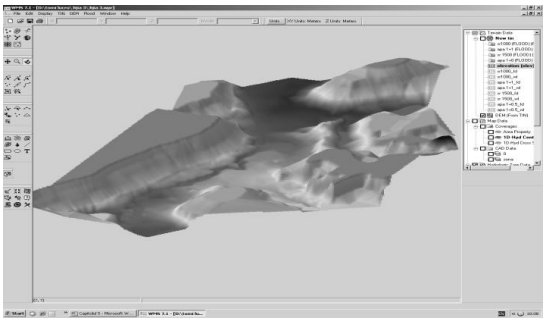

Figure 4 **TIN (3D View)**

The next stage is tracing the contour of the rivers from upstream to downstream determining the water flow direction, followed by drawing the related *banks (figure 5).*

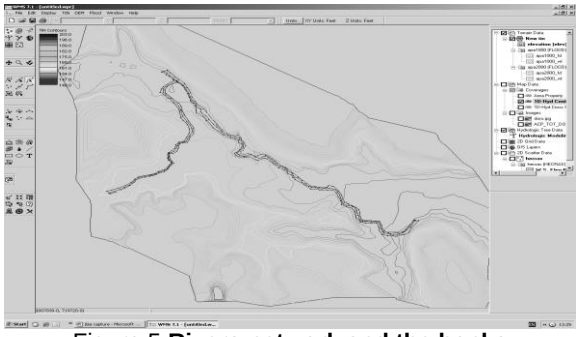

Figure 5 **Rivers network and the banks**

Given that will be applied a hydraulic modeling, the main parameter to be entered into the program is the roughness, which will depend on the calculated water level. Thus, depending on the land use, each cross section will contain different roughness in the major river beds. We will create a new layer that will contain different types of soil which we assimilate different properties based on ortophotoplans which relates precisely the type of land use.

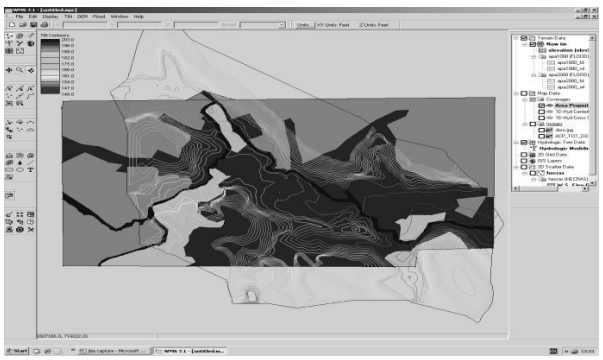

Figure 6 **Land use**

The next step is creating *(figure 7, 8)* and extracting the cross sections that contain parameters such as terrain elevation, type of material through which the section is crossing, of sections points properties. These will be extracted from TIN, land use and centerline layer. After extracting them, we can visualize the properties in a special window assigned to them.

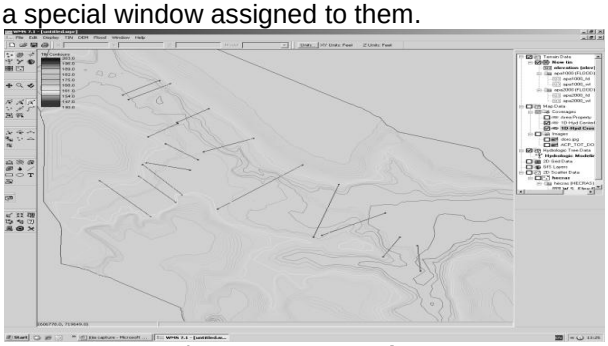

Figure 7 **Cross sections**

Figure 8 **Cross sections attributes**

The second step was to create the schematic network in WMS and introducing roughness on each type of material. WMS interacts with HEC RAS using a geometric file HEC-GeoRAS. This file contains the cross-sectional data used by HEC RAS besides three-dimensional georeferenced data. After creating the schematic network *(figure 9, 10)* WMS will include two separate data representations. The first is the conceptual model previously created and contains all layers, and the second is the numerical model stored in the cross sections schematic network of each river or portion of the river. After that, the bridges will be introduced in the conceptual model, the last step is represented by the introduction of boundary conditions such as flow rates if we have steady movement or measured hydrographs for unsteady movement.

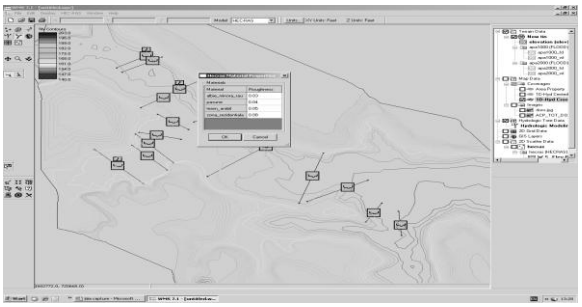

Figure 9 **Creating the schematic network and introduce roughness on each type of material**

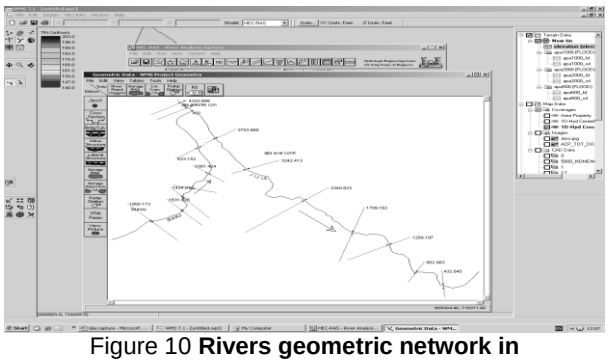

Figure 10 **Rivers geometric network in HEC - RAS**

With the help of HEC RAS we set up and run the simulation, and then the processed results are exported back to WMS for visualization.

Basically, if the roughness of the minor and major riverbed were chosen well based on field observations or orthophotomaps updated during the phenomenon of flooding, should the flooding simulated band to coincide quite well with the observed one, which means that the model was calibrated.

## RESULTS AND DISCUSSIONS

The modeling was done on Jijia River at the confluence with Buhai River in Dorohoi city. The data used for calibrating the results was considered the flood in June 2010 in the town of Dorohoi, which resulted in considerable damage.

The results are shown in one-dimensional format (1D) in HEC-RAS, but also in two-dimensional (2D) by depths and water levels. In one dimensional format can be view the water depth processed from HEC-RAS in both cross-sectional and longitudinal profile (*figure 11, 12*).

Due to the abilities of the program WMS to interpolate the water level calculated in HEC-RAS with the ground line based on available TIN, the result consist in the flood hazard map *(figure 13, 14, 15)*.

As can be seen, the observed band during flood coincides and overlaps almost perfectly over the one simulated using software. This means that the digital terrain model on which the sections were extracted coincided with field reality, and the roughness applied to the cross sections are according to the land use of the studied area. It can respond that the model was calibrated. The main hydraulic parameter which was varied for calibration was the roughness coefficient. Its value depends on the land use in the area, and for the best possible accuracy is required dated ortophotoplans during extreme events. To obtain the result, the collaboration between the two software was necessary. HEC-RAS is giving only the one dimensional outcomes and WMS needs the

hydraulic calculations performed in HEC-RAS, in order to obtain the 2D results.

Basically there is interdependence between the two software. The two dimensional results dimensional might be achieved by intersecting the water level obtained in HEC-RAS with the line soil surface line, using other specialized software, but on the building of HEC-RAS model we need to have already the complete dataset, such as completely cross sections and their subsequent processing by introducing roughness.

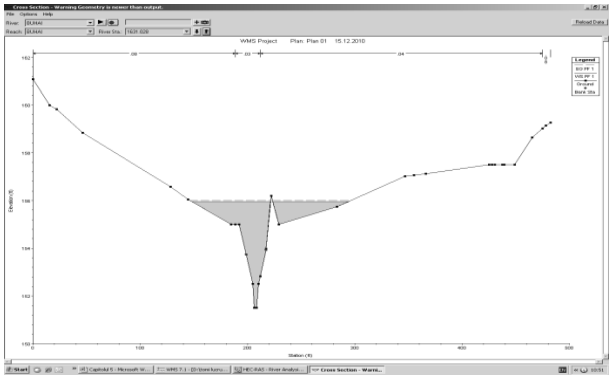

Figure 11 **Water level in cross section inHEC RAS**

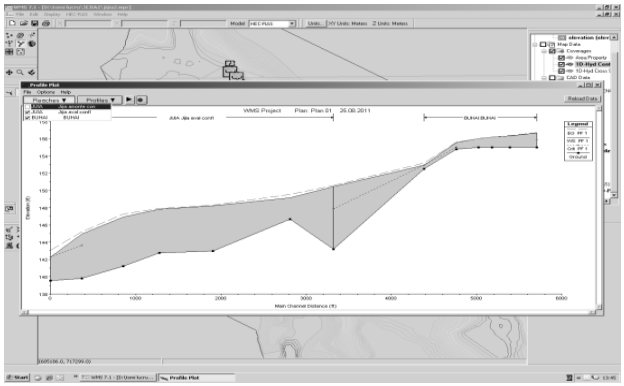

Figure 12 **Free surface of water line viewed in longitudinal profile in HEC RAS**

The advantage of using WMS is that we can automatically extract the cross sections from DTM, which have already set up the hydraulic parameters extracted from the land use layer. Also, we are benefiting from the automatic processing of cross sections by extending them, which we cannot do in HEC-RAS. Thus, it shrinks very much the working time and painstaking work, which in case of a large model would only take several days to process the sections. WMS has GIS tools which are very user friendly, also thanks to advanced tools for visualization of results and possibilities for their processing as well as data entry model.

Figure 13 **Water depth in WMS**

Figure 14 **Free surface of water line viewed in longitudinal profile in WMS**

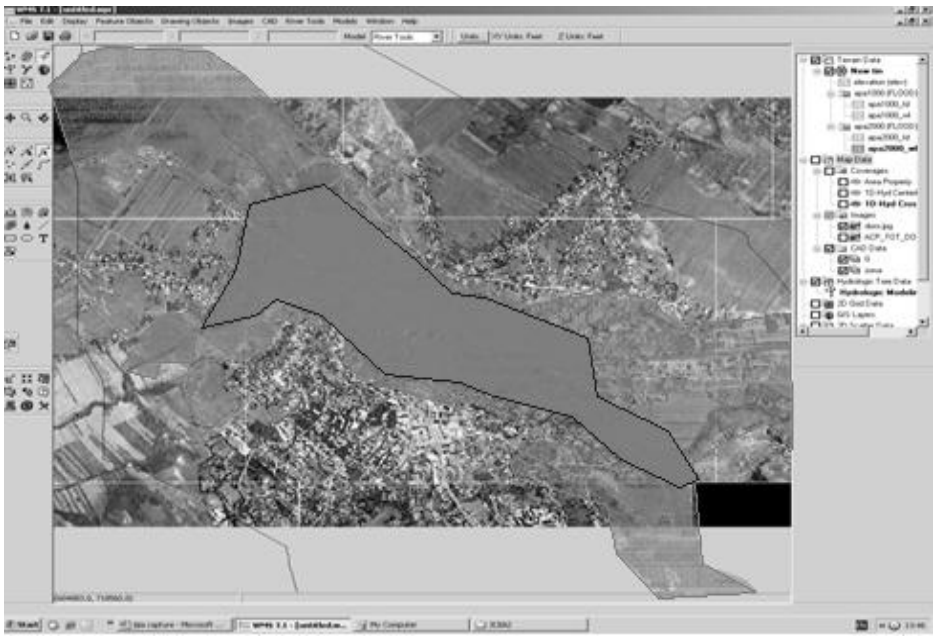

Figure 15 **Comparison between the observed flood strip during the flood (dark hatch) and the resulting WMS (light hatch)**

## CONCLUSIONS

As a general conclusion of this work, one can say that the use of software engineering greatly eases the work of specialists. The results are obtained in a very short time compared to traditional methods. The results are also more expressive and have a more exact accuracy if the model is well built. Results can be seen using two-dimensional depths and water levels flooded the entire area, which greatly facilitates further processing such as flood risk mapping and quantification of damages. If the model shows errors in some ways like unacceptable values of the roughness coefficient, they are displayed immediately enabling the specialist to rectify the problem, while in a traditional calculation these errors may be overlooked leading to erroneous results.

Establishment of these hydraulic models on all watercourses, their calibration and validation, would mean a technical and scientific progress because with their help, experts in the field could draw up hazard and flood risk maps, could create floods prognoses, could study the morphological phenomena of rivers and simulate eutrophication and water quality. All of these are extremely useful because it would greatly reduce the damages as a result of extreme events, being able to easily make decisions on the different actions and engineering works which should be applied after using the results of running such models.

Once a model has been developed, calibrated and validated it can be used successfully to interpret different scenarios when initial conditions are changed. For example, changing the discharge coefficient due to deforestation of mass or modifying the longitudinal profile of a sector due to the proposed regularization, heightening the levels due to works of art, etc.

Therefore, it can be said that the results obtained using the software cannot be compared both quantitatively and qualitatively to those obtained by conventional methods. They are much more accurate. The only attention should be given to the right implementation of input data, the initial conditions and more accurate representation of the situation in the field by placing all buildings and works in the floodplain. Today, on the global market all specialists in the field, both working in design or execution, uses such programs to improve the accuracy of projects.

## ACKNOWLEGMENTS

We thank to the developers of WMS and HEC RAS software, namely the Research Laboratory for Environmental Modeling, Brigham Young University, in cooperation with the US Army Corps of Engineers - Station Experiments for Waterway for providing with explicit and very helpful tutorials and methodology.

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# DETERMINATION OF DROUGHT SENSITIVITY OF MAIZE INBRED LINES VIA MONITORING CANOPY TEMPERATURE AND LEAF WATER STATUS

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**Abstract**

Drought is one of the most significant phenomenon that limits crop production in all around the world. Breeding drought resistant varieties is a key strategy for future agriculture production. Since global climate change has been already leading to increase frequency of drought events, limited time for breeding new varieties, more effective indirect selection techniques and useful traits for drought tolerance have received more attention. For these aspects, our study was aimed to determine drought sensitivity of maize plants by monitoring canopy temperature depression (CTD) and leaf water status. For this purpose, a field experiment was conducted with 80 maize (*Zea mays* L. Indentata) inbred lines under well-watered and short-term drought conditions during V7-9 growth stage. Plants were subjected to stress conditions for 15 day by withholding irrigation. CTD, SPAD values, leaf and soil water status was regularly monitored during stress period. The results showed that drought stress had a significant effect on CTD for all genotypes. The mean CTD values of all 80 genotypes under well-watered and drought conditions were 8.59 and 9.74 respectively. Drought treatment caused significant decrease in SPAD values of all lines. The average SPAD values at the end of the drought treatment (15th day) were 40.7 and 44.6 under well-watered and drought conditions respectively. However, no significant variation was observed between the mean values of relative water content of leaves under well-watered (83.9 %) and drought (84.3 %) conditions. Beside above given overview of the general results, response of individual inbred lines to gradually decrease in soil water content was evaluated using with regression line and its slops of the recorded physiological parameters.

**Key words**: Maize, drought, SPAD, DANS, RWC.

Drought is one of the most significant phenomenon that limits crop production in all around the world. The negative effects of drought depend on its severity and length. The intensity of drought stress may vary from year to year and it is closely correlated with the amount of rainfall water and the air temperatures (Soltani A. *et al*, 2001; Dalil B. and Ghassemi-Golezani K., 2012). The future predictions state that cereal demand of the world will increased by 70% by 2050 (Casaretto J.A. *et al*, 2016). Moreover the intervals between drought periods become shorter by the effects of global climate change. Currently, an increase in world surface temperature was already detected by 0.6 °C over the last century. Also it is expected that the temperature of the world will increase by 4-6°C at the end of this century (IPCC, 2013). Under this situation, more efficient usage of irrigation water reserves for irrigated crop systems such as maize is a great necessity in terms of future aspects.

Maize is a crucial cereal for human and animal nutrition. World total maize production is about 1 billion tons according to FAO, (2014). Drought related yield losses due to global warming limits the total maize production for the areas in which the maize production is practiced with rainfall irrigation. But decrease in water reserves threatens the artificial irrigated maize lands as well. Drought tolerance is known as very complex multi-genetic trait involving numerous physiological processes (Liu Y. *et al*, 2011) and conventional selection criteria such as grain yield are not useful due to their low heritability under drought condition. In other words it is difficult to select drought tolerant maize genotypes based on their grain yield potentials. These challenge, force plant breeder to use other physiological parameters such as leaf temperature which is easy to measure and informative about the severity of plant stress.

Leaf temperature is an indirect indicator of plant transpiration. Transpiration occurs on plant leaves and stomata play significant role in this event. When adequate amount of water is available in plant root zone, the stoma becomes open and allows water to vaporize from the leaf surface and leaf temperature decreases as a result of this

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process. But in case of water scarcity in soil, stomatal pores are closed and transpiration stops which result in an increase on leaf surface temperature.

Various methods and calculations were described to interpret the leaf temperature data (Dejonge K.C. *et al*, 2015). One of those methods is using plant canopy temperature (Tc) and air temperature (Ta) to identify the stress level of the plant. The difference between Tc and Ta gives useful data to quantify the water stress (Idso S.B. *et al*, 1977; Dejonge K.C. *et al*, 2015).

Relative water content of the leaves (RWC) and the SPAD values are also widely accepted parameters to measure the intensity of the drought. Number of researches stated the importance of these two traits for detecting the severity drought stress in plants. Siddique M.R.B. *et al*, (2000), stated that the relative water content and water potential decline under drought conditions. SPAD meter is a spectrodiometrical screeening technique which allows fast and non-destructive measurements in large field trials (Araus J.L. *et al*, 2012).

In the light of this information, the aims of this study were to evaluate different maize inbred lines in terms of their responses to mild term drought stress based on three physiological traits as degrees above non-stressed canopy (DANS), chlorophyll content (SPAD) and leaf relative water content (LRWC) and identify the effects of drought to these traits.

## MATERIAL AND METHOD

The plant material of this research was provided form USDA (United States Department of Agriculture). Eighty inbred dent maize lines were evaluated in the field trial in 2015 maize growing season. The study was conducted at experimental fields of Ege University Faculty of Agriculture Department of Field Crops.

Field experiment was set up with 80 inbred lines in randomized complete block design with three replications. The seeds were sown into the rows of 2 m length. The spaces between rows and between plants were arranged 70 and 20 cm respectively. Each plot consisted of two rows. The compound fertilizer (15-15-15 NPK) was applied to both experiments as 90 kg N per ha with the sowing date. Remaining part of N was applied when the plants were at V5-7 stages as 180 kg N ha-1 in the ammonium nitrate form. The plots were irrigated via drop irrigation system.

The split plots were used in randomized complete block design. Drought application was used as factor A while the genotypes were used as factor B. Common irrigation practices were applied until the plants reached to V7-9 stage. After that stage drought application started and continued for 15 days. Control plots were irrigated regularly while drought plots had no irrigation during the drought application.

A fully developed youngest leaf was used at three selected plants in both drought and control plots for every genotypes. Three measurements were taken with infrared thermometer from the upper surfaces of every chosen leave. First reading was taken from the bottom part, second from the middle part and third from the tip of the leaf. Than the average of these values were used the canopy temperature (tc) for a given genotype. Temperature measurements were done every day during the drought application (15 days). To avoid the misleading effects of the air temperature changes in a chosen day, the measurements were taken between 01:00 pm and 04:00 pm for every day. To calculate the temperature depression, difference between canopy temperatures of stressed and non-stressed plants for given genotypes were found and recorded as degrees above non-stressed canopy (DANS).

SPAD values of every genotype in both drought and control plots were measured via the SPAD meter and recorded. SPAD measurements were taken in the first and the last days of the drought application.

Three plants were selected from each plot and fully developed youngest leaves were cut over the ligule. Then the leaves were weighted and recorded as fresh weight (W). Secondly the leaves were placed into the plastic buckets 1/3 full of water and the buckets were stored in a dark room with 4 Co air temperatures for a night. Than the leaves were weighted again and obtained value was recorded as turgid weight (TW). Then the leaves stayed in the drying oven at 105 Co for 24 hours and weighted lastly to take the dry weight (DW). The relative water content (RWC) was calculated by the following formula;

RWC (%) = [(W-DW) / (TW-DW)] x 100

The statistical analyses were done via MS Excell and TARIST (Açıkgöz N., 1994) statistical package program.

## RESULTS AND DISCUSSIONS

Taghvaeian S. *et al*, (2014) suggested that the degrees above non-stressed canopy DANS responded to irrigation and was strongly correlated with plant measurements including leaf water potential. The DANS values of the genotypes from the 11th day of the drought treatment can be seen in Figure 1. The first ten genotypes represent the

plants with the highest DANS values (stressed plants) while the second ten genotypes represent the plants with lowest DANS values (non-stressed plants) for a given day in terms of canopy temperature.

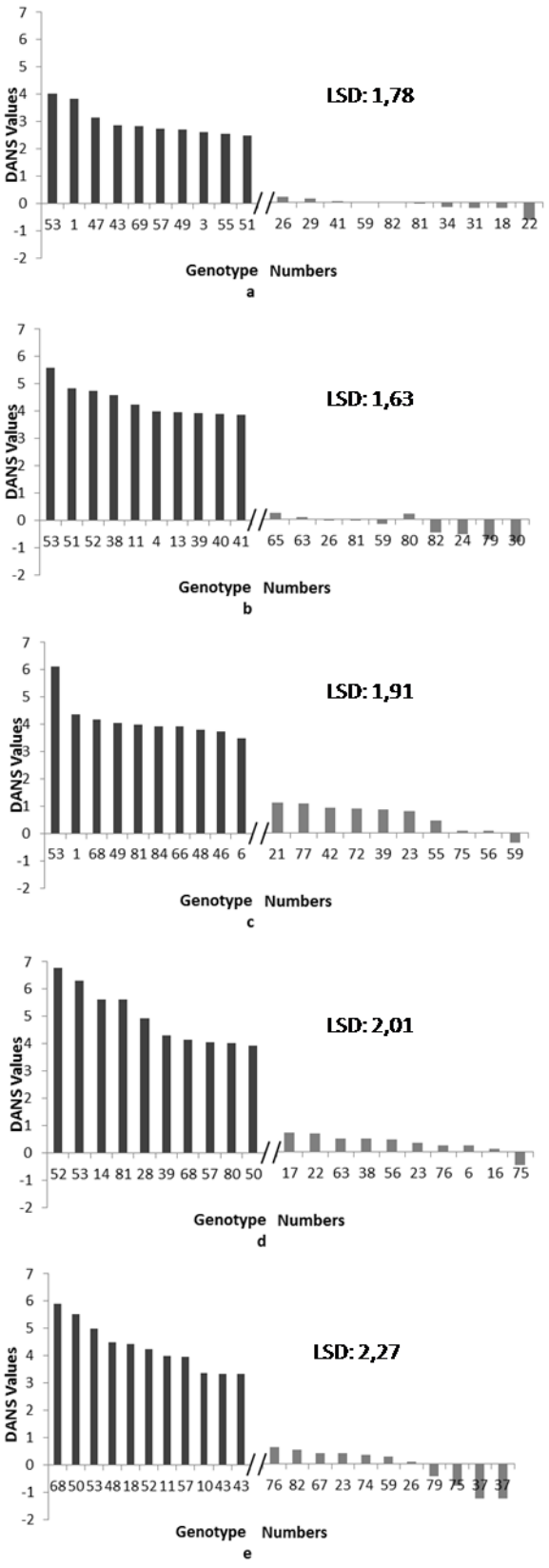


Figure 1 **DANS values of the genotypes for five days of drought treatment. a: 11th day, b: 12th day, c: 13th day, d:14th day and e:15th day of the drought treatment**

The remaining 60 plants are not shown in the figure. When examining the genotypes with highest DANS values, it was shown that genotype number 53 come into prominence as one of the most susceptible genotypes in terms of DANS values among the investigated lines (*figure 1 a, b*).

Genotype number 53 placed in first ten lines after the 11th day of the application. The genotype number 53 had the highest DANS values in 11th, 12th, 13th days of the drought application (*figure 1 a,b*). Besides, genotype number 75 was consistently showed lowest DANS values from the 13th day of the drought application (*figure 1 c,d,e).*

The average relative water content values of the leaves form drought and control plots are shown in Figure *2*. No significant difference was found from the analysis of variance between the drought and control plots in terms of relative water content means.

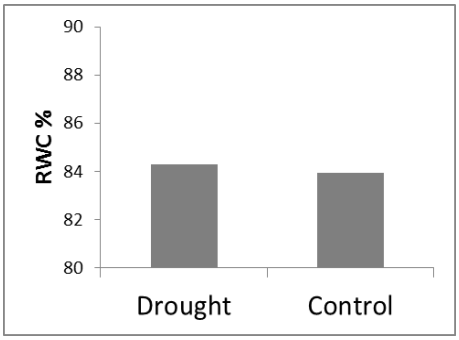


Figure 2 **Means of RWC values of drought and control plots**

Chlorophylls are one of the most important structures for photosynthesis. It was reported that the chlorophyll content is affected by negatively by the drought and the chlorophyll contents of resistant plants could be affected less from drought conditions (Khayatnezhad M. and Gholamin R., 2012; Zobayed S. *et al*, 2005). The average chlorophyll content values of drought and control plots are shown in Figure 3. Significant difference was found between drought and control plots in terms of chlorophyll contents. Figure 3shows that the plants in control plots had higher SPAD values than those of the plants in the drought plots.

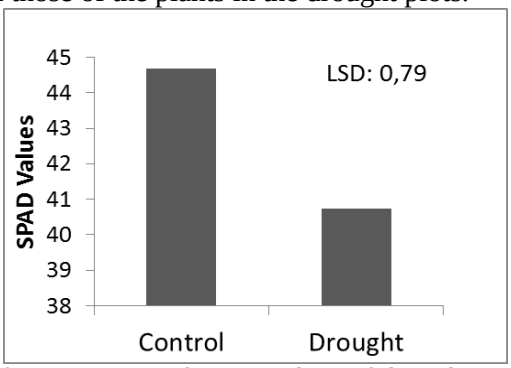


Figure 3 **Means of SPAD values of drought and control plots**

## CONCLUSIONS

In conclusion it can be said that, genotype 53 come into prominence with its high sensitivity to the drought. Besides genotype number 75 had lower sensitivity to drought application with respect to DANS values. For relative water content, our drought application did not affect this trait. Lastly for SPAD values, there was a significant difference between control and drought plots which stated that the drought application has clearly dropped the chlorophyll content of the leaves.

## ACKNOWLEGMENTS

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# ADAPTATION OF COTTON TO DIFFERENT WATERING REGIMES

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**Abstract**

Many physiological functions and morphological properties determining yield of cotton plant may inhibited by different water regimes. The aim of the present study was to investigate morpho-physiological adaptation of cotton plants to different irrigation regimes. For this purpose, a pot experiment was conducted under fully controlled growth chamber. Cotton plants (*Gossypium hirsutum* L.) were exposed three irrigation regimes. Plants were irrigated when water holding capacity reach 20%, 40% and 60% to field capacity in I20, I40 and I60 treatments respectively. Physiological parameters such as transpiration, canopy temperature depression (CTD) and SPAD values and morphological parameters such as adaxial and abaxial stomatal density were determined. Lowest transpiration found in I20 treatments than I40 and I60 treatments. SPAD value remained lower level in I20 treatment whereas higher in I60 treatments during different irrigation regimes. Stomatal density was higher in adaxial surface than abaxial surface of leaves. On the other hand, increasing stoma number per unit leaf area in adaxial surface with lower irrigation frequency was recorded. Our results suggested that cotton plants adapt to different water regimes via regulating transpiring organs and their functions.

**Key words**: Cotton, water regime, SPAD, CTD, stomatal density, irrigation frequency

Increasing in global food requirement forces enlarge agricultural land all over the world. However, global climate change is still a major limiting factor for the future agriculture production. Among many consequences of climate change, drought is a major detrimental factor for crop production. Novel water management strategies need to be improved for irrigated crops such as cotton in water limited environments. Increased irrigation frequency is one of the common methods to maximize irrigation use efficiency. However, limited irrigation due to increased frequency may lead cotton plants to face with temporary water stress condition.

Cotton is a widely grown industrial crop. It has a critical importance as the main raw material of weaving and clothing industry. Additionally it is widely used for producing oil and animal feed. The production and consumption of cotton is increasing day by day due to rise in human population (Gündüz *et al*, 2003). However, environmental influences like global warming still constraint the plant production in a large part of the world. One of the most significant indicators of the global warming is drought. Thus, drought is still seen as a major challenge for the future of agriculture. The magnitude of drought stress may vary from year to year. Also this effect is strongly correlated with the rainfall regimes and the air temperatures (Soltani *et al*, 2001; Dalil and Golezani, 2012). This study aimed to investigate the adaptation of cotton plants to different irrigation frequencies. In this direction the physiologic and morphologic adaptations of cotton plants were monitored, in case of irrigating the plants with same amount of water in different irrigation frequencies.

## MATERIAL AND METHOD

The commercial cotton cultivar named MAY P 06 was used as plant material. The pots used in this study were 10 cm height and 5 cm width and made of incorruptible plastic. The bottom parts of the pots were isolated via a plastic cover to avoid of water leaking. The pots were filled with a mixture consisted of one part sand and three parts peat. Four seeds for each pots were sown into the pots in 12$^{th}$ April 2015. Than healthiest one plant was selected from every pot and other three were removed. Then all pots were fertilized with 15-15-15 compound fertilizer as 10 kg N/da for every pot. The trial was conducted under fully controlled conditions. Growing conditions were 25 C$^{o}$ day-night temperature with 12 hours dark and 12 hours daylight and under 40-50% relative humidity. The trial was conducted in randomized plots design with four replications. Irrigation frequencies were

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used as a single factor and three different irrigation frequencies with the same amount of water were applied to the pots. The soil water content was regulated via gravimetrically. The pots were completed to 60% of WHC via irrigation when they reach fewer than 20%, 40% and 60% of WHC for first (I20), second (I40) and third (I60) irrigation treatments. During the treatment 4 traits were measured as transpiration rate, stoma density on abaxial and adaxial surfaces of the leaves, canopy temperature deficit (CTD) and SPAD value.

Transpiration rates of the pots were recorded daily by gravimetric way. An empty pot (just filled with sand-peat mixture) was placed near the other pots to calculate the evaporation. Since the evapotranspiration occurred in the pots with plant, the transpiration could be easily calculated by removing the evaporation value from the evapotranspiration value.

For stoma density, the 5$^{th}$ leaf of each plant was used. Transparent nail polish was applied to the abaxial (underface) and the adaxial (upper surface) part of the leaves. Than the plaster tape was sticked to the surfaces after the nail polish was dried. Than the stoma prints obtained on the plaster tapes were captured under the microscope and stoma numbers were counted.

Canopy Temperature Depression values were calculated by following formula.

$$CTD = t_c - t_a$$

Where the $t_c$ is the leaf temperature value obtained from the forth leaf of the plants by taking three different measurements via the infrared thermometer, while the $t_a$ is the ambient temperature measured by TINYTAG.

SPAD value of the plants were determined via KONICA Spadmeter. Daily measurements were done at the forth leaves of the cotton plants.

## RESULTS AND DISCUSSIONS

The transpiration rates of three different irrigation frequency applications can be seen at *figure 1*. The cotton plants in I60 irrigation treatment had 15 g/day average transpiration rate and the daily transpiration rates varied from 8 to 15 g (*figure 1*). The average transpiration rates were observed as 13g and 7g for I40 and I20 treatments respectively. Additionally daily transpirations varied from 3 to 21 g for I40 treatment, while it varied from 0 to 24 for I20 treatment (*figure 1*). The transpiration amount of three treatments continued close to each other at the beginning of the experiment. But the transpiration almost stopped in I20 treatment. However, the transpiration rate climbed to normal level after the irrigation applied 10$^{th}$ day (*figure 1*). Highest transpiration was observed for I60 treatment, while lowest transpiration values obtained from I20 treatment. This indicates that, the transpiration rates increase as the irrigation frequency increases.

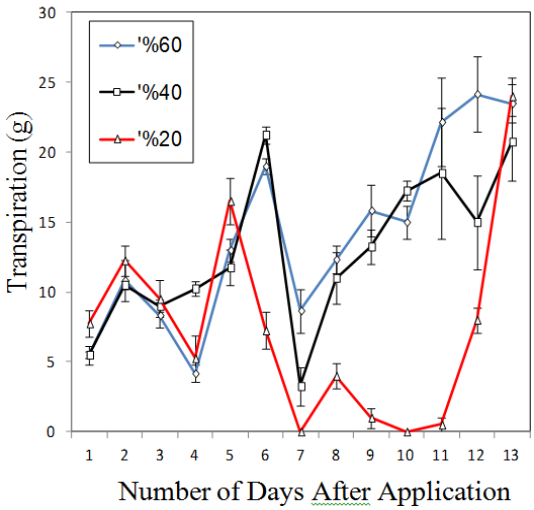


Figure 1 **The effects of three different irrigation frequencies to transpiration rates of cotton plants**

The SPAD values are shown in *figure 2*. *figure 2* shows that, all three treatments have the SPAD values from 32 to 40. The average SPAD values for I60, I40 and I20 treatments were 35.8, 36.8 and 37.0 respectively. The most frequently irrigated plant group (I60 treatment) always had lower SPAD values than those of the other groups. I20 treatment showed highest SPAD values until 10$^{th}$ day, however this increase was stopped after this day. Increase in leaf surface area and decrease in chlorophyll density could be the cause of this situation. Hence, it can be said that the greenness of the leaves decreases as the irrigation frequency increases. Çekiç (2007) reported that it was possible to observe an increase in chlorophyll density due to decreasing in leaf surface area under drought conditions.

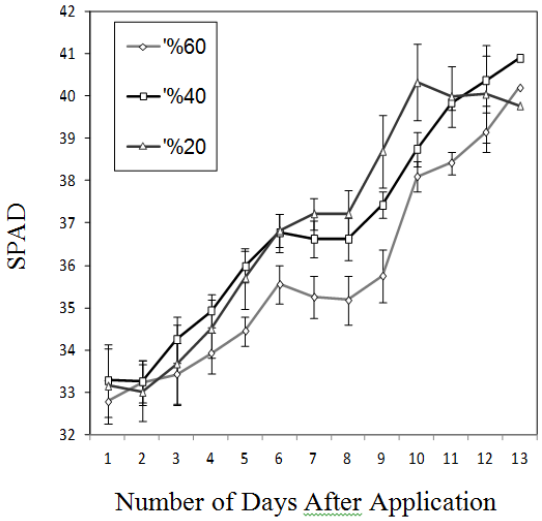


Figure 2 **The effects of three different irrigation frequencies to chlorophyll contents (SPAD) of cotton plants**

CTD is accepted as one of the most important drought indicator for the plants (Dejonge

*et al*., 2015). When the CTD values were examined, it was shown that the CTD values of three treatment varied from 4.2 to 8.2 and maximum average CTD was obtained as 5.6 from I60 treatment, while minimum value was measured as 4.6 from I20 treatment (*figure 3*). In I40 treatment average CTD value was recorded as 5.0 (Figure 3). It can be interpreted as the CTD values proportional to the transpiration rates. Three treatments had shown almost same CTD values in the first 5 days of the application. However significant decline was observed in I20 treatment since the sixth day of the trial. The I20 treatment exhibiting the lowest transpiration rate had also the lowest CTD values. Belko *et al*. (2012), reported higher transpiration values in higher transpiring plants. But the CTD values of this treatment increased after 10$^{th}$ day of the trial (*figure 3*).

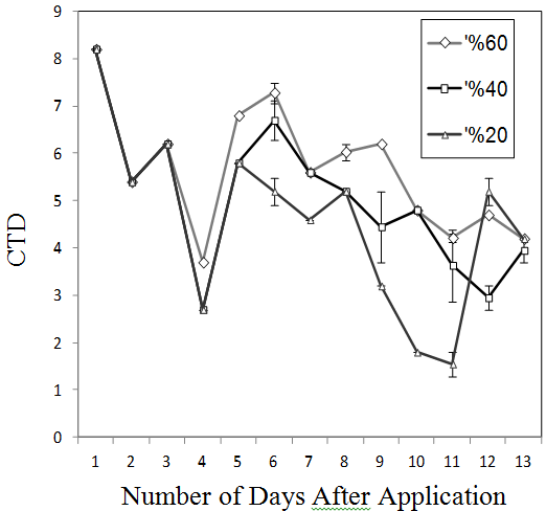


Figure 3 **The effects of three different irrigation frequencies to canopy temperature depression (CTD) of cotton plant**

Adaxial and abaxial stoma densities of three different irrigation frequencies are exhibited in *figure 4*. When the stoma density values from abaxial surface of the leaves was investigated, it was seen that stoma densities were found 2.3, 2.0 and 2.8 for I60, I40 and I20 treatments respectively (*figure 4*). The differences between the treatments were found insignificant for the abaxial surfaces. However, significant differences were detected between three treatments for the stoma densities on adaxial surfaces (*figure 4*). The stoma density of I60 treatment varied from 12 to 16 and average value was found as 13.3. Additionally, for I40 treatment the stoma densities changed from 7 to 11 and the average was 9.6. Lastly, the abaxial stoma density of I20 treatment varied from 6 to 9 and average was 7.8. The stoma density of I20 treatment was found statistically higher than those of other two treatments. Besides, there was no significant difference between 40% and 60% treatments in terms of abaxial stoma density.

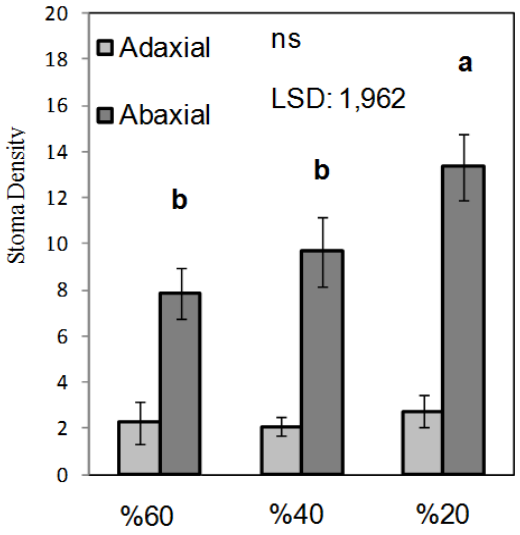


Figure 4 **The effects of three different irrigation frequencies to abaxial and adaxial stoma density of cotton plant**

## CONCLUSIONS

In conclusion, we may suggest that regulated deficient irrigation caused decrease on photosynthetic activities. Our results suggested that cotton plants subjected to lower irrigation frequency narrow their leaves to reduce transpiration. This response is a common adaptation of a plant subjected to water stress. On the other hand, increasing stoma number per unit leaf area in adaxial surface with lower irrigation frequency was found. This result could not reveal as an increase in transpiring organs under lower irrigation frequency but a consequence of narrowing leaves under water deficit condition. Our results suggested that cotton plants adapt to different water frequency via regulating transpiring organs and their functions as water stress conditions. Therefore we may suggest that determining irrigation frequency in cotton production should be considered as a main factor rather than irrigation amount.

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# CONSIDERATIONS ON REHABILITATION OF IRRIGATION SPRINKLER PLOTS AND OF THE PUMPING STATIONS

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**Abstract**

The paper presents an analysis of the guidelines for the rehabilitation of irrigation plots to sprinkler watering. Irrigation systems from Romania were conducted in 40 to 50 years, and most are degraded at the present stage. Part of irrigation sprinkler plots is in operation, but the important phenomena of wear and aging. Their rehabilitation is carried out on the two major components, pressure pumping station and (PSP) and the network of pipelines. Rehabilitation and modernisation of the PSP is achieved differentiated on structural and functional components: constructive structure, technological hydromechanics line, protection installation from accidental pressure variation, electrical supply installation, installation of monitoring and automation parameters. Case studies drawn on several SPP from Moldova reveal the complexities of rehabilitation and modernization. This should be the successive stages and by using modern materials and technology execution.

**Key words:** rehabilitation, irrigation sprinkler plot, pumping station, hydromechanics installations

Irrigation systems in Romania were made 40-50 years ago, in the art and materials existing at the time. Much of the irrigation systems were dismantled after 1990 and only a few are still in operation. Irrigation systems in operation (generally the sprinkler for watering) show degradation processes constructive and functional system.

At the current stage are used most small irrigation systems (irrigation plot) with sprinkler watering. Most of them were made in the years 1967-1985 and they were components of major irrigation systems. A number of irrigation systems were equipped for watering mixed (surface irrigation + sprinkler watering. At the current stage is practiced mainly sprinkler watering. Irrigation plot was designed in two pump units equipped with: a - plot equipped with a "pressure pumping station" (codified PPS); b - plot equipped with "single line pumping station" (pumping station supplying water of the single distribution pipe for irrigation SLPS). In the first variant, PPS supplies a network of buried pipes for high pressure sized (7.0 - 8.0 bars). In the second version, pumping stations are located on the inlet channel and fuel distribution pipe one high pressure (6.5 ... 8.0 bars).

Irrigation systems made in both versions wings distribute the water through the sprinkler. The first version of equipment below presents a case that can apply both types of irrigation (sprinkler + flow furrows). This variant can now two pipelines: the first is for sprinkler network (pressure 8-9 bar); the second pipeline is to wet the flow furrows (low pressure, 4.0 bar).

Rehabilitation and modernization of SPP is done differentiated structural and functional components: building structure, hydromechanical technological line, installation of protection from accidental pressure variation, energy supply system, plant monitoring and process automation operation. Case studies drawn on several PPS from Moldova reveal the complexities of rehabilitation and modernization. This should be the successive stages and by using modern materials and technology execution.

## MATERIAL AND METHOD

The case studies were prepared for sprinkler irrigation systems located in Iasi, Vaslui, Braila and Insula Mare of Braila. For each irrigation system was developed technical expertise to determine the structural and functional status. Technical expertise has analyzed the current state of the constructive structure of the pumping station operational after a period of 35-40 years.

Technical expertise has analyzed the current state of structural and functional technological lines of the pumping station. Functional state of the

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technological line analysis of hydro energy balance is achieved by pumping aggregates. Energy balance is drawn up based on measurements made pumping station for various operating situations. The main parameters considered in the analysis (Luca M., 2000; Exharhu M., 1997)

- energy used for pumping

(1) $$E = P_a \cdot T \ ,$$

(2) $$E = \frac{2{,}725 \cdot k \cdot V \cdot H}{\eta_a}$$

where E is energy , kWh; V - the volume of water pumped thousand $m^3$; H - to the head, m ; $\eta_a$ - yield pumping aggregates ; $P_a$ - aggregate installed capacity pumping; T - pumping time; k - coefficient which takes into account energy consumption in auxiliary facilities;

- the specific energy consumption for transport under load H unit volume pumped:

(3) $$e = \frac{2{,}725H}{\eta_a} \cdot \left( \frac{kWh}{1000m^3 \cdot m} \right)$$

- unit specific energy consumption per unit volume of water under a load H = 1.0 m:

(4) $$e = \frac{2{,}725}{\eta_a} \cdot \left( \frac{kWh}{1000m^3 \cdot m} \right)$$

- randamentul agregatului de pompare:
- yield pumping aggregates:

(5) $$\eta_a = \eta_T \cdot \eta_m \cdot \eta_p \cdot \eta_h \ ,$$

$\eta_a$ where is the total yield; $\eta_T$ - yield of electrical transmission; $\eta_m$ - electric motor yield; $\eta_p$ - pump yield; $\eta_h$ - hydraulic yield.

Relationships (3, 4 and 5) are applicable only if the pumps are identical.

Equipment for the pumping station with old and new proposed parameters will determine the operating point ($Q_F$, $H_F$, n, D) (Burchiu V. *et al*, 1981; Luca M., 2000).

## RESULTS AND DISCUSSIONS

The research was conducted on plots irrigation pumping stations equipped with pressurization (PPS) of the pipeline. Most irrigation plots with SPP were performed in the years 1970 -1985, according to type projects (Project 4824R - 1984). Pumping stations were carried out only type SPP infrastructure, which consists of mud box, chamber grids and wet suction hopper. Building structure is made of reinforced concrete. On the cover plate of the tank is placed pumping aggregates and hydraulic pumps. On board chamber grids and mud box mounted installation grilles facility for water filtration.

Irrigation plots have areas of 800 ... 2000 ha. The plot of applied irrigation watering mixed type (sprinkler + flow furrows), or only sprinklers. Pressurizing stations (PPS) were fitted with diagonal vertical pump type VDF (type later removed), MV and MA. Providing pumps designed to ensure operating parameters for the two methods of watering.

PPS1b station pressurizing of the irrigation system Soloneţ-North is a classic presentation *(figure 1)*. Irrigation plot serves an area of 1428 ha. Pressurizing station was designed in 1980, made in 1980-1983 and commissioned in 1983. The pumping station was designed with two pressure stages, to serve two methods of watering *(figure 1)*:

- sprinkler watering served by step I was pumping (parameters: flow Q = 0.800 $m^3$/s and pressure P = 8.50 bars);
- flow furrows served by the second stage of pumping (parameters: Q = 0.200 $m^3$/s and pressure P = 4.50 bars).

Aggregates pumping parameters are shown in *Table 1*.

Table 1

**Technical data pumping aggregates PPS1b mounted**

| Vertical pump MV 253 x 4 | Vertical pump MA 200 x 5 |
|---|---|
| Q = 0.140 $m^3$/s | Q = 0.064 $m^3$/s |
| P = 8.50 bars | P = 4.50 bars |
| n = 1500 rot/min | n = 1500 rot/min |
| N = 200 kW | N = 55 kW |
| U = 380/660 V | U = 380/660 V |
| η = 60% | η = 55% |

a b

Figure 1 **The hydromechanics line to old SPP1b: a - front view; b - side view, highlighting the two pressure stages**.

a

b

Figure 2 **Details on the status of the pumping station SPP1b components: a - taps and check valves on the discharge line; b - hydrophor installation**.

From the analysis results in the following (Luca M., 2012):

- hydro mechanical technology line of stage I and stage II after 35 years of operation presents an advanced physical wear; This condition causes a sharp decline in yield parameters (hydraulic pumping operation) and an increase in costs per $m^3$ of water pumped;

- type MV and MA pumps are worn and outdated as technical level after 35 years of operation; MV and MA pumps is no longer manufactured and are not spare parts; pumping unit energy consumption of large east because of low yields;

- hydraulic installation of the pumping station is worn, outdated operating periods (valves, dampers) and outdated; pipes are worn out and causes loss of water with high pressure pumping *(figure 2 a)*;

- drive electric motors that are worn and outdated technical level after being used for 35 years; yield electric motors is low and exhibits frequent damages;

- hydraulic installation of shock protection system is fully degraded *(figure 2 b)*;

- monitoring installation of the operational parameters is partially degraded;

- pumping station does not have an automation system.

Simulation parameters functioning of the pumping station pumps operating after 35 years an increase in energy consumption by about 28 ... 37 % from baseline at start-up (Luca M., 2012).

In conclusion, that should be performed rehabilitation and refurbishment of the pressurizing pumping station to increase efficiency and decrease energy consumption in operation. Directions rehabilitation of the pumping station is:

1. Rehabilitation works constructive structure of PPS by restoring integrity wet tank and mud box. Resizing and achieve concrete plate supporting new pumping aggregates, according to their weight and the hydraulic system.

2. Replacement of pumping aggregates with modern pumps and high efficiency. Engines will present a variable speed drive to reduce energy consumption in pumping engines (frequency converter).

3. Replacing the hydraulic pumping station (pipes, valves, check valves, fittings, etc.). The valves will allow for automation processes in the pumping station.

4. Rehabilitation of the plant protection hydraulic shocks the structural and functional components. The installations of the pumping station adapting to process automation.

5. Rehabilitation energy supply system components and structural adjustment process automation. Power demanded by new pumping aggregates should fit value existing electrical transformer station.

Figure 2 **Details on the status of the monitoring instalation**

All sequences rehabilitation process must be carried out fully to achieve the correct operation of the pumping station. SPP1b pumping station was rehabilitated in compliance with the above requirements. In the first stage construction was rehabilitated suction chamber, mud box and access area. In the second stage were selected pumping aggregates and were mounted on a reinforced concrete resized. In the third stage they were rehabilitated other facilities serving pumping station.

PPS 1b Solonet–North station was equipped with variable speed pumps. Pumping station was commissioned in 2016 *(figure 3)*.

From studies on how to rehabilitate irrigation plots in Moldavia revealed a series of problems:

- lack of rehabilitation of reinforced concrete structure of the tank and mud box; without verifying the resistance of the plate tank and resize it;
- equipping pumping station with pumps we do not calculate the point of pumping parameters (flow, pressure, power and yield);
- no hydraulic installation rehabilitation of the pumping station;
- no rehabilitation facility hydraulic shock protection installation of the pumping stations and to some it was disbanded;
- lack of automation installation of pumping station operation.

a b

Figure 4 **The pumping station SPP1b rehabilitated: a - general view; b – hydraulic installation.**

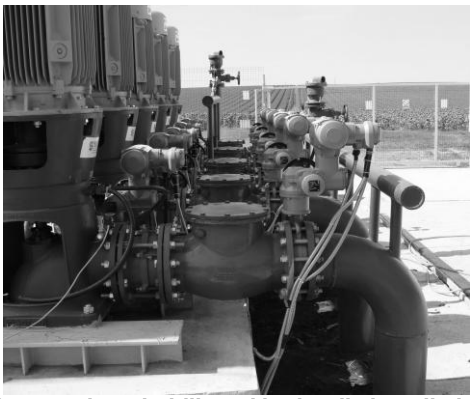

Figure 5 **The rehabilitated hydraulic installation of the pumping station SPP1b**

Pumping stations serving only rehabilitated and analyzed sprinkler watering.

## CONCLUSIONS

Irrigation plots are the most common components of the old rehabilitated irrigation systems made in Moldavia.

Rehabilitation of pumping for pressurizing is performed on all building structures and facilities components to achieve low power consumption and decreasing water loss.

Rehabilitation of pumping stations type SPP had to be made to the prior art complex with the introduction of monitoring and automation of mining.

A series of restoration projects lately type SPP pumping stations were not conducted in a complex way, a situation that causes a malfunction with high energy consumption and the water loss in the system.

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# MOLDAVIAN GRAY FOREST SOILS TRANSFORMATION DUE DEFORESTATION AND AGRICULTURAL USE

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**Abstract**

With deforestation and employment in the agricultural use the forest soils from Codri area of Moldova begin another stage in its development under anthropogenic factor action in climatic conditions favorable for the development of steppe vegetation and formation of chernozem soil. Such changes as formation of the new (arable) layer with average thickness 34 cm from the genetic material of the former three horizons of gray forest soil (AEhţ + AEh + BEhtw), clay content increasing in arable layer as a result of increasing "in situ" weathering process followed by the reduction of the textural differentiation on the profile, humus content decreasing, balanced bulk density value increasing as the result of dehumification and weaker structure and hydrolytic acidity reduction by 2-3 times in arable layer is occurred.

**Key words**: greyzems, deforestation, Moldova, soil

With deforestation and employment in the agricultural use the forest soils begin another stage in its development. Being formed around the end of Pleistocene and early Holocene when the climate was more colder and more humid, favorable for forest vegetation growth development (Adamenco O.M. *et al*, 1996), and developed in the present time in semiarid climatic conditions corresponding to the chernozems area, gray forest soils from Republic of Moldova evolution is an interesting scientific research topic both in point of view of their development under the forest as well as farmland. Thus now under the forests continues to evolve gray forest soils due to the biological factor, but under the climate regime typical for chernozems area. It gives them some characteristics that distinguish them from the other regions.

To highlight and evaluate changes of arable grazyems proprieties under anthropogenic factor action in the specific conditions of Moldova, we aimed to investigate changes occurred in the morphology, properties and the elementary processes of gray forest soils (grayzems) employed in the agricultural use in Ivancea village, Orhei district, Moldova`s Codrii area. To achieve this research we use the comparative research method making comparison between grayzem under forest and grayzems aside employed in agriculture.

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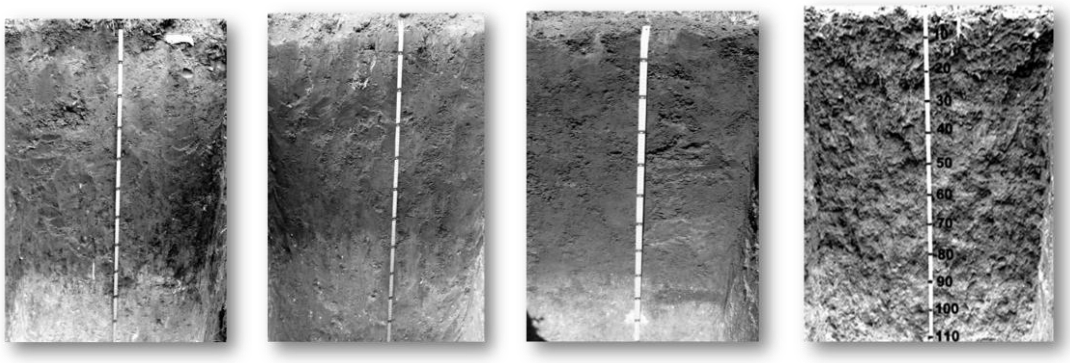


*gray soils of primary forest with semiprofound humus profile*

*gray arable soil with semiprofound humus profile (used as arable land about 100 years);*

*gray arable soil with moderately profound humus profile (free from the forest vegetation more than 100 years).*

*cambic arable chernozem evolved from gray soil during prolonged pedogenesis under the steppe vegetation*

Figure 1 **Forest and Arable greyzem soil profiles**

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## MATERIAL AND METHOD

As the object of study were selected gray soils (grayzems) from the forest and those which were employed in agricultural use from the experimental field of Institute of Pedology, Agrochemisry and Soil Protectection from the village Ivancea, Orhei district, Codri area, in the Central part of Moldova, that are evolved on clayey-loamy loess deposits placed on the Pliocene alluvial deposits. Moldavian Codri area is located between the 150-250 m height, in the warm and semihumid climatic area.

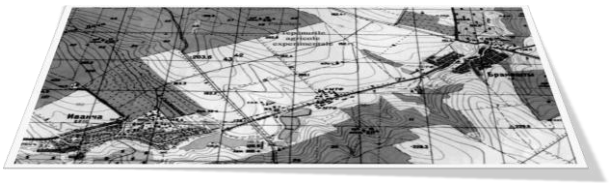

Figure 2 **IPAPS "N. Dimo" experimental fields location**

To highlighted the gray forest soils changes due the change of climatic conditions and agriculture use we study four tipe of soil (*figure 1,3*) located alongside each other:

- gray soils under primary forest;
- gray arable soil used as arable land about 100 years;
- gray arable soil free from the forest vegetation more than 100 years;
- cambic arable chernozem evolved from gray soil during prolonged pedogenesis under the steppe vegetation

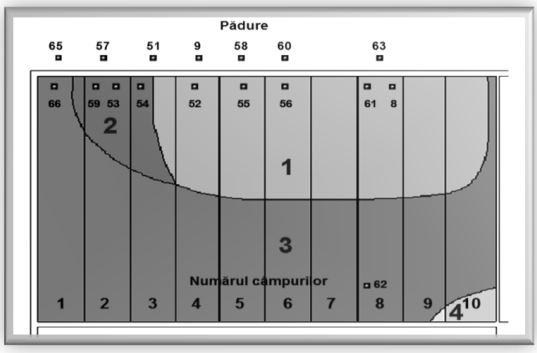


Figure 3 **Soil distribution scheme of investigated areas in the experimental field.**

*Legend:*
**1** *–gray arable soil semimoderately humiferous with semiprofound humus profile (used as arable land about 100 years);*
**2** *- gray arable soil semimoderately humiferous with moderately profound humus profile*
**3** *- cambic arable chernozem moderately humiferous with deep profound humus profile*
**4** *–eroded arable leached chernozem with moderately profound humus profile*

## RESULTS AND DISCUSSIONS

Forest greyzems are characterized by a clear differentiation of the profile. During the depth 0-31 cm we can see three genetic horizons: AEhţ, AEh and Behtw with medium texture and low compaction, under which is located iluvial very compacted horizon. It was established that the loss of clay (90 t / ha) from eluvials horizons (AEhţ, AEh, BEh) of gray forest soil are about nine times smaller than its accumulation in iluvial horizons (835 t / ha), what confirm the leading role of alteration "in situ" processes in the textural profile differentiation of these soils in conditions of Moldova. Forest soils are also characterized by good structural state and soil aggregates hidrostability in 0-20 cm layer. Forest soils are characterized by thin fallow horizon on surface (8 ± 2 cm) with rich (8.52 ± 0.56 %) humus content. With the deep humus content decreases sudden and is equal to 2.93 ± 0.20 % in AEh horizon. Average value of hydrolytic acidity for 0-34 cm layer of gray forest soil is 6.9 ± 2.9 me/100g.

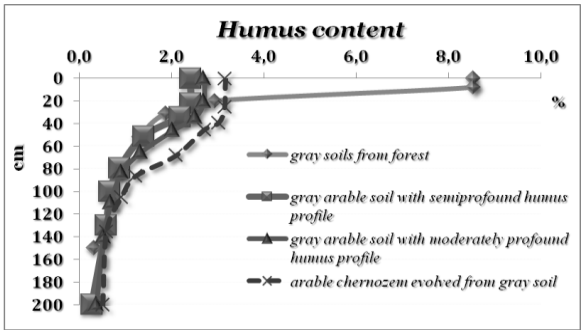


Figure 4 **Humus content of researched soils (average data)**

A common feature for both gray forest soils and the arable land is comparatively small depth (about 80 cm from surface) of occurrence of iluvial carbonate horizon extremely highlighted; the maximum carbonate content varies within 20-28%. Carbonates are shaped in massive accumulation of carbonate concretions and veined. This is a consequence of contrast warmer hydrothermal regime under which influence soils were formed. It should be mentioned that in forest soils carbonate accumulations are more expressed than in arable soils. Hydrothermal regime changes to a more humid on arable grayzems have led to a more homogeneous distribution of carbonates in the all parental rock.

Arable layer of the gray soil permanently used in agriculture around 100 years is the mixture of genetic material from three forest soil surface horizons AEhţ, AEh şi BEhtw. This layer has lost initial favorable structure and became rough and highly compact, texture has changed from the middle to middle-fine and the color from gray to reddish brown. The 0-30 cm layer practically lost

its ability to keep the loose state after basic processing. Balanced bulk density of the arable layer at 10-30 cm depth (below the periodic tillage layer) to mid-summer reach values equal to 1.50 to 1.55 g/cm ³, and the degree of compaction - 17 - 18%. As a result, the state of physical quality of this layer becomes unfavorable for crop plants growth.

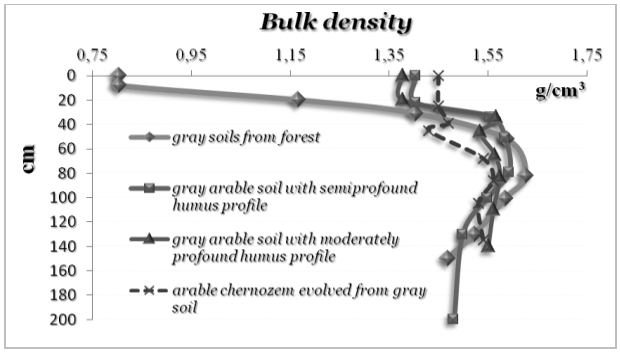


Figure 5 **Values of soil bulk density of forest and arable gray soils (average data).**

Gray arable soils throughout the profile are low in total phosphorus content, unlike the forest gray soils which are characterized by high content of total phosphorus in AEhţ horizon as a result of biological accumulation of this element from litter and other organic debris.

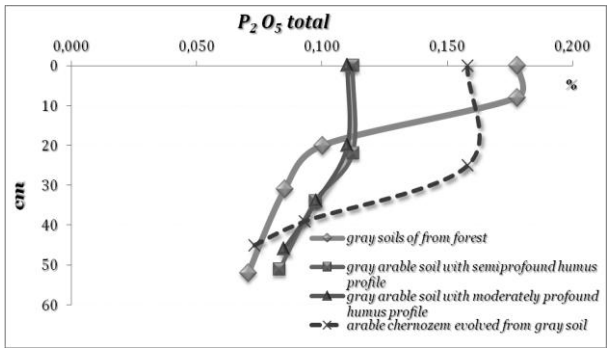


Figure 6 **Phosphorus content in researched forest and arable gray soils (average data).**

Caried out research also show that hydrolytic acidity value in arable layer was by 2-3 times lower like in the soils from the forest. This led to the eluvial-iluvial process and profile textural differentiation halting. Due to this soils become more suitable for the majority crop plants growth.

It was determined that remediation of the properties of these soils should be directed towards increasing the content of organic matter in arable layer and improving the unfavorable structural condition in plowed layer

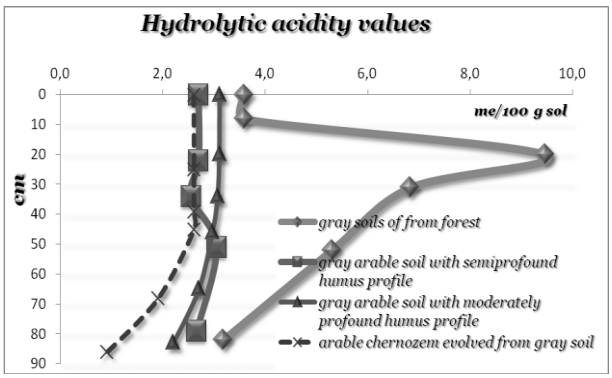


Figure 7 **Hydrolytic acidity values of researched forest and arable gray soils (average data).**

Arable gray soils also are characterized by unfavorable physical properties due to the high content of colloidal clay and compacted natural iluvial horizon located below 30-35 cm.

To improve studied grayzems quality was appreciated effect of some agro-pedo-ameliorative measure on the physical and chemical characteristics of these soils (as resistance to penetration, bulk density, degree of compaction, hydrolytic acidity, pH, etc.) and winter wheat productivity

We investigated five different soil improvement measures:

• EP1 - blank, topsoil procesing with discs and harrows to 12-15 cm depth;

• EP2 - 40 cm depth soil plowing with paraplow (subsoiling) + topsoil procesing;

• EP3 - 40 cm depth soil plowing with paraplow+ introduction of 12.5 t/ha of beet lime + topsoil procesing;

• EP4 - 40 cm depth soil plowing with paraplow+ introduction of 12.5 t/ha of beet lime and a dose of 50 t / ha livestock manure + topsoil procesing;

• EP5 - 40 cm depth soil plowing with paraplow+ 50 t/ha livestock manure introduction + topsoil procesing.

The carried out research have demonstrated that in the experemental field subjected to subsoiling the resistance to penetration in the 15-40 cm layer substantially descrease from 15 to 11 kg/cm$^2$ in arable layer and from 21 to 13 kg/cm$^2$ in postarable layer. This facilitated plant roots to penetrate soil to the depth of 35-40 cm while the thickness of the roots spreading in the blank experimental field did not exceed the depth of 20-25 cm.

The best influence on the wheat harvest had a subsoiling with beet lime and livestock manure introduction (combined method). If subsoiling increased harvest by about 4.4 q/ha compared to the blank then cumulative effect of subsoiling, beet lime and livestock manure introduction increased

harvest by about 11.5 q/ha due to improved hydrological and nutrition conditions in the soil. Broadly speaking we find that subsoiling helped to increase yield by 12%, the beet lime introduction – by 2%, livestock manure introduction – by 12%, and combined method increased the harvest -by 32% compared to the blank.

During the research were determined three stages of degradation and gray soil regradation in the investigated region what corresponds to identified soil types:

I. stage of conservative degradation - at this stage takes place the homogenization of the upper part of the profile, dehumification, destructuring of structural aggregates and soil compaction, reducing soil acidity, stopping eluvial-iluvial and cambic processes what led to the decreasing of humuso-accumulative processes intensity and morphological and textural differentiation in the profile.

II. Stage of partial regradation as a result of the short phases of arable gray soil pedogenesis in steppe vegetation (long swarding). It is characterized by humification process intensification and humus profile thickness increasing without significant changes in humus quality.

III. Stage of regradation in chernozem under the influence of pedogenesis process under the steppe vegetation. Among characteristic features of soil at this stage are listed the intensification of humus accumulation, higher humus quality and the formation of the deeper humus profile.

## CONCLUSIONS

Soils evidenced on the research area are characterized by the following morphological characteristics and common features: comparatively small depth of carbonates leaching (80-90 cm from ground surface) followed by formation of a highlighted iluvial carbonate horizon very compact when is dry; strong argilization in the middle part of the profile; the similar way of the clay distribution on the profile; existence of the special formation inherited from pedogenesis stage in forest vegetation (holes of the former roots of trees, Fe2O3 and MnO2 cutan on the walls of these holes)

Gray soils used about 100 years in agriculture are characterized by following changes in morphological characters and properties:

- formation of the arable layer with average thickness 34 cm from the genetic material of the former three horizons of gray forest soil (AEhţ + AEh + BEhtw);
- increase in arable layer by about 6.0% clay content compared with the analog section of the forest soil as a result of increasing "in situ" weathering process followed by the reduction of the textural differentiation on the profile;
- humus content decrease in arable layer 0-34 cm on average by 1.74% (43 percent of initial content) compared to the humus content in the same section of the forest soil;
- resistance to compaction loss in arable layer, balanced bulk density achieve values to the 1.55 - 1.57 g/cm3 (strong compaction) and poor physical condition as the result of dehumification and weaker structure;
- hydrolytic acidity value descreasing by 2-3 times in arable layer and the eluvial-iluvial process and profile textural differentiation stopping (positive change);
- cambic arable chernozem is characterized by intensification of humus accumulation process, higher quality humus formation (humato – fulvic or humatic) and the deeper humiferous profile.

The most effective studied gray soil improuvement measures were found to be subsoiling with beet lime and livestock manure introduction. The combined method of the researched grayzems physical and chemical improvement is more effective than the methods applied separately.

## ACKNOWLEGMENTS

This research work was carried out with the support of Institute of Pedology, Agrochemistry and Soil Protection “Nicolae Dimo”.

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# CHARACTERIZATION OF REPRESENTATIVE SOILS FROM THE CONFLUENCE OF PERESCHIVUL MIC WITH PERESCHIVUL MARE

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**Abstract**

The studied area belongs to Tutova Rolling Hills. The geological substrate consists of recent and loose deposits belonging to Kersonian, Meotian, Pontian, Dacian and Romanian, predominantly with sands and clay infilled. These deposits are bisected by a consequent network of parallel valleys, NNW-SSE oriented. The resulted relief is hilly, younger and monotonous, with numerous extended hills, within detaches narrow ridges and slopes association quite steep. The main rivers that drain the Tutova Rolling Hills territory are Tutova, Pereschiv, Zeletin and Berheci. Pereschiv River is located in the central-southern Tutova Rolling Hills, with a basin that occupies an area of approximately 23266.768 ha. Representative soils of the studied area belongs to classes Chernisols, Cambisols, Protisols (Regosols), Anthrosols and Hydrisols. Chernisols class includes soils very rich in humus, well structured and have the highest fertility. Chernisols prevails on the reverse cuesta of the valleys of Pereschivul Mare and Pereschivul Mic rivers. On lands with greater slope prevails Anthrosols and Regosols. In the plains of the both rivers appear alluvisols and gleysols. Chernisols are used as arable lands and Anthrosols presents a high level of degradation due to clearing of trees and vine plantations.

**Key words**: Tutova Rolling Hills, Pereschivul Mare, Pereschivul Mic, soil profiles

In the basin area, was modeled a sculptural relief, constituted by sandy-clayey inter-fluviums affected by geomorphological processes like gullying erosion, landslides, crumbling. Along the Pereschiv valley, appears an accumulation relief represented by alluvial plains and accumulation glacis (Niacşu L., 2012).

In terms of the type of erosion, the erosion surface represents 34% from the amount of eroded land, then the erosion in depth with 26.4% and then landslides with only 13.1%.

The temperature of the soil cover (10-11°C) is a little higher than air temperature (8-9°C). The large variations of soil and air temperature have major effects on rocks disintegration. The material is detached in the winter time due to freezing and the transport of this material begins in the springtime, due to thawing and melting (Niacşu L., 2012).

In the Pereschiv basin, erosion has unearthed only Superior Badenian-Romanian deposits, although Ionesi L. (1994) identifies 4 cycles of sedimentation: Inferior Devonian–Carbonifer, Permian–Triassic, Jurassic–Cretacic–Eocen and Superior Badenian–Romanian. In the sediments brought to the surface, predominant deposits are Maeotian, Pontian and Dacian with recent alluviums, but the studied basin area is essentially Maeotian.

The vegetation consists of forest steppe species and deciduous forests. In this area are characteristic sessile oak forests (*Quercus petraea*) mixed with *Quercus pedunculiflora* (gray oak) and *Quercus pubescens* and rare *Quercus frainetto*.

In the Pereschiv basin, there are two zones of vegetation, which make the difference between latitude and altitude.

The forest zone (the vertical one) is situated on 250-300 m altitude and it is composed by two subzones: sessile oak and beech subzone and sessile oak and oak subzone. The herbaceous species are *Poa nemoralis, Brachypodium silvaticum, Fragaria vesca, Viola odorata, Convallaria majalis.* The forests have been extensively cleared the land being later used for agriculture (Niacşu L., 2012).

The forest steppe zone (the orizontal one) is characterized by herbaceous vegetation interrupted only by some clumps of forest: *Quercus* and *Tilia species*.

Complex relief and vegetation conditions prompted the formation of a complex envelope

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soil. Some of the lands are degraded by landslides and have severe restrictions for the arable use.

Knowledge of dominant characteristics of soils are important to establish an effective management of the soil resources and and preventing or reducing their degradation.

## MATERIAL AND METHOD

Our investigation were carried out in the area from the confluence of Pereschivul mic with Pereschivul mare. The study area belong to the geomorphological unit of Tutova Rolling Hills.

In order to highlight main characteristics of dominant soils from the studied area, some soil profile were made in the representative location.

Choice of representative locations for the main soil profile was done taking into account the particular characteristics of relief. The location of the soil profiles is shown in *figure 1*.

The first two locations soil profiles are located in upper and lower thirds of the heavily tilted slope from Valley of Pereschivul Mare. The representative soil for arable land is located on the face of landslide from Cabesti and Pereschivul Mare Valley.

We also studied soil profiles from wetland flood plain of Pereschivul mare and from terraces that have been clearing plantations trees and vine.

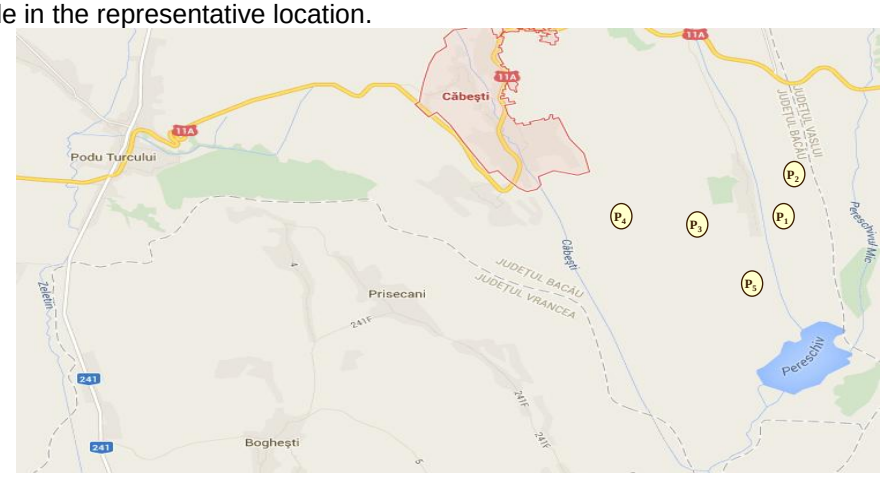


Figure 1 **The location of the soil profiles (P1- $P_5$) in the confluence area Pereschivul Mic with Pereschivul Mare**

The soil units were completed with new obtained data, in the field and laboratory. It was necessary the equivalence of taxonomic units name, from the Romanian System of Soil Classification (Conea A. *et al,* 1980) and the Romanian System of Soil Taxonomy published 2003, 2012 and 2014 (Florea N. *et* Munteanu I., 2003 and 2012, Vlad V. *et al,* 2014).

Disturbed samples from the soil profiles were used to determine the total soil organic matter by potassium dichromate method (Walkley-Black method), the calcium carbonate by Scheibler method. The chemical analyses in three replicates for each depth were independently performed (Stoica E. *et al,* 1986, Dumitru E. *et al*, 2009, Obrejanu G. *et al,* 1964).

The particle size distribution was also determined. The textural classes and subclases were established after Romanian clasification system (Soil Survey Methology, 1987).

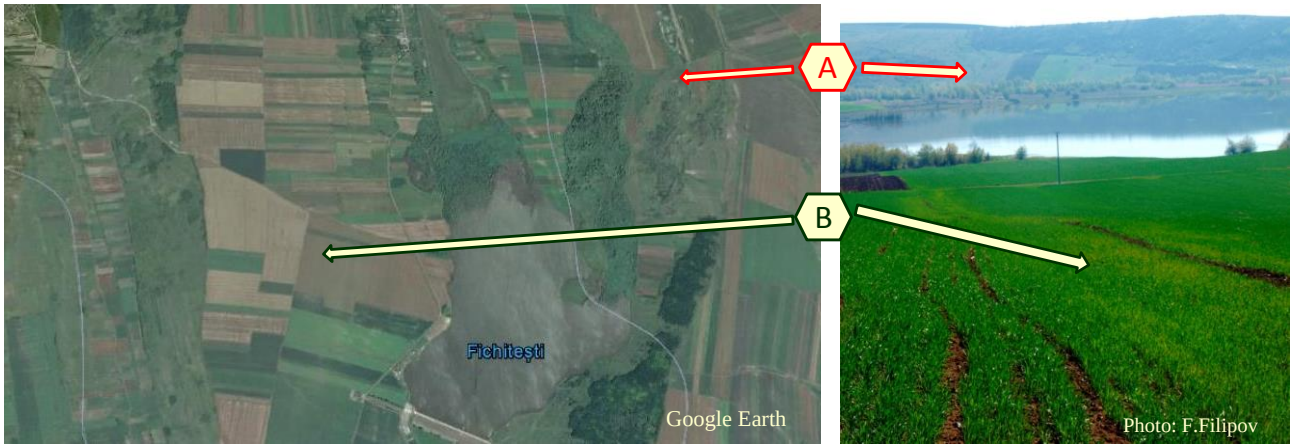


Figure 2 **The faces and cuestas landslides of the Pereschivul Mare catchment A - cuesta relief from Pereschvul Mare Valley; B - The face of landslide from Cabesti and Pereschivul Mare Valley)**

## RESULTS AND DISCUSSIONS

Typical hilly area (*figure 2*) of Tutova Rolling Hills linked to developments of different soil units.

First profile was made near the left slope of the river Pereschiv, in the lower third, South-East of Căbeşti village, Bacău county (*figure 3*). The GPS coordinates are 46° 10' 96" North latitude and 27° 29' 85" East longitude. The soil profile is located upstream Fichiteşti lake, the altitude is 94 m. The land has, Western exposition, with a slope of 18°. Alluvial plain, meadow vegetation with reed, willow, poplar, natural vegetation and *Helianthus angustifolia* expanded from the plantation nearby. Parental material clayey delluvium. Usage for intensive grazing leads to continuous degradation of the land resources.

Soil features highlights the cumulative effect of poor land management.

The first soil horizon is the thatch layer (0-4 cm) consisting predominantly of organic material. The humus accumulation horizon with a thickness of only 12 cm humus shows small humus reserve. Due to continuous erosion, soil remains in the early stages of development. Calcium carbonates exists in all soil horizons. The calcium carbonates presence can be easily seen deeper than 20 cm (*figure 3*). The slight alcaline soil reaction is due to presence of calcium carbonates.

The soil with no significant profile development is defined as calcaric Regosols (after Romanian System of Soil Taxonomy, Florea N, 2003, 2012 and Vlad V., 2012) or Calcaric Leptic Regosols (WRB 2006 and 2014).

Details of soil thatch layer, humus accumulation and local accumulation of calcium carbonates are illustrated in figure 3.

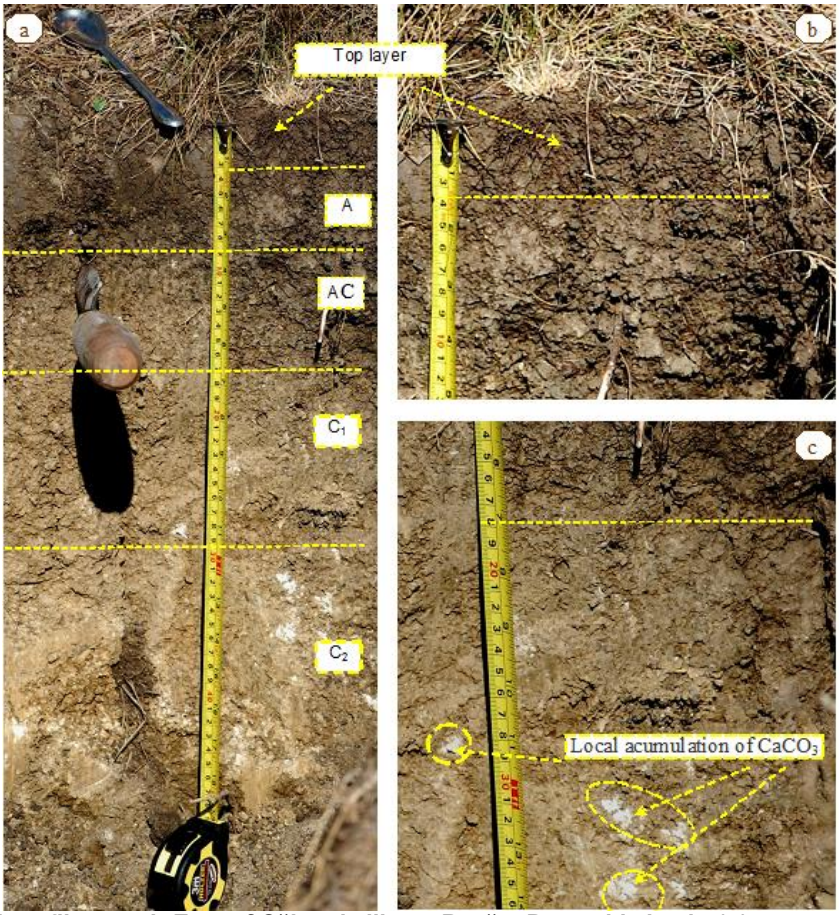


Figure 3 **Soil profile, South-East of Căbeşti village, Bacău, Pereschiv basin** (Photo: Lungu C.)

The second profile was located in the upper third of slope (Lungu C., 2015).

The coordinates of soil profile are 46° 13' 45" North latitude and 27° 30' 11" East longitude. The soil profile is located on the upper third of moderately sloped land, with Western-South-East exposition and on the altitude of 198 m. The soil is defined as Cambisol eutric (Florea N. *et al*, 2012) or Eutric ochric Cambisols (WRB 2014). The diagnostic horizon is B cambic from middle part of soil profile (figure 4)

The soil is the beginnings of horizon differentiation. A slight humus accumulation on the upper part of soil profile (A horizon) is

evidentiated by light brown colour. The B horizon is developed after leaching of calcium carbonate and changes in colour and structure.

The Eutric ochric Cambisols formation is favored by relative dry climate (under 500 mm), by high water permeability and by active geologic erosion. Moderate eroded soil developed on diluvial deposits consisting in maeotian sands. Usage for grazing, ruderalised degraded pasture. General slope is 15°.

In all soil horizons we could see biological neoformations represented by earthworm and mole channels.

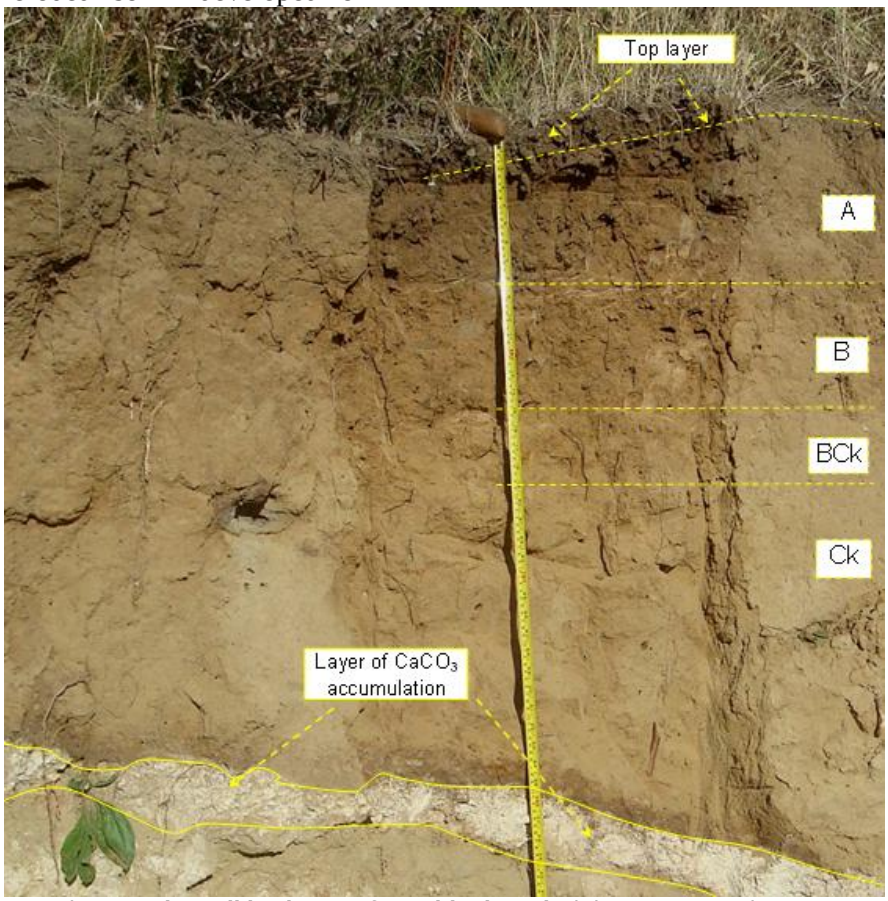


Figure 4 **The soil horizons of Cambisol eutric** (Photo: Lungu C.)

The representative soil for arable land is Chernozem cambic mezocalcaric (figure 5) depth of occurrence of calcium carbonate being 70 cm (Florea N. *et al*, 2012). After european soil classification (WRB-2014) soil is defined as Haplic Chernozems.

The cambic mezocalcaric Chernozem formation processes consisted of bioaccumulation, clay formation and leaching of calcium carbonate. Bioaccumulation was favored by saturation colloidal complex with $Ca^{2+}$. Clay formation occurs after removal of $CaCO_3$ and formation of iron hydroxides.

The Cambic Chernozem has high useful soil volume and good inernal drainage. Relatively uniform color of soil matrix indicates that the soil is not affected by excess moisture. The soil is relatively loose except plowpan layer that appears, locally. Discontinuous soil compaction is evidenced by the different distribution of roots. In the compacted place, the plants roots has preferentially distribution, especially on the faces of structural aggregates.

The Chernozem cambic mezocalcaric is slightly eroded and has a medium texture at the top (table 1) and coarse at the base of soil profile.

Soil has a nonhomogeneous texture, differentiated on profile. The textural differentiation occurs due mostly to textural nonhomogeneity of delluvial deposits, reshuffled by geomorphological slope processes (erosion).

Soils with medium texture, are most favorable for the majority of crops. Excess moisture present in lowland areas and humid climates can be easily removed due to good soil drainage. After A. Canarache (1991), the best expressed positive features are found in sandy clays containing less than 24-25% clay.

Silty clays are susceptible to crust formation and erosion. Coarse sandy clays and coarse loamy clays are very susceptible to compaction.

The granulometric composition is the determining factor of cohesion and adhesion of soil on which depends the resistance to plowing.

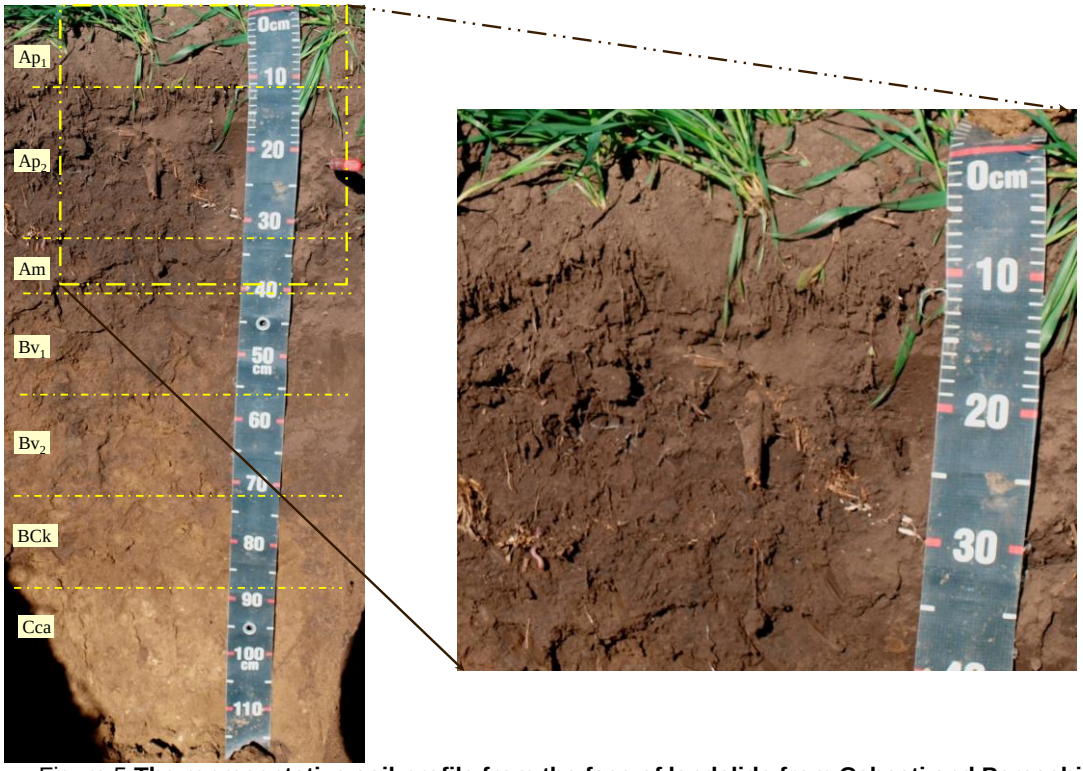


Figure 5 **The representative soil profile from the face of landslide from Cabesti and Pereschivul Mare Valley** (Photo: F. Filipov)

Table1

**Texture of cambic chenozem**

| Depth (cm) | Horizon | Size particle (%) | | | | Texture |
|---|---|---|---|---|---|---|
| | | coarse sand | fine sand | silt | clay | |
| 0-14 | $Ap_1$ | 2,5 | 57,2 | 21,6 | 18,7 | Fine sandy loam |
| 14-32 cm | $Ap_2$ | 3,2 | 59,1 | 20,3 | 17,4 | Fine sandy loam |
| 32-40 | Am | 2,7 | 59,2 | 18,9 | 19,2 | Sandy loam |
| 40-54 | $Bv_1$ | 1,6 | 50,4 | 23,5 | 24,5 | Medium loam |
| 54-70 | $Bv_2$ | 4,3 | 45,5 | 25,4 | 24,8 | Medium loam |
| 100-140 | BCk | 6,7 | 62,6 | 19,8 | 10,9 | Middle loamy sand |
| 140-175 | Ck | 7,4 | 63,8 | 20,3 | 8,5 | Middle loamy sand |

The soil is poor to moderately stocked with humus and nutrients. Annual fertilization with complex fertilizers on crop establishment, ammonium nitrate and ammonium sulphate fertilizers, associated with the foliar fertilizers, compensates the nutrient deficiency in soil. Soil reaction is slightly acid and neutral in arable layer and in the subarable layer (Am).

Frequently, in marginal areas of agricultural parcels not apply fertilizers, the plants stagnate growing and became chlorotic, the yield diminish considerably (*figure 5*).

Figure 5 **The wheat strip from parcel margin where the plants are chlorotic due to poor application of fertilizers**

## CONCLUSIONS

The features of calcaric Regosols with no significant profile development highlights the cumulative effect of poor land management. natural vegetation. Some plants such as *Helianthus angustifolia* expanded from the the neighboring area.

The Eutric ochric Cambisols from upper part of slope is developed under dry climate (under 500 mm) and active geologic erosion.

The representative soil for arable land is cambic Chernozem with high useful soil volume and good inernal drainage. Relatively uniform color of soil matrix indicates that the soil is not affected by excess moisture. The soil is relatively loose except plowpan layer that appears, locally.

Discontinuous soil compaction is evidenced by the different distribution of roots. The plants roots has preferentially distribution, especially on the faces of structural aggregates.

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# INJECTOR OF PRIMARY SOLUTIONS WITH HYDRAULIC CONTROL

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**Abstract**

The injector within the structure of the equipment usable for fertigation of horticultural crops, developed under the PN-II-PT-PCCA-2013-4-0114-*FERTIRIG* project, Financial Agreement no. 158 /2014, is the type double diaphragm pump, compact design, its body embedding both the hydraulically controlled directional valve, which controls the change in the direction of motion of the mobile assembly with membranes, and the valves for intake/ discharge of primary solution. The injection device uses irrigation water as the working (driving) fluid; this water is taken from the same pipeline in which the primary solution (that in a mixture with the irrigation water forms the fertilizing solution) is injected, which provides autonomy in operation of the fertigation equipment in any spot of the irrigation enclosure. The overpressure needed to perform injection is achieved on the principle of difference between the active surfaces of driving chambers and injection chambers. The injector shall be installed in bypass against the pipeline which supplies the drip or micro sprinklers irrigation plant, with which it forms a working assembly. The pump working pressure is 2.5…3 bar, and it is limited to such values by the pressure allowable in the irrigation water distribution network. Laboratory tests have highlighted that for the previously defined pressure range, at flow rates of the irrigation plant of 10.5...13.5 l/min, the device achieves injection flow rates of 2.5...3 l/min, at frequencies of the mobile assembly of 90...110 double strokes/min. Tests on the fertigation equipment, in real operating conditions, will be conducted at the premises of project partners USAMV Iasi and ICDP Pitesti Maracineni.

**Key words**: Injection device, fertigation, primary solution, hydraulic control

Irrigation techniques have continually evolved towards reducing water consumption at plants (dripping, micro-sprinkling) and a higher capitalization of water by mitigating losses and pairing with other works (fertilizing, herbiciding, etc). (Șovăială Gh. *et al*, 2015)

A modern agriculture cannot be conceived without irrigation, which is both a high performance technological sequence in agro technology of crops and the most important technical means of eliminating the water deficit in soil, thus representing the infrastructure for sustainable development. The fertigation equipment, intended for fertigation of horticultural crops in protected areas (vegetables and flowers), and respectively for fertigation of horticultural crops in open field (vegetables, trees and fruit shrubs), includes the device which injects the primary solution into the irrigation water, the container for the preparation of the former, devices for measurement and control of operating parameters, hydraulic connection elements between items of equipment. This equipment enables coupling the technical elements of irrigation with the technical elements of fertigation, so that at the end of watering, when there is reached the depth of water penetration in the zone of prevailing development of plant roots, there is administered the entire amount of fertilizing solution necessary to plants, determined according to the state of plant growth.

The injector is connected in parallel (by-pass system) to the main circuit of the irrigation facility, by two quick couplers, in order to take over the water used as a driving fluid, and respectively in order to inject the primary solution; this assembling system does not introduce hydraulic pressure loss in the pipe of the irrigation facility.

## MATERIAL AND METHOD

The injector, which is the main component of the fertigation equipment, is intended to introduce the primary solution into the supply pipeline of the irrigation facility that it serves. The mixture of primary solution and irrigation water forms the fertilizing solution, which reach plants via the distribution network and devices.

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The injection device, type double diaphragm pump (Avram M., 2005), hydraulically driven, uses as a working fluid the irrigation water taken from the same pipeline in which primary solution is injected, which provides autonomy in operation in any spot of the irrigation enclosure. Injection pressure is achieved on the principle of difference between the active surfaces of driving chambers and injection chambers, and it can be determined accurately, according to the hydraulic parameters of the irrigation facility with which it forms a working assembly, early since the equipment design stage. Flow of injected primary solution can be adjusted within a wide range, by adjusting the flow which supplies the driving chambers, and respectively by throttling the flow which supplies the control chambers of the hydraulic directional valve, thus altering frequency of the piston, which is jointed with the membranes that separate driving chambers from injection chambers.

The injector (*figures 1...3*) has compact design; in its body *1* there are mounted the mobile assembly, the hydraulic directional valve, the primary solution intake/discharge valve assembly, the throttles of control chambers of hydraulic directional valve, and the piston which controls the spool of hydraulic directional valve.

**The mobile assembly** consists of piston *2*, membranes *3*, outer flanges *4* and inner flanges *5*, special screws *6* for fastening the membranes to the piston.

**The hydraulic directional valve,** spool fitted, *7* is a 2-position / 4-port valve.

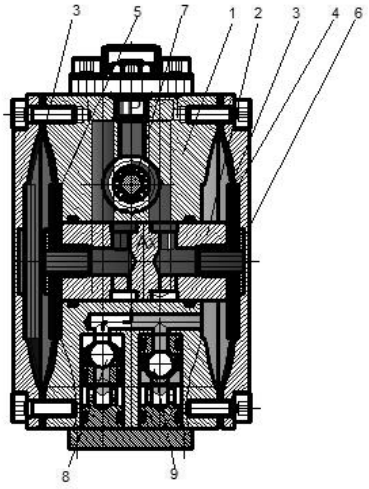


Figure 1 **E-E section through the injection device 1-body; 2-piston; 3-membranes; 4-outer flanges; 5-inner flanges; 6-screws fastening the membranes; 7-hydraulic directional valve, spool fitted; 8-primary solution intake valve; 9-primary solution discharge valve**

**The** primary solution intake/discharge **valve assembly** – each injection chamber is connected to an intake valve-*8* and a discharge valve-*9*. The intake/discharge valves of the two injection chambers are interconnected and also connected to the primary solution intake nozzles *As*, and respectively connected to the primary solution discharge nozzles *Re* (*figure 3*).

The piston which controls the spool of hydraulic directional valve-*10* is shown in figure 2.

The driving chambers are bounded by the outer surfaces of the membranes and the caps *11*, while the injection chambers are bounded by the inner surfaces of the membranes and the body.

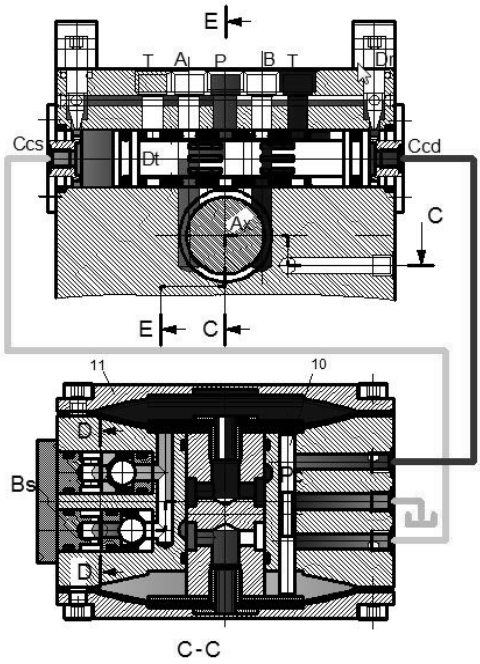


Figure 2 **C-C section through the injection device 10-piston controlling the spool of hydraulic directional valve; 11-caps**

**Principle of operation**

Depending on the position occupied by the spool of hydraulic directional valve, the port P is connected either to the port A or the port B, from which, via interior channels in the body and piston, the driving chambers are supplied with pressurized water. On the outside, ports A and B are sealed with plugs.

Through the ports T the fluid from the driving chambers is alternately discharged (A to T or B to T), in the phase of retraction of the membrane assembly (decrease in capacity of the driving chambers).

The water discharged from the driving chambers is distributed to the plants through a distribution pipe with embedded drippers.

Also from the port P the control chambers *Ccs-Ccd* of hydraulic directional valve are continuously supplied with pressurized water. The mobile assembly alternatively moves, by means of the inner flanges, the control piston, which shortly before reaching the stroke end connects one of the control chambers to the atmosphere, causing spool valve switch from the control chamber which is pressurized to the chamber which is depressurized. The throttles *Dr* maintain a position of equilibrium for the directional valve.

Supplying the left driving chamber with pressurized water causes the mobile assembly to move to the right, resulting in:

-discharge of driving fluid from the right driving chamber;

-intake of primary solution in the right injection chamber;

-injection of primary solution from the left injection chamber.

Decreasing the capacity of the left injection chamber (implicitly increasing the pressure), causes placing the intake valve ball on seat and rising the discharge valve ball from seat. Increasing the capacity of the right injection chamber (implicitly generating depressure) causes rising the intake valve ball from seat and placing the discharge valve ball on seat. The injection chambers are alternately connected to the joint intake couplings (on the tank with primary solution), respectively discharge couplings (in the supply pipeline of the irrigation facility) (*figure 3*).

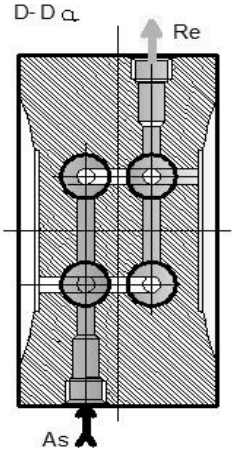


Figure 3 **Connections between primary solution intake/discharge valves**

**Injection device parameters**

If the injection device is type positive displacement pump, to calculate the pump flow *q* one needs to know the volume $V_s$ of primary solution injected per stroke and pump frequency *f*. (Biolan I. *et al*, 2010), As the volume $V_s$ of primary solution injected per stroke is a value imposed through design, pump frequency is calculated as:

$$f = \frac{n\,[strokes]}{t\,[min]}, \text{ where}$$

n- no. of strokes made;

t – time required for performing the strokes.

Flow of injector is calculated as:

q [l/h] = 60 x f [strokes / min] x $V_s$

Note. In simple action pumps, stroke means moving in both directions, while in double action pumps stroke means moving in only one direction.

The injection equipment introduces the primary solution (of concentration $C_m$) in the irrigation water existing inside the irrigation facility, in order to produce the final solution (the fertilizing solution of concentration $C_s$). The equation for primary solution concentration is:

$$C_m\,[g/l] = \frac{M}{V}, \text{ where:}$$

*M*- mass of chemical fertilizers, expressed in grams;

*V*- volume of water in which fertilizers were dissolved, expressed in (l); this volume must be greater than the water volume in which chemical fertilizers reach saturation.

If chemical fertilizer is purchased in liquid form, primary solution concentration $C_m$ is expressed as percentage (%) and it is made by the producer. The same goes for fertilizing solution concentration $C_s$; it is also expressed as percentage (%), and the injection dosage as well. For the case of drip irrigation there is recommended a fertilizing solution concentration $C_s$ of less than 4 g/l to not clog the drippers:

$C_s \le 4$ g/l

When calculating time of making fertigation $T_f$, there are two possible situations.

*In the case of using soluble solid fertilizers,* in which the primary solution is prepared by the person who makes irrigation, time $T_f$ is calculated by using the equation:

$$T_f\,[min] = \frac{60 \times M[g]}{Q[\frac{1}{h}] \times C_s\,[\frac{g}{l}]}$$

*If there are used liquid fertilizers* (which represent the primary solution), time $T_f$ is calculated by using the equation:

$$T_f\,[min] = \frac{60 \times M[g]}{Q[\frac{l}{h}] \times C_s\,[\%]}$$

This mentioned time $T_f$ must be less than or equal to the time of making irrigation *T*, to ensure environmental protection.

If the irrigation facility makes fertigation while operating, then fertigation time is equal to irrigation time:

$T_f = T$, where:

T- irrigation time, [min];

$T_f$ – fertigation time, [min].

Final solution concentration is calculated as:

$$C_s\,[g/l] = \frac{60 \times M[g]}{T\,[min] \times Q[\frac{l}{g}]}$$

or $$C_s = \frac{60 \times V\,[l]}{T\,[min] \times Q[\frac{l}{h}]}$$

If there are used soluble fertilizers and one knows the concentration of fertilizing solution and the flow of injection equipment (and implicitly the injection dosage), primary solution concentration is calculated by use of equation:

$$Cm\,[g/l] = \frac{C_S\,[\frac{g}{l}]}{r[\%]}$$

From equations: q [l/h] = 60 x f [strokes / min] x $V_s$

and $C_s = \frac{60 \times V\,[l]}{T\,[min] \times Q[\frac{l}{h}]}$, it results:

$$V[l] = \frac{M[g] \times r[\%]}{C_S[\frac{g}{l}]} \text{ or } V[l] = \frac{M[g]}{C_m[\frac{g}{l}]}.$$

## RESULTS AND DISCUSSIONS

Tests on the injection device in laboratory conditions aimed to demonstrate injector functionality and to determine the main technical and functional parameters. These tests have been conducted with the help of the hydraulic equipment tests stand which uses pressurized water as the working fluid, with collaboration of project partners; the aforementioned tests stand is part of the infrastructure existing in the Laboratory of Environmental Protection of INOE 2000-IHP Bucharest.

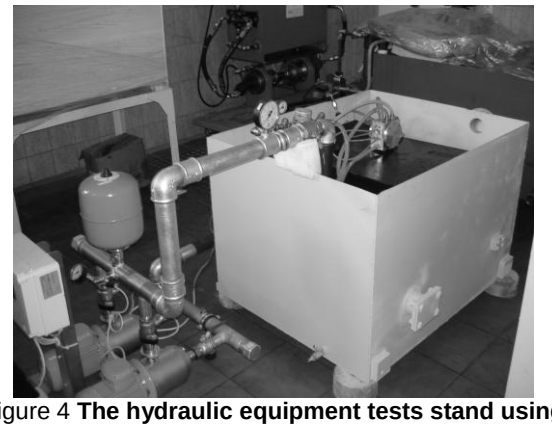

Figure 4 **The hydraulic equipment tests stand using pressurized water as the working fluid**

The pumping block on this stand, type WILO ECONOMY CO-2 MHI 206/ER-RBI-CALOR, consists of two high pressure horizontal centrifugal pumps, with no self-priming, stainless steel, connected in parallel, of flow $Q_{max}$ 10 $m^3$/h and pump head $H_{max}$ 67 mWC.

Preliminary results of laboratory tests are presented in *table 1*.

Table 1

**Technical and functional parameters of injector**

| p (bar) | f (ds/ min) | $Q_{inst}$ (l/h) | $Q_{inst}$ (l/ min) | $q_{inj}$ (l/ min) | r (%) | Ra-hid (%) |
|---|---|---|---|---|---|---|
| 2.0 | 70 | 384 | 6.4 | 2.2 | 0.19 | 45.8 |
| 2.5 | 94 | 624 | 10.5 | 2.8 | 0.29 | 46.6 |
| 3.0 | 112 | 798 | 13.2 | 3.4 | 0.42 | 48.5 |
| 3.5 | 120 | 960 | 16.0 | 3.5 | 0.56 | 43.7 |
| 4.0 | 170 | 1140 | 19.0 | 4.1 | 1.06 | 44.5 |
| 4.5 | 192 | 1200 | 20.0 | 4.5 | 0.36 | 44.0 |

p- water pressure in the irrigation facility, bar;
f- frequency of pump mobile assembly, double strokes/min;
$Q_{inst}$- flow of the irrigation facility, l/h; l/min;
$q_{inj}$- flow injected by pump, l/min;
r- injection rate- concentration of fertilizer in the irrigation water, (%);
Ra-hid- hydraulic efficiency, (%).

The minimum pressure at which the pump starts running is 0.5 bar, and maximum working pressure is 6 bar.

Pump hydraulic efficiency, seen as the ratio of fertilizing solution injected flow $\upsilon_{inj}$ and water volume consumed for the operation of the pump $\upsilon_m$, $\frac{\upsilon_{inj}}{\upsilon_m} \cdot 100$, (%), is determined by the hydraulic parameters of water in the driving chambers and the fertilizing solution concentration.

Pressure up to which the pump operates at high efficiency is 3.0 bar, hydraulic efficiency being 48.5 %, consistent with hydraulic efficiency of dosing pumps existing on the global scale.

## CONCLUSIONS

Preliminary laboratory tests highlighted injector functionality and achievement of the main technical and functional parameters in accordance with the ones forecast in the design phase.

Following completion of laboratory tests, which will be conducted in accordance with the testing methodology drafted in Phase 2 of the project no. 158/2014, we will proceed to conducting tests in real operating conditions at the headquarters of project partners ICDP Pitesti Maracineni- for fertigation, by using drip irrigation equipment and micro sprinklers, of intensive crops of apple, blueberry and strawberry, and respectively USAMV Iasi- for drip fertigation of horticultural crops in protected areas.

## ACKNOWLEGMENTS

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# CLIMATE CHANGE IMPACTS ON CROP PRODUCTION IN TURKEY

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**Abstract**

Global warming of concern is widely recognized as a main environmental issue by scientific community and the predictions are claimed that total increase in temperature will be 3.2˚C at the end of the present century. Countries across the globe are doing their own action plan to adapt and mitigate climate change taking into account their domestic capabilities. Turkey has been also started to face significant consequences of climate change and implanted her own actions plans. Sustainable agricultural production and food security is one of the major challenges. However, assessment of effects of climate changes on agriculture is usually concerned in a general overview and impacts of the change on particular products are missing for Turkey. Wheat, barley, maize, sunflower and cotton are the largest field crops grown in Turkey. This paper focuses on complex effects of global climate change on these main field crops in Turkey considering physiological functions to address crop development, yield and production.

**Key words**: climate change, crop production, Turkey

Although climate change and global warming were concerned as a serious environmental problem by scientists in early 1970's, the predictions had started earlier, about 120 years ago (Weart S.R., 2008). Today, long-term records of NASA reveal that the global average surface temperature has increased 0.8˚C in only last three decades (Lynch P., 2012). Thus global warming of concern is widely recognized as a main environmental issue by scientific community and the predictions are claimed that total increase in temperature will be 3.2˚C at the end of the present century (Solomon S. *et al*, 2007). Global warming, the most obvious and harmful consequence of all human activities, affects most seriously the agricultural production. The estimations demonstrated that, globally, climate-induced reduction in agricultural productivity amounts to 16% (20% in Turkey) by the 2080s (Cline W.R., 2007). However the United Nations of Food and Agricultural Organization estimates that food demand of world population will increase 70% in next 40 years and the increase will be more pronounced in developing countries (FAO, 2006).

Wheat, barley, maize, sunflower and cotton are the largest field crops grown in Turkey. And the proportion of these major crops to total harvested area is more than 72%. Different aspects of climate change such as elevated carbon dioxide, higher temperature and precipitation pattern have different impacts on physiology, development and yield of these agricultural products. Wheat and barley ($C_3$ species) and maize ($C_4$ species) have a different response to increasing carbon dioxide concentration while winter and summer crops possess a different adapting capacity to climate change. On the other hand, change in climate may have more profound effect on yield in South than North Regions of Turkey.

## EFFECTS OF CLIMATE CHANGE IN TURKEY

Turkey's climate can be generally characterized as warm or hot in summer and cold or very cold in winter period. However, coastal areas of Turkey are much milder than inner lands (MSO, 2016). Therefore west and southern coastal Anatolia have a Mediterranean climate whereas plateau in the center has a steppe climate (large temperature difference in day and night). On the other hand, along the coast of the Black Sea Region has a continental climate. Effects of climate change are expected to vary region to region in Turkey because of these distinct climate zones.

Most of the climate change scenarios have agreed that temperature increase will be reach 5℃ for general in Turkey. And annual precipitation will decrease 30% in west and south regions while increase 20% in north regions (*figure 1*). Fujihara

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Y. *et al* (2008) investigated potential effects of climate change in Seyhan River Basin in South Part of Turkey where one of the most productive agricultural lands are located. They predicted about 160 mm reduction in annual precipitation which leads to water scarcity with increasing water demand in the basin.

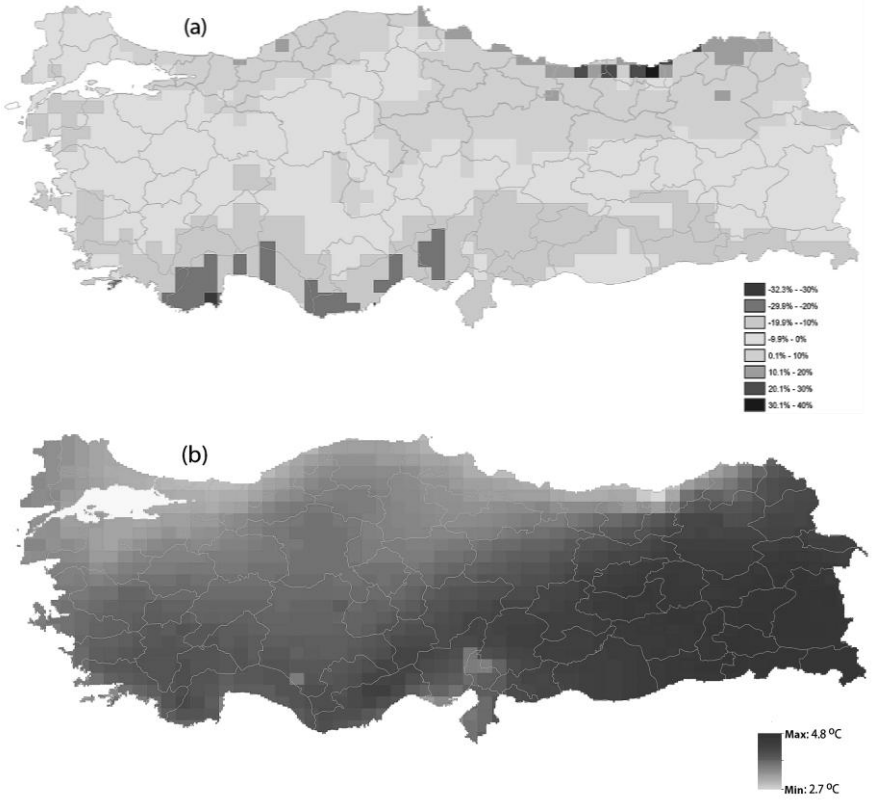


Figure 1 **Simulation maps of ECHAM5 global climate change model A2 for changes in precipitation (a) and temperature (b). Data is calculated based on the changes between 1961-1990 records and 2070-2099 scenarios (Şen, 2013; Önol and Semazzi, 2009)**

Underground water level has decreased more than 20 meters over the last 20 years in Konya which is located on the high plains of Central Anatolia. According to the projections of Köken E. *et al* (2015), temperature will increase about 1.5-3℃ and precipitation will decrease 25-50% in the basin. GAP-Şanlıurfa basin has experienced 17 abnormal to exceptional dry years since 1951 (Aydoğdu M.H. and Yenigün K., 2016). Conventional arid agricultural systems are being rapidly transformed to irrigated system in the basin situated Southeastern Turkey during last few decades (Özdoğan M. *et al*, 2006). On the other hand, more than 10% decrease in precipitation and 4-5℃ increase in temperature are expected for the basin until end of the present century (*figure 1*).

Climate scenarios estimate 2-4℃ increasing in temperature for The North Coastal Regions of Turkey. However, they also predict 200-300 mm increase in precipitation over Northeast part whereas not significant change is expected for Northwest part of the region (Terzioğlu S. *et al*, 2015). Projections for the end of 21$^{st}$ century suggest that reduction in annual precipitation will reach 50% in Gediz and Greater Menderes Basin in the Aegean coastline (TMEU, 2012).

To assess response of main crops to future environmental conditions, the distinct variations in impacts of climate change across Turkey should be considered.

## EFFECTS OF CLIMATE CHANGE ON CROP PRODUCTION

Average production amount of wheat considering last 5 years is 17.4 million ton in Turkey (TUIK, 2016). Most of the wheat is produced in center of the Turkey around Konya Basin (*figure 2*). Although top producing city is Konya (1.5 mil. ton), wheat is generally grown in all around Turkey.

Konya and central part of Turkey where have already lowest precipitation receiving region (Dursun S. *et al*, 2012), is one of the most sensitive region in terms of climate change impacts on crop production. Especially wheat production is very depending on total rain amount and distribution during growth period. More than 70% of the precipitation receives during autumn and winter period whereas limited rainfall between April and

June frequently causes drought stress in wheat (Soylu S., Sade B., 2012). Though water scarcity might be experienced during all growth stages of wheat due to unfavorable rainfall distributions, effects of drought markedly increase in post-anthesis and grain filling stages (Ozturk A., 1999). These crucial stages of wheat growth are considered as a most important period regarding to yield formation (Acevedo *et al*, 1999). Drought-inhibited reduction in post-anthesis photosynthesis and remobilization of dry matters to the grain lead to significant decrease in grain yield (Patla J.A. *et al, 1994;* Ercoli L. *et al*, 2008). Generally, 10 mm decrease in total rain amount causes 13.4 kg/ha yield reduction in the region (Soylu S. and Sade B., 2012).

Wheat is more often grown in arid and semi-arid regions of Turkey under rain-fed conditions thus water scarcity due to climate change can be expected as a main limiting factor in production. On the other hand, Tonkaz *et al* (2010) reported that 6℃ increase in both maximum and minimum air temperature lead 30% decrease in wheat yield. They also revealed that every 40 ppm increase in $CO_2$ level cause 150 kg/ha increase in grain yield.

Impacts of climate change are expected to intensify in the next decades and drought events will more frequent and severe especially wheat production lands in Turkey. Therefore sustainability of production in rain-fed agricultural systems is not high in the region. Implementing higher grain yield strategies under drought conditions concerns two main approaches: (*i*) breeding tolerant and high yielding genotypes, (*ii*) improving agronomic water use efficiency (Fischer R.A., 1999). Early-maturing wheat genotypes also might avoid late-season drought stress in rain-fed wheat production system. Improved water management systems considering critical development stages of wheat (before stem elongation and booting stage) must be implemented in irrigated wheat lands.

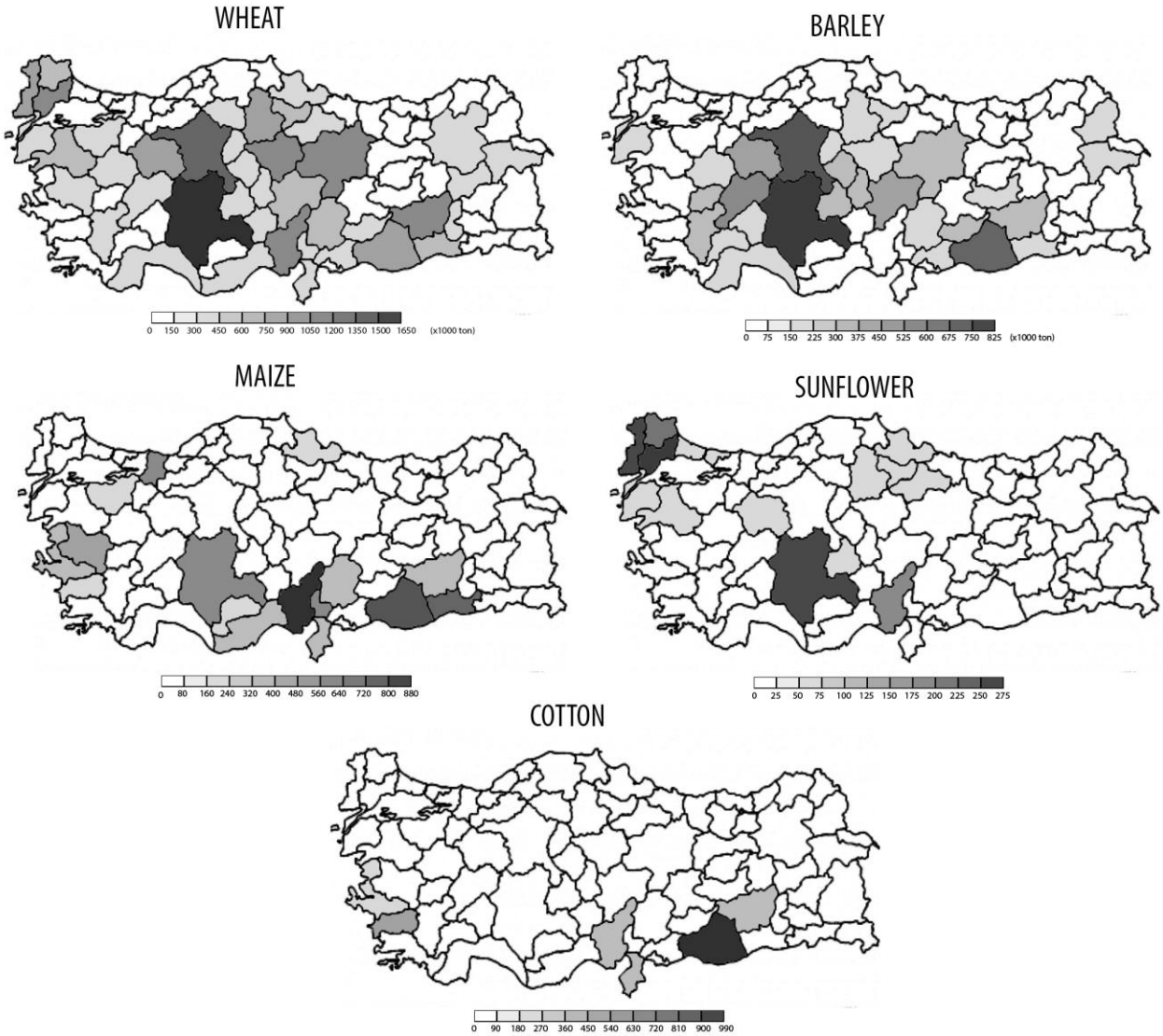


Figure 2 **Distribution of wheat, barley, maize, sunflower and cotton production in Turkey. Cities are colored based on average annual production amounts between 2011 and 2015**

Turkey produces about 6.8 million tons of barley per year (*figure 2*). And similar distribution of barley cultivation areas with wheat can be seen in *figure 1*. Barley is relatively more tolerant to insufficient lands than wheat (Li C. *et al*, 1970). Soylu and Sade (2012) observed lower reduction in barley yield than wheat yield during dry years in the central part of Turkey. And they suggested that better adaptation of barley plants to dry periods was mostly based on earlier maturation and avoidance of plants from drier months after May. However, the advantage of barley in years which dry and warmer conditions are experienced at the end of the season is not observed if the stress conditions occur during earlier growth stages. Although barley might be suggested for the lands where wheat production would be not possible as a result of climate change in near future, breeding tolerant varieties and increase agronomic water use efficiency seems one of the best solutions.

Maize production has not a wide distribution throughout the country as wheat and barley cultivated lands (*figure 1*). Totally 5.4 million tons of maize grain is produced per year in Turkey. And most of the producers are situated in South and Southeastern and Coastal West parts of Turkey (*figure 1*). These lands have generally Mediterranean type climate conditions. Climate change projections suggested approximately 3℃ increase in average temperature and 10-30% decrease in annual precipitation in these regions (*figure 1*). Yan W. and Hunt L.A. (1999) have described that photosynthesis is restricted and maize growth inhibited under higher than maximum of 41℃ air temperature. Over 40℃ has already often experienced during summer period especially in Şanliurfa Basin (Southeast part of Turkey). Frequently, maize plants are subjected to heat stress during reproductive stages and grain yield significantly reduces. Maize cultivars which have a short vegetation period has an advantage to avoid heat stress during these critical stages, however they have lower yield potential. Early sowing might be another option. Since maize plant sensitive to chilling stress during initial stages of the development, new cultivars may be suggested to develop to early sowing.

Impacts of rising atmospheric $CO_2$ concentration result of the climate change is expected to be not a significant on maize plant because it has $C_4$ carbon fixation properties (Lobell D.B. *et al*, 2011). Water use efficiency of $C_4$ plants such as maize is already about double that of $C_3$ plants (Huang R. *et al*, 2006). However, water use efficiency in maize production could be increased by better water management using with new irrigation and agronomic techniques.

Sunflower is main oil plant in Turkey and annual production is about 1.3 million tons based on last 5 years data (*figure 2*). Northwest part of Anatolia was the main sunflower cultivated regions until last decade. But the production has rapidly increased in the center of the Anatolia since Turkeys rising need to plant oils. On the contrary to Thrace Region in the Northwest, sunflower is mostly grown in irrigated lands of Konya basin in the Center of the country. Therefore water scarcity, exacerbated by climate change will be a great risk for sunflower production in the region. Groundwater level has already started to decrease 0.7 m per year in some locations in the basin (Doğdu M.Ş. *et al*, 2007).

Water requirement of sunflower is about 450-500 mm during growing season in Konya (Soylu S. and Sade B., 2012). Improving water use efficiency in sunflower cultivation should be considered for a sustainable production in the region. Elevated atmospheric $CO_2$ concentration due to climate change is predicted to enhance water use efficiency in sunflower (Harrison P.A. and Butterfield R.E., 1996). But, improved agronomic managements are still needed to implement to reduce irrigation amounts.

Most of the predictions revealed that climate change shortens the length of the sunflower growing period (Harrison and Butterfield, 1996). This impact would be more drastic in the center of the Anatolia than in Northwest regions in terms of future projections (*figure 1*). Existing cultivars may not become convenient in the future.

Turkey produces about 2.3 million tons of cotton (*figure 2*). Approximately half of the cotton cultivated lands locate in Southeast of Anatolia around Şanlıurfa-Harran Basin. Cotton production has drastically increased in the basin last decades because of the ultrastructural improvement in water sources by a national project (GAP). However, excessive increase in irrigated lands would be not sustainable in terms of the water resource management in the future. One of the reasons of increasing water use in Şanlıurfa-Harran Basin is being widespread of cotton production lands (Özdoğan M. *et al*, 2006). Bayder A. and Kanber R. (2012) suggested that better soil-water management, using drip irrigation system, higher sowing density and developing tolerant varieties could be a part of the solutions for sustainable cotton production.

The mean air temperature higher than 35℃ during day time restricts photosynthesis whereas higher than 25℃ during night time lead higher respiration resulting higher assimilate lose in cotton plant (Bange M. *et al*, 2007). Harran Basin has already often faced with more than 35℃ during

June to September (MSO, 2016). High temperatures have negative effects on cotton yield especially during flowering and early ball development (Oosterhuis D.M., 2013). Early sowing might be one of the possible options to avoid heat stress during these critical stages. Impacts of climate change can be expected to be more pronounced for cotton cultivated lands in Southwest of Turkey. Therefore improving heat tolerant varieties and efficient water management applications should be adapted primarily for the region.

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# COMPARING SOME CYTOLOGICAL AND MORPHOLOGICAL CHARACTERS OF DIPLOID AND AUTOTETRAPLOID PERENNIAL RYE *(Secale montanum Guss.)*

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**Abstract**

The objectives of the study were to obtain artificial tetraploids of perennial rye (*Secale montanum* Guss.) by using colchicine, and to compare tetraploid and diploid plants with respect to some cytological and morphological characteristics.

The seeds were germinated and 2500 seedlings with 2-3 mm root length were selected. A colchicine solution ($C_{22}H_{25}NO_6$) of 0.1% was applied for a period of 3 hours at 30$^o$C. they (200 control and 2500 treated seedlings) were planted to the growth flats. Control seedlings (untreated) were planted as a single row (50 seedlings) to each growth flat. After 2-2.5 months, surviving seedlings were transplanted individually to the pots and were grown under greenhouse conditions.

Tetraploid plants were obtained at a rate of 5.97 %. Aneuploid, mixoploid and chimeric plants were also observed. In diploid plants, meiotic division was generally regular whereas in tetraploid plants, meiotic division was more irregular. In tetraploids of $C_0$ generation, the percentages of AI with regular segregation (14:14), irregular segregation (13/15; 12/16, etc.), lagging chromosomes, and a bridge were 59.87%, 11.18%, 19.74%, 9.21% respectively. The tetraploid plants grew more vigorously than diploids. Although demonstrating a lower number of tillers and seed set percentage, tetraploid plants showed higher leaf size, spike structures and stoma length, as compared to diploids. Induced tetraploid plants may be use as breeding material for the improvement of forage rye.

**Key words**: *Secale montanum Guss*, autotetraploid, meiosis, morphological characters

The wild perennial rye (*Secale montanum* Guss.) is believed to be the ancestor of the cultivated rye (*S. cereale* L.). Eastern Anatolian region of Turkey is one of the primary gene pool centers of *Secale montanum* Guss. (Hoffman W. *et al,* 1985). There are many different form of perennial rye in Turkey. Among these *Secale montanum* Guss *var. anatolicum* Boiss. and *Secale montanum* Guss *var.vavilovi* Grossh are important varieties (Kün E., 1988). These perennial species have large stature; high frost resistance strong tillering ability, slightly more prostrate growth habit and more tolerance to poor soils and drought, and their seeds are easily germinated (Evans G. M. *et al,* 1982; Reimann-Philipp R., 1986; Richard R., Wang C., 1987). Therefore, *Secale montanum* Guss has a low chromosome number (2n=14) and is cross-pollinated (Akgün I. *et al,* 1996). These characters are ideal for induced autoploidy breeding (Sağsöz S. *et al*, 2012).

After the reports on the efficacy of colchicine in the induction of chromosomal reduplication in plants, it has been used successfully in a number of plant species (Hague L. M., Jones R.N., 1987; Hassan L. *et al,* 1989; Sağsöz S. *et al,* 2002). The effects of doubling the chromosome number have been studied in many autotetraploid crops (Narasinga P.S.R.L., Pantulu J.V., 1982; Arundhati K. *et al,* 1983; Klinga K., 1986; Evans G.M., Rahman, M.M., 1990).

The objectives of the study were to obtain artificial tetraploids of perennial rye (*Secale montanum* Guss.) by using colchicine, and to compare tetraploid and diploid plants with respect to some cytological and morphological characteristics.

## MATERIAL AND METHODS

The seeds of perennial rye *(Secale montanum* Guss*)* were collected from the plants naturally grown in Erzurum, Turkey. The seeds were germinated and 2500 seedlings with 2-3 mm root length were selected. A colchicine solution ($C_{22}H_{25}NO_6$) of 0.1% was applied for a period of 3 hours at 30 $^o$C. After the seedlings were washed 6-7 times first with deionized water and then with tap water, they (200 control and 2500 treated

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seedlings) were planted to the growth flats. Control seedlings (untreated) were planted as a single row (50 seedlings) to each growth flat. After 2-2.5 months, surviving seedlings were transplanted individually to the pots and were grown under greenhouse conditions. Some cytological and morphological characteristics of the diploid and tetraploid plants were examined. Tetraploid plants were determined through microscopic evaluations.

Root-tip samples for mitotic chromosome counting were taken from treated seedlings. Five or six root-tips were selected from each plant. The root tips were pretreated in α-monobromnaphthalene saturated with water, for 3 hours at room temperature, fixed in Farmer's solution (3:1 ethyl alcohol : acetic acid ), stained by the Feulgen method after hydrolyzing for 20 min in 1 N HCL at 60 °C, and squashed in 45% acetic acid. To determine the chromosome number, at least five good metaphase plates from each plant were examined

In meiotic studies, spikes were fixed in Carnoy's solution. After 48 hours, the spikes were transferred to 70% alcohol solution and stored at 4-5 °C. Squash preparations of pollen mother cells (PMCs) were prepared using 2% aceto-carmine staining. The frequency of the various chromosome configurations in the cell at the first metaphase, the number of chromosomes in anaphase I plates and the number of micronuclei in tetrad cells were recorded in a number plants from each group. Chromosome associations and distribution were recorded in PMC at metaphase I and anaphase I from 15-30 cells per plant. Since the plants were maintained in the greenhouse, floret fertility was also determined in these plants at maturity.

Spike length, spikelet number, stoma length, tiller number, 1000-grain weight, the length, the width and the thickness of the leaves, and seed-set were determined in diploid and tetraploid plants.

The morphological characteristics of diploid and tetraploid groups were compared using t- test

## RESULTS AND DISCUSSIONS

***Chromosome Number after the Colchicine Treatment:*** 5.36% of colchicine treated seedlings survived, and they showed retarded growth, had thick coleoptiles, dark-colored, wide and short leaves among treated seedlings. Five showed full albino and 6 demonstated partial albinos characteristic. Most of the abnormal seedlings died within the first month. Mitotic chromosomes of seedlings were evaluated 35-40 days after planting to the pots. After the colchicine treatment, the rate of tetraploid plants was 5.97 %, and aneuploid and mixoploid plants with high levels of chimeric structures were also obtained (*table 1*). Moreover, it was observed that diploid perennial rye plants had 2n= 14 chromosomes and their tetraploids had 2n=28 chromosomes (*figure 1, 2*) Tissues from sectorial chimeras were vegetatively propagated and separated from diploid and poliploid clones differing in the number of chromosomes. Plants showing mixoploid characteristics were grouped based on their appearance and separated from diploids.

Table 1

**Mitotic chromosome counting in surviving seedlings after colchicine treatment**

| Cytological characters | Percentage of seedling survival after treatment |
|---|---|
| Tetraploid | 5.97 |
| Diploid | 83.58 |
| Aneuploid | 2.98 |
| Mixoploid | 2.24 |
| Chimeric | 7.46 |

***Investigation of Meiosis:*** The stage of metaphase I could be examined from 361 polen mother cells of the control plants and 150 polen mother cells of tetraploid plants.

The stage of anaphase I (AI) was examined using 870 polen mother cells of control plants and 152 polen mother cell of tetraploid plants (*table 2*). In diploid plants, the percentages of AI showing regular segregation (7:7) and irregular segregation were 91.5 % and 0.8% respectively. In addition, 1.8% and 5.8 % of AI had lagging chromosomes and/or chromatids, and a bridge, respectively (*figure 3*)

In tetraploids of $C_0$ generation, the percentages of AI with regular segregation (14:14), irregular segregation (13/15; 12/16, etc.), lagging chromosomes, and a bridge were 59.87%, 11.18%, 19.74%, 9.21% respectively.

The tetrad stage was examined in diploid and tetraploid plants *(table 2*). The number of micronuclei per tetrad (M/Q) and percentages of tetrads without micronuclei were determined ((*figure 4*). The results are presented in Table 3. In control and tetraploid groups, M/Q was 0.038 and 0.298 respectively, while the percentage of tetrads without micronuclei were 96.18% and 70.16% respectively

***Seed-Set:*** The seed set was estimated from the same plants used for analysis of meiosis. The seed-set in the tetraploids was significantly lower than that in diploids ($P<0.01$). In diploid and tetraploid plants, the percentages of seed-set were 42.38 % and 19.36 % respectively (*table 3)*.

***Characteristics of Spikes:*** The data regarding spikes characteristics in the diploids and tetraploids were shown in *table 3*. Effect of ploidy

level on the spike length and number of spikelets per spike was statistically significant (P<0.01). The mean spike lengths in the diploid and tetraploid plants were 8.07 cm and 10.79 cm respectively; the numbers of spikelets in each spike were 26.08 and 33.81 respectively.

***1000 Grain Weight:*** The size of seeds of tetraploid plants increased significantly as compared to diploid plants (P<0.01). While 1000 grain weight of tetraploid plants was 10.95 g, it was 6.39 g in the diploid plants (*table 3*).

***Number of Tillers:*** The increase in ploidy level did not significantly reduce the numbers of tillers per plant. While it was 75.50 in diploids, the number of tillers per plant was 63.10 in tetraploids (*table 3*).

***Leaf Characteristics:*** In perennial rye plants, the width and thickness of leaves increased significantly (P<0.01) depending upon ploidy level. The leaf lengths of diploids and tetraploids were 19.86 cm and 21.50 cm and did not differ significantly. While leaf width and thickness in diploids were 4.73 mm and 0.49 mm respectively, in tetraploids they were 5.87 mm and 0.70 mm respectively (*table 3*).

***Stoma Lenght:*** Depending upon doubling the chromosomes in perennial rye, stoma length was significantly increased (P<0.01). The lengthes of the stomata in diploids and tetraploids were 19.82 and 22.65 µm respectively (*table 3*).

After the colchicin treatment to germinated seeds of perennial rye *(Secale montanum* Guss*),* tetraploid plants (2n=28) were obtained with a ratio of 5.97%, and aneuploid and mixoploid plants with chimeric structures were also observed. Additionally, it was also found that the ratio of unaffected plants were at a high level. The results showed that meiotic (anaphase I and tetrad) division was generally regular in diploid plants whereas in tetraploid plants, meiotic division was found to be mostly irregular.

Anaphase I data revealed a greater irregularity (irregular segregation, lagging chromosomes and/or chromatids and bridge) in the tetraploids as compared to the diploids. Tetraploids had a higher proportion of tetrads with micronuclei and a lower percentage of seed-set with respect to diploids. Higher micronuclei number per tetrad may result from higher lagging chromosomes and bridges at anaphase I. Sağsöz S. *et al,* (2002) reported a significant positive correlation between the frequency of anaphase I with lagging chromosomes and the frequency of the micronuclei in tetrad in the autotetraploid ryegrass populations. In addition, the bridges observed in our study could originate from paracentric inversions (Sybenga J., 1992). Evans G.M., Rahman M.M., (1990) reported that the segregation of the chromosomes in anaphase I has been regular in the pollen mother cells which do not contain trivalent and univalent in autotetraploid barley. Moreover, they observed that some quadrivalents may not show balanced segregation (2:2). The low fertility problem originates from cytological instability and physiological inharmony due to unbalanced gene combinations (Elgersma A., 1990). A number of previous studies demonstrated that the reason for low fertility in different species was univalents and trivalents (Narasinga P.S.R.L., Pantulu J.V., 1982; Evans G.M., Rahman M.M., 1990). The proposal that the meiotic irregularities are responsible for low fertility through the production of genetically imbalanced products is widely held and is based on the correlations between the pattern of chromosome pairing and disjunction at meiosis. It is known that after artificial tetraploids are obtained, seed-set will increase depending on the selection (Arundhati K. *et al,* 1983). On the other hand, genetic factors as well as environmental factors also influence seed-set (Elgersma; 1990)

Autotetraploid perennial rye plants grew more vigorously as compared to their diploids. In tetraploids the length, the width and the thickness of the leaves, the spikelet numbers of spikes and 1000-grain weight increased while the tiller number decreased, and the differences among these characters were highly significant. Rachis and the stoma length were higher in tetraploids than those in diploids. Our results are in agreement with the observations of (Phafler P.L. *et al*, 1984; Poehlman J.M., 1987).

## CONCLUSIONS

The results of this investigation suggest that tetraploid plants often larger than diploid plants of the same species. Induced autoploidy may be one way of improving these perennial diploid species and the tetraploid plants may be use as breeding material for the improvement of forage rye for Turkey conditions.

Table 2

**Anaphase I chromosome distribution, number of micronuclei per tetrad (M/Q) and percentages of tetrads without micronuclei in diploid and autotetraploid perennial rye (*Secale montanum* Guss)**

| Ploidy | N | | Regular (7/7 or 14/14) | Irregular | Lagging | Bridge | Tetrad | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | N | M/Q | % |
| **2n=14** | 870 | No | 796 | 7 | 16 | 51 | 996 | 0.038 | 96.18 |
| | | % | 91.50 | 0.8 | 1.8 | 5.8 | | | |
| **2n=28** | 152 | No | 91 | 17 | 30 | 14 | 248 | 0.298 | 70.16 |
| | | % | 59.87 | 11.18 | 19.74 | 9.21 | | | |

Table 3

**The means and standard errors (SE) of morphological characters in the diploid and autotetraploid plants**

| Morphological characters | Ploidy | No. of sample | N | Mean ± SE | t-value |
|---|---|---|---|---|---|
| Seed –set | 2n | 50 | 10 | 42.38 ± 16 | 3.02** |
| | 4n | 50 | 10 | 19.36 ± 18 | |
| Spike length (cm) | 2n | 50 | 10 | 8.07 ± 1.95 | 4.05 ** |
| | 4n | 50 | 10 | 10.79 ± 0.85 | |
| No.of spikelets per spike | 2n | 50 | 10 | 26.08 ± 5.13 | 3.39** |
| | 4n | 50 | 10 | 33.81 ± 5.03 | |
| 1000 grain weight | 2n | 400 | 4 | 6.39 ± 0.02 | 22.42** |
| | 4n | 400 | 4 | 10.95 ± 0.03 | |
| No. of tillers | 2n | 10 | 10 | 75.50 ± 29.48 | 0.95ns |
| | 4n | 10 | 10 | 63.10 ± 28.47 | |
| Leaf length (cm) | 2n | 150 | 10 | 19.86 ± 1.20 | 1.25ns |
| | 4n | 150 | 10 | 21.50 ± 0.53 | |
| Leaf width (mm) | 2n | 150 | 10 | 4.73 ± 0.5 | 4.38** |
| | 4n | 150 | 10 | 5.87 ± 0.6 | |
| Leaf thickness (mm) | 2n | 150 | 10 | 0.49 ± 0.13 | 4.23** |
| | 4n | 150 | 10 | 0.70 ± 0.08 | |
| Stoma length (µm) | 2n | 500 | 10 | 19.82 ±1.11 | 2.88** |
| | 4n | 500 | 10 | 22.65 ± 3.13 | |

* Significant at 5 % level; ** Significant at 1 % level; ns nonsignificant

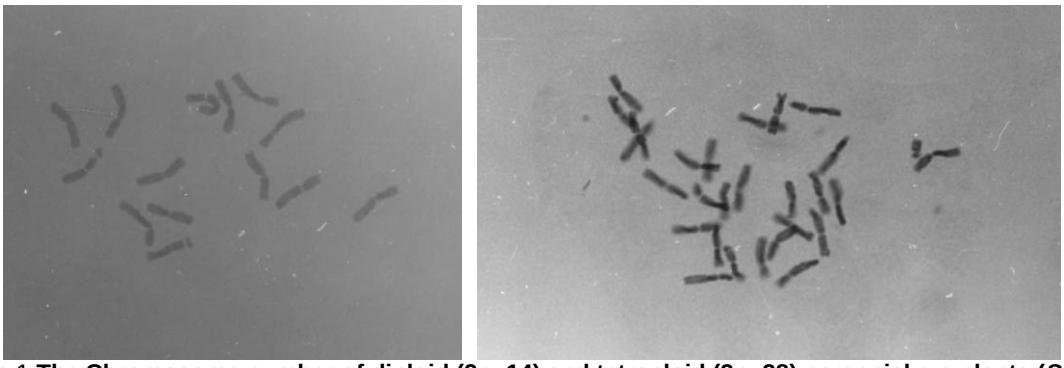

Figure 1 **The Chromosome number of diploid (2n=14) and tetraploid (2n=28) perennial rye plants (*Secale montanum* Guss.).**

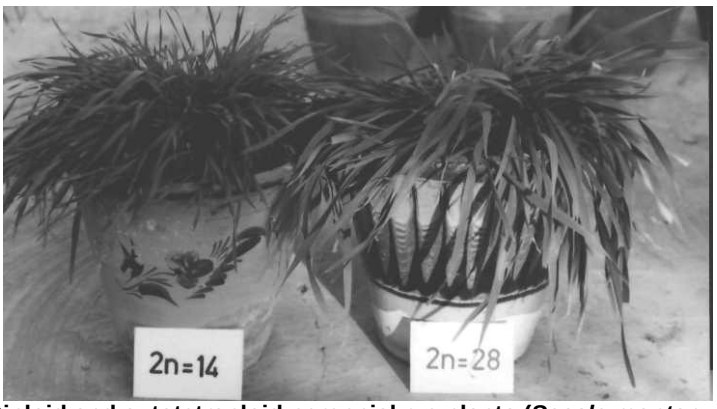


Figure 2 **Diploid and autotetraploid perennial rye plants (*Secale montanum* Guss.).**

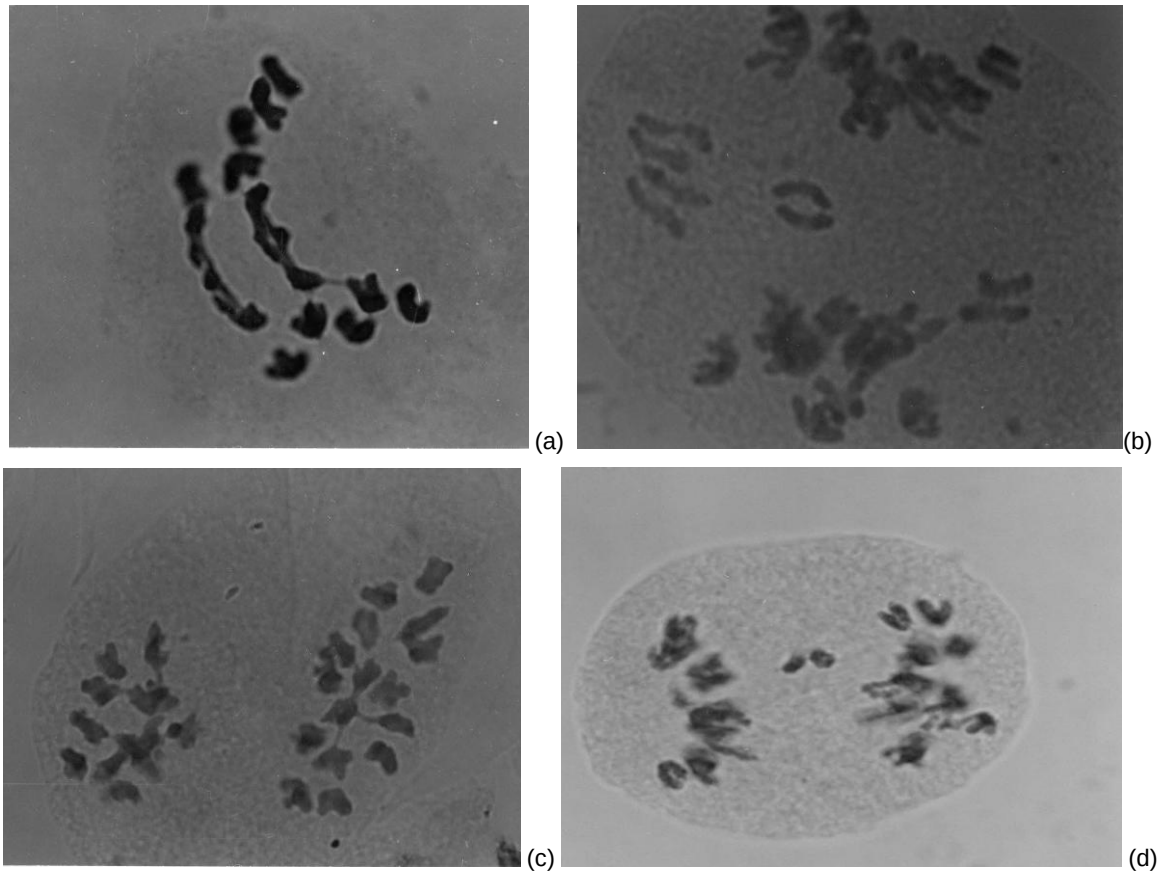


Figure 3 **Irregular chromosome segregations at AI in diploid (a) and autotetraploid (b,c,d) perennial rye plants**

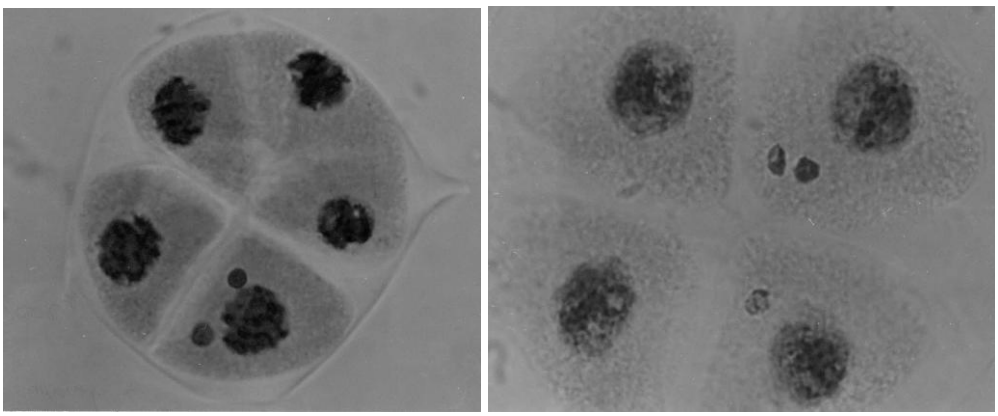

Figure 4 **Tetrad with micronuclei and abnormal tetrads in autotetraploid perennial rye plants**

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# ON THE AGRICULTURAL USE OF SEWAGE SLUDGE IN ROMANIA

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**Abstract**

The construction of new waste water treatment facilities in Romania, especially in rural areas, increases the production of sewage sludge. European Commission recommends the reuse of wastes and since sewage sludge is a byproduct of waste water treatment, sustainable approach must be taken into consideration for the proper management and disposal. Sewage sludge contains high amounts of organic matter and nutrients and thus the reuse in agriculture is very important. This can be achieved following secondary treatment of the sewage sludge (biosolids) and depends also on the local conditions. Because the use of sewage sludge in agriculture is limited in Romania in accordance with its potential, the aim of the current paper is to emphasize the benefits of reusing this waste.

**Key words**: biosolids, reuse of waste, fertilizers

Sewage sludge results in the process of waste water treatment and is called biosolids when suffers a secondary treatment for sanitation (reduction of fermentation, moisture, macronutrients and pathogens). The most frequent methods for sanitation are aerobic and anaerobic fermentation, incineration, composting, sterilization or the use of lime. With the European Union (EU) legislation that aims the improvement of life quality especially in rural areas, in Romania, the number of wastewater treatment facilities is increasing. Moreover, the development of the collecting and treating systems of municipal wastewater resulting from domestic, economic or industrial activities, by a growing number of wastewater treatment plants is a reflection of welfare of the modern society.

Large amounts of sewage sludge are produced in EU, approx. 10 million tones dry solids (d.s.)a year and needs special measures for a sustainable management and disposal (Salado R., 2010; Kelessidis A., Stasinakis A.S., 2012). Biosolids contain high amounts of macronutrients and thus the use in agriculture is regarded as the most viable method of reusing this waste. The Sewage Sludge Directive 86/278/EEC regulate its use in agriculture in such a way as to prevent harmful effects on soil, vegetation, animals and men. Due to legislative restrains, that aim to ensure the safety of the citizens as well as to protect the environment, the methods used in the treatment of the wastewater lead to increasingly higher quality of sludge (Fytili D., Zabaniotou A., 2008; Smith B.R., 2009). However, in Romania, the use of biosolids in agriculture is still limited.

Most scientific papers shows positive effects of biosolids on plants by improving the yield because of the macro nutrient content (Cornfield A.H. *et al*, 1976; Vaca R. *et al*, 2011; Özyazıcı M.A., 2013; Chrysargyris A., Tzortzakis N., 2015) but also on the physico-chemical properties of soils on which they are used, by altering the bulk density of the soil, aeration and stabilization of eroded soils (Holz S.C. *et al*, 2000; Ros M. *et al*, 2003; Gu C. *et al*, 2013; Mihalache M. *et al*, 2014). There are also articles that shows some negative effects, concerning the increase in heavy metals in plants and soils, pathogens and esthetic alteration of environment through smell (Singh R.P., Agrawal M., 2007; Mazen A. *et al*, 2010; Vaitkute D. *et al*, 2010; Collivignarelli M.C. *et al*, 2015).

Considering the fact that production of biosolids will increase in Romania accordingly to the number of new wastewater treatment facilities, the aim of the current paper is to present an up to date comparative analyses concerning the production and disposal of sewage sludge in

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Romania, with a special emphasis on the agricultural use.

Table 1

**Sewage sludge production and utilization in Romania (thousands tones dry solids)**

| Time | Total production | Landfill | Other | Compost and other applications | Agricultural use | Incineration |
|---|---|---|---|---|---|---|
| 2005 | 67.8 | 55.9 | 6.6 | 4.7 | 0.7 | 0 |
| 2006 | 225.6 | 145.4 | 6.7 | 3.9 | 0.4 | : |
| 2007 | 99.6 | 44.4 | 7.7 | 2.7 | 0.7 | : |
| 2008 | 79.2 | 36 | 1.2 | 2 | 0.5 | : |
| 2009 | 120.5 | 58.1 | : | 15.8 | 0.1 | 0 |
| 2010 | 82.1 | 40.5 | 1.7 | 1.3 | 1.9 | 0 |
| 2011 | 114.1 | 53.9 | 1.5 | 0.2 | 1.8 | 0 |
| 2012 | 85.4 | 43 | 1.4 | 1.3 | 2.2 | 0.4 |
| 2013 | 172.8 | 117.7 | 46.5 | 0.3 | 8 | : |

## MATERIAL AND METHOD

The methods used employed the survey of literature mainly from the last 10 years. The dataset used for statistical calculations was obtained from EUROSTAT which is the official website responsible for presenting statistics of economical indices in EU. The statistical calculations for the period 2005 - 2013 for the selected indices was performed using Microsoft® Excel® software.

## RESULTS AND DISCUSSION

According to Eurostat (2016), in Romania, land fill is the most used method of sewage sludge disposal while agricultural use and incineration are the last (*table 1*). However, in EU there are countries in which the greatest percentage of the produced sludge is used in agriculture. For example, in 2012, Spain, Germany and United Kingdom were the largest sewage sludge producers with 2577.2, 1844.4 and 1078 thousands tones d.s. respectively of which 74.5%, 29.3% and 78.2% were use in agriculture. In other countries such as Hungary, Greece and Romania, despite the fact that they produce considerably amounts of sludge, its utilization in agriculture is limited (157.7, 118.6, 48.4, thousands tones d.s. total production of which 9.5%, 11.8% and 4.1% are used in agriculture). Even though in 2013 the total production of sludge increased in Romania to 172.8 thousands tones d.s. only 8 thousands tones (4.65%) d.s. were used in agriculture (Eurostat, 2016). The percentage of biosolids used in Romania is very low when compared to the one of the average EU of the 28 countries (*figure 1*). Some of the reasons why in Romania the agricultural use of biosolids is still limited are: the lack of awareness about its benefits as a fertilizer, fear of contaminating the land with heavy metals, the costs of sludge transport on agricultural land and the costs for monitoring the environmental impact.

In Romania, the legislation that regulates the use of biosolids in agriculture is the MO 344/2004 regarding the technical normative for environmental protection and especially soils when sewage sludge is used in agriculture. MO 344/2004 focuses on the content of heavy metals that are present in sewage sludge and in soil. Even though this law is built to encourage the use of biosolids in agriculture, it contain a paragraph that is ambiguous, Ch. 2, paragraph 9, the producer is responsible for the quality, quantity, transport, application of sludge on the agricultural land and also for any effects on environment and human health that may arise from sludge utilization. It is not clear what are the thresholds that may be used to define an effect and therefore the producers are discouraged to use biosolids in agriculture.

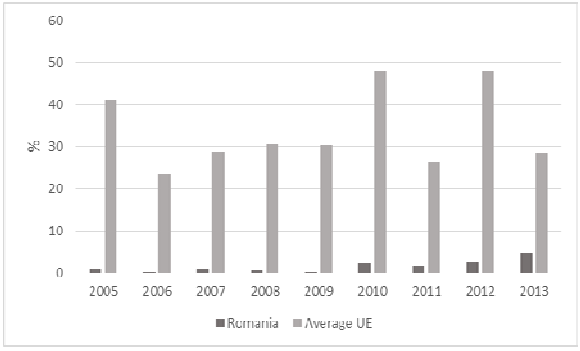


Figure 1 **Sewage sludge use in agriculture in Romania and average of 28 EU countries**

Research regarding the beneficial effects of utilizing sewage sludge for the crops fertilization in Romania, sustain its usefulness especially for the high amounts of macronutrients which improves soil quality that leads to greater yields. For instance, in a two year study, 1994-1996, at the University of Agricultural Sciences and

Veterinary Medicine, Bucharest, 10% sludge compost amendment to soil lead to an increased yield of maize with up to 199.9% (Stan V., 1996). Also, in a five year-crop rotation experiment with winter rape – wheat – maize – sunflower and wheat, at Podu-Iloaiei Agricultural Research Station, Iaşi County, the use of 40 tones/ha of sludge increased the yield of winter rape by 187% (Ailincai C. *et al*, 2011). Our previous work regarding the cultivation of *Ocimum basilicum* on an eroded soil amended with 15% biosolids from Iasi wastewater treatment plant, lead to an increase with up to 520% of *herba* yield (Burducea M. *et al*, 2016). Thus, the sewage sludge from Romania waste water treatment plants can be used, with very good performances, for the fertilization and soil conditioner for the land with agricultural purposes, especially for the growth of higher crops but also for some medicinal plants like basil, that are cultivated for the production of the essential oils.

The sewage sludge may be used in different scenarios, such as land spreading, incineration, landfilling, forestry or land reclamation. Each of the above directions has advantages and disadvantages, and the method to use for sludge disposal should consider the characteristics of the sludge and their compatibility with the environmental and geographical particularities and regulations of each country. Incineration of sludge may lead to release of gases such as $N_2O$ and $NO_x$ and toxic particles in the atmosphere, while landfilling may generate odor and vegetation disturbance (Przewrocki P. *et al*, 2004; Werther J., Ogada T., 1999). Some promising reusable methods are the biological ones, such as bacterial transformation of sludge to biocombustible (Angerbauer C. *et al*, 2008) or stabilization through the vermicomposting technique (Gupta R., Garg V.K, 2008). Land spreading may be a favored method, as the high levels of nutrients in sludge generate adequate levels of fertilization for soils and may also improve the physical characteristics of soils.

Usage of sludge as fertiliser in agriculture must however be carefully applied, as sludge contains not only elements needed for plant growth, but also numerous microorganisms, including pathogens (Arthurson V., 2008) organic pollutants and toxic metals (Hanay O. *et al*, 2008). These are the main reasons for which sludge is limited in agricultural use by regulations in many countries. In deciding if the sludge can safely be used in crops for fodder or human consumption, some aspects should be considered, such as the fact that the sludge characteristics vary significantly with its origin, with higher concentrations of pollutants in industrialized areas and with the type of treatments applied, but some of the data available is dated. The development of modern treatment stations lead to much improved sludge characteristics, and pollutants are, often, within regulatory values (Grøn C., 2007; Smith S.R., 2009).

## CONCLUSIONS

The quality of the wastewater and especially the industrial wastewater will influence the quality of the sludge, even if now it is conform to standard requirements, this could be changed in the future and will restrict the alternatives of sludge disposal. The valorization and reuse of biosolids is however dependent to the local conditions, local availabilities of farmland and crops suitable for sludge use. Local authorities and sludge producers should rise awareness and information campaigns for farmers and civil society on the benefits of using sludge in agriculture. Academia, sewage sludge producers and farmers should be brought together for exchanges of good practices. The MO 344/2004 should be amended in order to eliminate the ambiguity of some paragraphs with a more specific ones.

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# NEW CHALLENGES IN POTATO BREEDING TO COPE WITH CLIMATE CHANGE: DUAL TOLERANCE TO HEAT AND DROUGHT

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**Abstract**

Potato is a cool season crop with an optimal growth temperature between 17 and 21ºC, and it also very sensitive to drought stress. All climate scenarios indicate that the global climate is changing and will continue to change in the near future. The main challenges from climate change to agriculture and food production are the more frequent and severe drought and floods as well as adverse effects of high growth temperatures. The total global yield in the regions currently cropped with potato was calculated to decline up to 32% without adaptation to climate change. The breeding of heat and drought tolerant potato cultivars is one of the most feasible and practical approaches to cope with global warming. However, breeders are generally focused on development of heat or drought tolerant potato cultivars instead of dual tolerance to both stresses. Previous studies indicate that tolerance mechanism for heat and drought is different in potato. Screening of many breeding lines against heat and drought stress under field conditions during early generations is not feasible for many breeding programs due to high cost and labor requirements. Therefore, rapid and reliable screening methods are needed to evaluate large populations in early generations. Biotechnological tools offer some advantages to breeders for screening large populations especially against biological stress factors, but no sound achievements obtained for abiotic stress factors in potato up to now. Currently our research group has several projects to develop novel screening tools to identify heat and drought tolerant genotypes.

**Key words**: *Solanum tuberosum* L., abiotic stress, water stress, temperature, phenotyping

The potato (*Solanum tuberosum* L.) is a world crop growing in around 160 countries from sea level to 4000 m altitude and between the 50° S and 40° N latitudes. It is the fourth most produced food crop, and the first non-cereal crop in the world with an annual production of 385 x $10^6$ t (Anonymous, 2016).

Although it has a wide adaptation area, potato is a very sensitive to environmental stresses such as drought, heat, and salinity (Kikuchi *et al*, 2015). The majority of the annual world potato production is contributed by developing countries, where it is cultivated in marginal areas prone to environmental anomalies. Therefore, development of tolerant potato cultivar to harsh environmental conditions is very important for sustainable food production in less developed countries. In addition, sustainability of potato production has also been threatening by the global climate change in the most of traditional production regions in temperate zones.

All climate scenarios indicated that global climatic patterns are being greatly altered due to increasing atmospheric $CO_2$ concentrations. The Intergovernmental Panel on Climate Change (IPCC) reports that global mean temperatures increased 0.045ºCper decade during the last 150 years while it has increased almost four times more (0.177°C) during last three decades (Anonymous, 2007). It is expected that the global temperature will increase 1.1-6.4ºCdepending on regions until end of this century (Anonymous, 2007). The increases in temperature are associated with extreme variations in weather patterns, resulting in fluctuations in rainfall regimes (severe droughts or heavy rains), and/or atypically heat waves (Rötter, van de Geijn, 1999). Therefore, breeders have to consider effects of multiple stress factors when they aimed to develop crop cultivars adapted to climate change.

In this paper, it was discussed the effects heat and drought stress on potato crops, and breeding strategies to develop climate resilient potato cultivars.

## EFFECTS OF DROUGHT STRESS

Actually, water use efficiency of potato is higher than many other important food crops such as wheat, maize, rice, etc. Potato produces 5600

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kcal dietary energy with per $m^3$ of water applied while maize, wheat and rice produces only 3860, 2300 and 2000 kcal using same amount of water, respectively (Renault, Wallender, 2000). However, potato is more sensitive to water deficiency due to shallow root system (Iwama, 2008). Drought stress negatively affects plant growth, tuber yield and quality in different magnitude depending on the timing, duration and severity of the stress (Monneveux *et al*, 2013). Tuber initiation and bulking stages are the most sensitive stages to water deficiency, and both number and size of tubers significantly reduces due to inadequate water supply during these stages (MacKerron, Jefferies, 1986). Transient drought during tuber bulking also lead to secondary growth (dumbbell-shaped, knobby, or pointed-end tubers) (MacKerron, Jefferies, 1986). Growth, yield and quality responses of potato cultivars to drought stress significantly differ (MacKerron, Jefferies, 1986; Cabello *et al*, 2012; Stark *et al*, 2013; Banik *et al*, 2016).

Potato is grown as rainfed crop without irrigation in some countries in temperate regions while irrigation is essential in the most countries especially in sub-tropical and tropical regions. A fluctuation in rainfall regime or transient drought periods due to climate change significantly threats the potato production in rainfed production regions. On the other side, potatoes are irrigated up to twenty times using 700-900 mm water in some countries, i.e. Turkey. This results in depletion of ground water level and increase in production cost. Hence improving water use efficiency of potato cultivars is very crucial for sustainability of potato production in both types of environments.

## EFFECTS OF HEAT STRESS

The potato is a cool season crop with an optimal growth temperature between 17 and 21ºC (Levy, Veilleux, 2007). The higher temperatures than the optimum significantly affect several physiological processes related with yield and quality such as haulm growth, dry matter production and partitioning, tuber initiation and growth, photosynthetic rate, synthesis of hormones, enzymes and other metabolites (Levy, Veilleux, 2007). Supra-optimal temperatures significantly reduce canopy leaf area index, canopy photosynthesis (Fleisher *et al*, 2006; Timlin *et al*, 2006), tuber initiation and tuber growth (Struik *et al*, 1989; van Dam *et al*, 1996), and internal and external quality of tubers (Sterret *et al*, 1991; Lafta and Lorenzen, 1995; Rykaczewska 2015).

It is expected that the global temperature will increase 1.1-6.4ºCdepending on regions until end of this century (Anonymous, 2007). Hijmans (2003) estimated the effects of global warming on potato production in different regions of the world using different projections. He concluded that potential yield of potato could decrease around 18-32% in general, but decline can be higher in some regions (i.e. 36.7% in Turkey) if any precautions are not taken. Hijmans (2003) suggested that the detrimental effects of global warming could be reduced by shifting planting dates and development of heat tolerant cultivars. Apart from the global warming, breeding heat tolerant potato cultivars is also very important to get high yield in tropical, sub-tropical and Mediterranean-type environments due to supra-optimal temperatures during growing period.

## BREEDING STRATEGIES FOR CLIMATE RESILIENT CULTIVARS

The threat of climate change and aforementioned effects of drought and heat stress on potatoes confronts potato breeders with enormous challenges to generate climate resilient cultivars. Actually, climate change will also bring other problems such as salinity, frost, epidemics of new diseases and pests. However, breeders generally focus on improve only one of threats such as drought, heat, salinity, or a single disease. The focus on improving potato characteristics to tolerate drought and heat has generally been overlooked (Monneveux *et al*, 2013). Especially dual tolerance to heat and drought stresses will be very important since plants will generally face with both stresses simultaneously with changing climate in future (Peverelli and Rogers, 2013; Kole *et al*, 2015; Mazdiyasni and AghaKouchak, 2015). Where heat and drought stress occur simultaneously, they generally result in more extreme detrimental effects than would each stress separately (Peverelli and Rogers, 2013; Lipiec *et al*, 2013). Moreover, their joint presence can also alter plant metabolism in novel ways compared to each applied individually (Rizhsky *et al*, 2004). The severity of decline in tuber quality and yield increases when heat stress accompanies drought stress in potato (Ahn *et al*, 2004, Aksoy *et al*, 2015). Yield losses combined with low crop quality could drastically impact the economic output and the overall human food supply.

There are two prerequisites for success of a traditional breeding program aims to development of heat and drought tolerant cultivar: choosing the most appropriate parents, and using of the reliable screening methods in early generations (Hijmans, 2003; Levy, Veilleux, 2007). Previous studies indicated that it is possible to find sources for heat

(Gautney and Haynes, 1983; Levy, 1986; Levy *et al*, 1991; Reynolds and Ewing, 1989; Midmore and Prange, 1991) and drought tolerance (Coleman 2008; Cabello *et al*, 2012; Schafleitner *et al*, 2007; Sprenger *et al*, 2015) amongst potato cultivars, breeding lines, and wild *Solanum* species.

However direct selection for drought and heat tolerance by assessing performance and yield is very complex and time-consuming, as it requires trials on managed field sites either in areas with frequent droughts or under expensive rain-out shelters. In the most cases, it can be not possible to create a selection environment having both stresses simultaneously. As both drought and heat tolerances are multigenic traits, the combinations of favorable alleles that achieve high tolerances are very rare events. Thus, understanding the tolerance mechanism and novel screening techniques are needed to identify genotypes having dual-tolerance to both stresses. Recent developments in molecular biology and genetics offer new tools to breeders to develop more tolerant potato cultivars.

Phenomics and genomics are two important and trendy tools in developing stress tolerant cultivars. A high-throughput phenotyping is a key step to identify individuals tolerant to targeted stress factors (Ghanem *et al*, 2015). Screening of individuals for morphological (i.e. number and size of leaves, plant height, root size, etc.), physiological (i.e. chlorophyll content, carbon exchange rate, transpiration rate), and biochemical (i.e. stress enzymes, plant hormones) traits can give very useful information to define and ideotype under stressful condition (Ghanem *et al*, 2015). In recent years, imaging and monitoring systems have been used as a high-throughput phenotyping platform especially against stress factors (Araus. Cairns, 2014). These platforms generally use sensors, robotics, aeronautics, and high-performance computing tools, but more practical and low-cost approaches are also needed (Araus, Cairns, 2015; Ghanem *et al*, 2015).

In a broad term, genomics tools offer knowledge and information about single genes, pathways or gene networks, and genome structure and behavior (Langridge and Reynolds, 2015). Application of DNA markers to identify genotypes having desired traits have successfully implemented to breeding scheme of many crop species. Markers can provide a framework to identify genomic regions (e.g. quantitative trait loci, QTLs) that influence traits of interest (Ghanem *et al*, 2015). Unfortunately, a limited number of QTLs for complex traits of drought and/or heat tolerance have been detected by traditional QTL mapping approach while no validated selection markers have been developed for selection heat and/or drought tolerant potato genotypes. Recently several projects are ongoing to identify selection markers using Genome-wide Association Study (GWAS) approach. The Next Generation Sequencing technology along with phenotyping data are used for GWAS approach. Khan *et al* (2015) newly reported 45 QTLs related with drought tolerance in potato using GWAS approach. The main advantages of GWAS include: 1) no need to make crosses to generate segregating populations; 2) a collection of various cultivars and breeding lines can be utilized for mapping studies; 3) higher mapping resolution may be reached with many more meiotic recombination events (Aksoy *et al*, 2015). However, this approach also needs also collection of accurate phenotypic data to match traits and genes related to tolerance. Transcriptomics, miRNAs and trangenics can offer also useful tools to study on heat and drought tolerance in crops (Aksoy *et al*, 2015).

## CONCLUSIONS

It is obvious that global warming threats the sustainability of potato production in most regions throughout the world. Therefore, potato breeders should consider to develop tolerant cultivars to adapt upcoming changing environment. However, many recent potato breeding programs erroneously focused on only drought or heat tolerance instead of dual tolerance to both stresses whereas plants will generally face with both stresses simultaneously with changing climate. Hence we strongly suggest to include both stress factors in new breeding programs. Inclusion of phenomics and genomics tools to breeding program is also essential to accelerate breeding process of climate resilient potato cultivars.

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# GREEN MANURE - ONLY POSSIBILITY TO SAVE MOLDOVA'S ARABLE SOILS FROM DEGRADATION

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**Abstract**

The soil as an organic-mineral system is functioning normally and has a high capacity of agricultural production only if there is a constant flow of organic matter in its arable layer. In Republic of Moldova in the last 25 years organic fertilizers are practically not applied in agricultural soils. The agricultural output was reduced 2 times and livestock - 6 times. In terms of the lack of a rational ratio between the crop sector and livestock, it was established by calculation, that humus balance in the soils became profoundly negative, minus 1 t/ha/year. The only possible solution to change the situation is the use of green manure. Field research revealed that under the climate conditions of Moldova a harvest of green mass and roots of autumn vetch, incorporated into the soil as intermediate culture, leads to humus accumulation of about 2-3 t/ha. Also in the 8 t/ha of vetch organic residues absolutely dry incorporated into soil, contains almost 270 kg/ha of biological nitrogen, 60% of which (160 kg/ha) has a symbiotic origin. Thus, for the next two years this ensures a positive balance of organic matter in arable layer of soil. The system use of this procedure leads to solving the problem of humus and nitrogen in the soil and helps improve his physical quality. The bulk density of 0-20 cm arable layer was reduced from 1.37 to 1.21 g/cm$^3$. It has improved soil structural state and reduced its resistance to penetration.

**Key words**: balance, green manure, humus, soil, structure

Agriculture in Moldova is the most important branch of production. The primary means of production in agriculture is soil. Country's food security and population wellness depends on soils quality. Currently the agriculture is facing a number of major problems seriously affecting rural development. The classic tillage soil system increased the production, but it also determined the soil degradation characteristics and reduction the production capacity of agricultural land. The excessive soil tillage favored degradation processes and onset of other negative phenomena.

The chernozem is an organic-mineral system that can provide high capacity of agricultural production, only if there is a constant flow of fresh organic matter. Creation the positive balance of organic matter in soil is the main condition for maintaining his long-term fertility and avoid the degradation of arable layer. This can be achieved only through continuous application of organic fertilizers - manure or green manure. As result of the agrarian reform negative impact and other reasons, the manure as organic fertilizer is practically not used. Its production was reduced 6 times after the livestock reduction, recently concentrated in households. The collection, composting, transportation and incorporation cost of manure into the soil is high, and crop harvest do not compensate expenses. In this situation the balance of humus in the soil became profoundly negative and continues to be reduced annually by 1 t/ha. Simultaneously the agricultural output in Moldova has decreased 2 times.

## MATERIAL AND METHOD

The research object was cambic chernozem (leachate) of Central Moldova. The research aim was to restore soil characteristics by combining phyto- and agrotechnical methods, forming a positive balance of carbon, nitrogen and humus in the soil, stopping the degradation processes and regulation of $CO_2$ emissions in soil. To fulfill the predicted purpose in 2011-2016 were performed the following tasks: was founded the research polygon; initial assessment of soil quality condition on the polygon; cultivation and incorporation into the soil two crops of vetch on the experimental plot used as "occupied field"; determination of overhead and underground vetch mass incorporated into soil; plant analysis; harvests appreciation; assessing changes in characteristics of arable layer as a result of two crops incorporation of vetch green mass in one agricultural year. Investigations were carried out on the experimental fields of the Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo". The winter vetch was sown in mid- September 2011.

On 25 April 2012 the green mass of vetch was incorporated into the soil by disking. The

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spring vetch was sowed over four days, as well as green mass was incorporated into the soil in early September. On the strip and on the polygon surface were carried out the works required for basic sowing culture - winter wheat. Thus the experimental polygon was introduced again in the existing crop rotation at the experimental station. After winter wheat in the next years were sowed corn, sunflower and again winter wheat.

For the vetch sowing in the soil were introduced 100 kg/ha of nitrogen-phosphorus (ammophous). Every year under basic crop, early spring, was applied a starting dose of about 50-100 kg/ha of ammonium nitrate. On the experimental polygon and the adjacent field, unfertilized with green manure, was settled by 3 pair – micropolygons, located on the opposite with 10 $m^2$ area for soil research and appreciation the harvests of sown crops. The distance between micro-polygons is 50 m. Vetch was sown mixed with wheat - 80 kg/ha of vetch and 50 kg/ha of wheat. The research of field phase and laboratory were conducted according to classical methods and standards (Вадюнина А.Ф., Корчагина З.А, 1986). Assessment of the results was performed according to the methodology for developing soil studies (Florea N., 1975; Canarache A., 1990).

## RESULTS AND DISCUSSIONS

Intensive agriculture, soil tillage with heavy aggregate, resulted in the dehumification of arable layer, damaging the natural structure of agricultural soil and strong compacting of arable layer (*figure 1, 2*). Humification, dismantle and secondary compaction of arable layer is a crucial issue for chernozems in Moldova which 80 percent is characterized with fine or medium-fine texture (Cerbari V., 2015; Cerbari V., 2015a). Finely textured soils and favorable agronomic structure, unlike the unstructured or damaged structure ensures optimal plant growth and development (Berca M., 2011).

The balance of organic matter (humus) in arable soils must be equilibrated or positive. To assess the situation created recently was calculated balance of humus in arable soils of Moldova within the years 1990-2013 (*table 1*).

The data confirms that in 1990-1992 yrs, as a result of compliance with crop rotation with seven fields, of which one field with perennial grasses (alfalfa or sainfoin) and one field with annual grasses, simultaneous introduction about 6.7 t/ha of manure, in the arable soils of Moldova established a positive balance of humus.

Figure 1 **Chernozem cambic with glomerular-grainy structure, fallow**

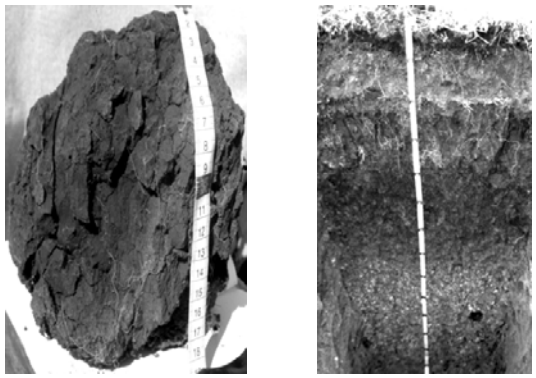

Figure 2 **Chernozem cambic with strongly compacted destructuring post arable layer, arable**

The land reform has led to the disappearance of fields sown with leguminous grasses from crop rotation; livestock was reduced by 6 times. In agricultural soils used in field crops the manure is basically not applied, the quantity of fertilizer was reduced catastrophically (40-50 kg/ha). In the described situation in arable soils was created a profoundly negative balance of organic matter and nutrients. The total agricultural production was reduced about 2 times (*table 1*).

The lack of equilibrated organic matter balance in the soils does not lead to increase the crop harvest even when increased applications of mineral fertilizers are used. The research showed that the rise in the last years of chemical fertilizers, incorporated therein, without a co-report balanced with organic and phosphorus fertilizers do not lead to the expected increase of crops.

Negative balance of organic matter in soils led to the decrease of humus content accumulated for millennia, deterioration in the structure and secondary strong compaction of soil arable layer. At the moment, due to destructuring, arable layer of chernozems practically lost the compaction to resistance.

Table 1

**The balance of humus in Moldova's soils on fields used in agricultural crops**

| Year | Surface, thousand ha | Basic harvest thousand tons / year | Basic harvest, absolute dry mass, th. t / year cereal units | Humus | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Humus formed as result of organic waste humification, remaining in the soil, th. t/year | Humus formed from application of organic fertilizers, th. t/year | Humus lost as a result of minera-lization, th. t / year | Humus balance | |
| | | | | | | | th. t/year | t/ha /year |
| 1990 | 1698.8 | 17190.9 | 5924.2 | 628.5 | 800.0 | -727.8 | 700.7 | 0.41 |
| 1991 | 1696.4 | 19530.0 | 6811.0 | 705.8 | 692.8 | -720.3 | 678.3 | 0.40 |
| 1992 | 1688.0 | 12908.0 | 4556.8 | 484.9 | 468.8 | -610.1 | 343.6 | 0.20 |
| 1993 | 1863.4 | 15346.6 | 5923.6 | 626.1 | 370.5 | -1833.6 | -837.1 | -0.45 |
| 1994 | 1804.8 | 9548.6 | 3466.4 | 277.2 | 147.5 | -1093.7 | -669.0 | -0.37 |
| 1995 | 1714.4 | 9766.9 | 4037.1 | 314.4 | 167.3 | -1665.9 | -1184.2 | -0.69 |
| 1996 | 1707.6 | 7338.1 | 3129.6 | 263.5 | 84.8 | -1467.9 | -1119.6 | -0.66 |
| 1997 | 1718.7 | 8454.1 | 4308.6 | 383.2 | 33.5 | -2300.6 | -1884.0 | -1.10 |
| 1998 | 1709.3 | 7016.8 | 3522.7 | 336.4 | 22.7 | -1901.6 | -1542.4 | -0.90 |
| 1999 | 1654.3 | 5757.5 | 3110.7 | 338.7 | 12.2 | -1773.3 | -1422.4 | -0.86 |
| 2000 | 1693.1 | 4980.6 | 2715.7 | 272.4 | 8.3 | -1610.1 | -1329.4 | -0.79 |
| 2001 | 1702.7 | 5666.5 | 3290.4 | 302.1 | 9.8 | -1978.9 | -1666.9 | -0.98 |
| 2002 | 1726.9 | 5552.2 | 3256.7 | 286.1 | 5.4 | -1971.7 | -1680.1 | -0.97 |
| 2003 | 1588.5 | 4087.0 | 2316.7 | 221.6 | 4.7 | -1486.9 | -1260.6 | -0.79 |
| 2004 | 1676.1 | 5579.8 | 3530.4 | 285.0 | 4.2 | -2222.0 | -1932.7 | -1.15 |
| 2005 | 1617.0 | 5551.1 | 3411.2 | 285.7 | 4.4 | -2115.9 | -1825.9 | -1.13 |
| 2006 | 1538.9 | 5345.6 | 3043.8 | 271.3 | 1.0 | -1894.7 | -1622.4 | -1.05 |
| 2007 | 1542.9 | 2534.6 | 1331.7 | 119.7 | 0.8 | -644.1 | -523.6 | -0.34 |
| 2008 | 1544.0 | 5948.6 | 3802.2 | 317.5 | 0.8 | -2263.8 | -1945.5 | -1.26 |
| 2009 | 1580.4 | 4054.3 | 2676.9 | 232.6 | 0.7 | -1611.5 | -1378.2 | -0.87 |
| 2010 | 1585.1 | 5194.3 | 3209.4 | 299.4 | 1.8 | -1927.1 | -1626.0 | -1.03 |
| 2011 | 1581.1 | 5058.4 | 3265.8 | 299.3 | 3.2 | -1994.1 | -1691.6 | -1.07 |
| 2013 | 1652.3 | 5556.1 | 3576.6 | 322.9 | 4.3 | -2080.4 | -1753.2 | -1.07 |

The unfavorable situation on the chernozems quality state can be improved only by increasing the organic matter flow and implementation of conservative soil tillage. Unfortunately, organic fertilizers in the form of manure practically there are no exist recently. Now, the task is to replace manure as organic fertilizer with another alternative source - green manure. Certain it serves as motivation to recommend a crop rotation with five fields to include an "occupied field" with leguminous crops, autumn and spring vetch (2-3 vetch crops incorporated into the soil as green manure in the agricultural year on the every field of crop rotation once in 5 years). Crop rotation structure may be: vetch occupied field →corn →winter wheat → winter/barley → sun flowers. This procedure, used in frame of any tillage system of agricultural land will lead to forming an equilibrated balance of organic matter in the soil, to remediation quality state and increasing production capacity. The testing procedure was conducted in the 2013-2014 yrs on the territory of commune Ivancea, district Orhei.

Initial physical and chemical parameters of soil were studied in autumn 2012 until the founding of experience. Cambic chernozems is characterized by clayey-loamy texture, weakly differentiated in profile, middle-quality structural composition, moderate compaction of recently arable layer, strong compaction of horizons Bhw2 and Bhw1. Humiferous profile is decarbonated, humus content in arable layer is comparatively low and ranges between 3.2-3.5%. Data on green aerial and roots masses of two crops of vetch incorporated into soil are shown in *table 2*

Table 2

**Total mass of organic debris and aerial roots of two crops of Vetch, incorporated into soil**

| Harvest | Dry mass, t/ha | Ash | N | $P_2O_5$ | $K_2O$ | C |
|---|---|---|---|---|---|---|
| | | % of absolutely dry mass | | | | |
| Total mass of organic debris | 12.0 | 5.9 | 3.6 | 0.7 | 1.9 | 42.0 |

Influence of green fertilizers on soil characteristics plowing on 20 cm depth for incorporation of the first crop of spring vetch under furrow, and worked in spring with discs at 12 cm depth for incorporation into the soil the next crop of vetch is shown in *table 3*. The harvest of basic crop after incorporation into the soil two crops of vetch green mass is presented in *table 4.*

Table 3

**Modification of the main features of arable layer of cambic chernozems**
(Numerator - the initial parameters; Denominator - the changed parameters)

| Horizon and depth (cm) | The balanced bulk density, g/cm$^3$ | Total porosity, %v/v | Sum of favorable aggregate 10-0,25 mm, % | Hydro-stability of favorable aggregates, % | Humus (organic matter), % g/g | Mobile forms, mg / 100g soil | |
|---|---|---|---|---|---|---|---|
| | | | | | | $P_2O_5$ | $K_2O$ |
| Ahp1 0-12 | 1.29<br>1.11 | 50.8<br>57.6 | 66.5<br>71.0 | 65.3<br>71.4 | 3.43±0.15<br>3.72±0.06 | 2.3±0.4<br>2.7 | 23±1<br>26 |
| Ahp1 12-20 | 1.41<br>1.35 | 46.4<br>47.9 | 51.5<br>54.4 | 68.7<br>72.4 | 3.22±0.08<br>3.40±0.05 | 1.7±0.2<br>1.9 | 21±2<br>22 |
| Ahp2 20-35 | 1.48<br>1.49 | 44.5<br>45.9 | 50.8<br>51.3 | 73.3<br>74.2 | 3.06±0.10<br>3.08±0.04 | 1.4±0.2<br>1,5 | 14±1<br>15 |
| Ah 35-50 | 1.43<br>1.41 | 46.5<br>47.4 | 79.3<br>78.5 | 75.7<br>74.8 | 2.86±0.09<br>2.85±0.07 | 1.2±0.2<br>1,2 | 13±1<br>14 |

Table 4

**Harvest of basic crops in 2013-2016 on the experimental variants after incorporation into the soil two crops of vetch aerial and roots green**

| Variant | Harvest on the evidence parcels (at 12% moisture) | | | | | | Harvest growth rate compared to control | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | average | t/ha<br>% | Probability essential difference , % |
| Year 2013, Corn, t / ha | | | | | | | | |
| ***Control - Corn*** | 6.2 | 7.1 | 5.9 | 6.3 | 6.5 | 6.4 | - | - |
| **I Year** - Corn after Vetch | 6.8 | 8.0 | 7.5 | 7.1 | 7.5 | 7.4 | 1.0<br>15.6 | 99.0 |
| Year 2014, Winter wheat, t/ha | | | | | | | | |
| ***Control - Winter wheat*** | 4.2 | 3.8 | 3.9 | 4.1 | 3.9 | 4.0 | - | - |
| **II Year** - Winter wheat after Vetch and Corn | 5.9 | 5.9 | 6.1 | 5.9 | 5.8 | 5.8 | 1.8<br>45.0 | 99.0 |
| Year 2015, Sun flower | | | | | | | | |
| ***Control - Sun flower*** | 1.5 | 1.2 | 1.4 | 1.5 | 1.4 | 1.4 | - | - |
| **III Year** - Sun flower after Vetch | 2.0 | 1.7 | 2.0 | 1.9 | 1.7 | 1.9 | 0.5<br>26.0 | 99.0 |
| Year 2016, Winter wheat, t/ha | | | | | | | | |
| ***Control - Winter wheat*** | 4.8 | 4.5 | 4.9 | - | - | 4.7 | - | - |
| **IV Year** - Winter wheat after Vetch and Corn | 5.8 | 5.6 | 6.0 | - | - | 5.8 | 1.0<br>20.8 | 95.0 |

## CONCLUSIONS

As result of incorporating in the arable layer of chernozem cambic in agricultural year 2012 two crops of vetch green mass about 12 t/ha of residues on a occupied field provided: accumulation in the soil of 430 kg of nitrogen, of which 260 kg fixed from the atmosphere; synthesis around 3 t/ha of humus or 1.7 t/ha of carbon; sequestration of about 6.3 t/ha of $CO_2$; a weakly positive balance of organic matter and nitrogen in the soil over a period of four years; an increase of maize crop of about 1 t/ha in the I year, 1.8 t/ha of winter wheat in the II year, 0.5 t/ha of sunflower in the III year and 1 t/ha of winter wheat in the IV year after incorporation into the soil of green mass of vetch.

Systemic use of green manure couple with phosphorus and potassium fertilities may partially restored gradually the quality of physical, chemical and biological status of soil and increase sufficiently the capacity of their agricultural production. The problem consists in development and implementation of a system that will use this procedure.

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# RESEARCHES REGARDING THE OPTIMIZATION OF THE OPPERATING PROCESS OF WHEAT DEBRANNING FOR GRINDING

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**Abstract**

Debranning is an operation which removes parts or the entire outer layer of wheat seeds, resulting in the removal of dust particles adhering to the surface of the grain and it also clears the wheat kernels hair. The debranning operation of cereals has a large influence on the grinding work process, on the content of minerals of the flour, on germs separation and broken kernels content; for these reasons the purpose of this paper is to optimize the constructive and functional parameters of the wheat debranning installation, namely to maximize the technological work process. In order to achieve the objective of this paper, a test rig was designed and built in order to study and optimize the operating process for wheat kernels debranning; the technological line consists of: horizontal debranning machine with frusto active bodies made of Eureka type braided wire and an aspiration system. In order to study the influence of debranning operation on the quality indices of wheat seeds, several structural and functional parameters of the machine were varied and the variations of the following indices were observed: broken kernels content, ash content and the amount of peeled coating. As a result of the laboratory investigations it was found that the percentage of broken grains, the ash content and the amount of peeled coating varies with the rotor speed and the distance between the two frusto jackets. The percentage of broken grains is directly proportional to the inner jacket speed and inversely proportional to the distance between the two conical drums made of braided wire. The experimental tests showed that the percentage of ash was affected by the rotor speed and the distance between the two drums of the debranning machine. Corroborating the results regarding the content of broken grains, percentage of ash and the amount of peeledcoating led us to the conclusion that the optimum operating regime of the machine was obtained when the distance between the tapered drums was d = 10 mm, the rotor speed was 150 rev/min and 250 rev/min respectively.

**Key words**: wheat, debranning, conditioning

By studying the operation of conditioning, researchers have tried to determine the influences of this process on wheat kernels and flour made from them, but until this moment they were not able to determine the exact recipe of wheat conditioning (Cozma D., Țenu I., 2014).

Modern technologies of processing wheat in market economy conditions involve better use of raw materials in order to obtain products with high nutritional value at the lowest possible production costs. (Iorga L, Câmpeanu G., 2004).

Analyzing the structure of wheat grain and chemical composition of various anatomical parts of it, it appears that the endosperm layer with the highest concentration of vitamins, enzymes, minerals and nutritional components essential for the proper functioning of the human body is the boundary between endosperm and aleurone layer; which is why it is necessary to study the process of conditioning (Wheat Quality & Carbohydrate Research, 2015).

In conclusion to preserve valuable elements from whole wheat, the working procces of the pelling machine and its optimal working regime must be followed closely in order to obtain a flour in line with market requirements (Brătucu G., 2009).

## MATERIAL AND METHOD

The Glossa wheat variety from Hălăuceşti, Iaşi was used for this study. Grain sampling was conducted using the method stated in ISO 13690/2001. In order to carry out the researches on the work process of the wheat brushing machine, the grain was received, homogenized and stored.

For the experiences was used an experimental stand, designed and built in order to study the debranning process of wheat kernels and to optimize its constructive and functional parameters, in order to improve the quality indices

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of cereal seed respectively of the flour obtained after milling.

For the design of experimental stand were taken into account primarily the conditions it must fulfill:

• to process small portions of the product;
• allow changing various process parameters which influence the technological effect of operation;
• simple construction;
• must be made of demountable assemblies to enable to easily change components in order to modify the working parameters;
• the machine must be equipped with an engine aviable to modify the rotor speed;
• the form of the tapered drums must be tronconical in order to ensure the transportation of the product from the inlet to the point of discharge;
• machine drums must be concentric to ensure uniformity of debranning process;
• must offer the possibility of changing the distance between the tapered drums;
• in order to remove dust from the grain mass and to ensure that the mineral particles will not be released into the environment, the machine must be connected to a suction system.

The technological scheme of the device used in the experiences is shown in figure 1 and in figure 2 is presented the debranning laboratory stand.

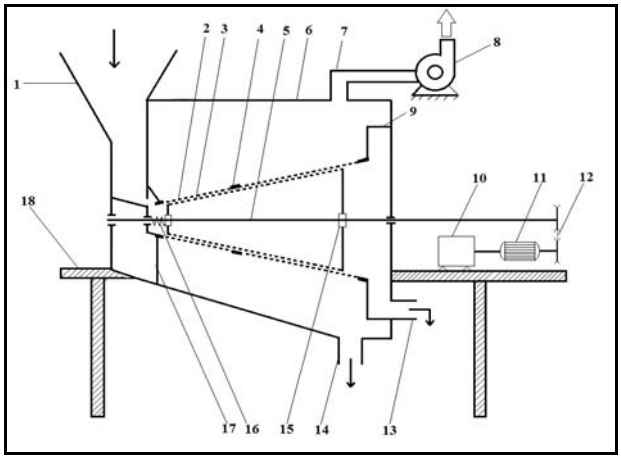
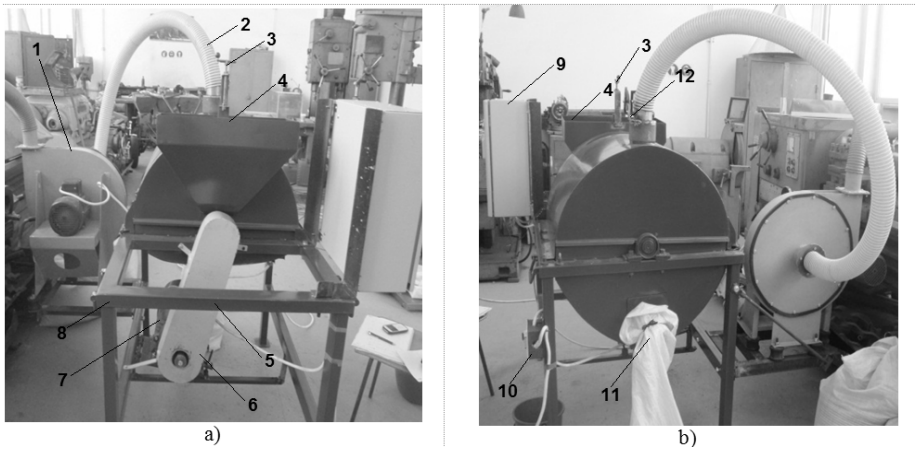



Figure 1 **Technological scheme of the debranning machine:** 1 - inlet; 2 - fixed braided wire jacket; 3 - rotative braided wire jacket; 4 - metal rings; 5 - shaft; 6 - casing; 7 - suction channel; 8 - fan; 9 - evacuation area for debranned seeds; 10 - speed converter; 11 - electric motor; 12 - belt transmission; 13 - debranned seeds outlet; 14 - impurities outlet; 15 - mounting flange; 16 - helical spring; 17 - fixing system for the outer jacket; 18 - frame.




a) b)

Figure 2 **Wheat debranning machine**: a) Left view; b) Right view
1 - fan; 2 – suction tube; 3 - bolt for adjusting the feed rate; 4 - hopper; 5 - frame; 6 - belt transmission; 7 - electric motor; 8 - frame; 9 - frequency converter; 10 - switch; 11- outlet for debranned seeds; 12 - device for regulating the suction flow in the system

To study the influence of the debranning operation on the percentage of broken grains ($B_s$), ash content ($C_c$) and the amount of the removed pelled coating ($C_i$) were varied two experimental factors: the distance between the conical drums (d) and the rotor speed (n). Table 1 presents the experimental variations conducted in the laboratory with the factors graduations.

Table 1

**Experimental variants performed on the debranning machine**

| Nr. var. | Rotor speed, n [rpm] | Distance between drums, d [mm] |
|---|---|---|
| **$V_{d1}$** | 100 | 6 |
| **$V_{d2}$** | 150 | 6 |
| **$V_{d3}$** | 200 | 6 |
| **$V_{d4}$** | 250 | 6 |
| **$V_{d5}$** | 100 | 8 |
| **$V_{d6}$** | 150 | 8 |
| **$V_{d7}$** | 200 | 8 |
| **$V_{d8}$** | 250 | 8 |
| **$V_{d9}$** | 100 | 10 |
| **$V_{d10}$** | 150 | 10 |
| **$V_{d11}$** | 200 | 10 |
| **$V_{d12}$** | 250 | 10 |
| **$V_{d13}$** | 100 | 12 |
| **$V_{d14}$** | 150 | 12 |
| **$V_{d15}$** | 200 | 12 |
| **$V_{d16}$** | 250 | 12 |
| **VdM** | - | - |

## RESULTS AND DISCUSSIONS

After the technological operations of cleaning and conditioning carried out on wheat kernels for milling, a certain percentage of broken grains was obtained, which negatively impacts both the grinding process itself and the quality of the finished product (Panțuru D., Bârsan I., 1997).

In order to determine the structural and functional parameters of the debranning machine that influence the quality indices of wheat, were taken samples from all the 16 experimental variants. After that, was determined the percentage of broken kernels, ash and the amount of debranned coating.

Table 2 shows the percentage of broken grains, ash content and amount of peeled coating, results obtained from laboratory tests conducted on the debtanning machine by using different distances between the drums and various rotor speed.

Table 2

**The variation of broken wheat kernels percentage, ash content and peeled coating**

| Nr. Var. | Ash content, $C_c$ [%] | Broken kernels content, $B_s$ [%] | Debranned coating amount, $C_i$ [%] |
|---|---|---|---|
| **$Vd_1$** | 1.520 | 22.16 | 0.76 |
| **$Vd_2$** | 1.563 | 23.68 | 0.81 |
| **$Vd_3$** | 1.636 | 26.92 | 0.96 |
| **$Vd_4$** | 1.569 | 27.3 | 1.42 |
| **$Vd_5$** | 1.542 | 7.74 | 0.35 |
| **$Vd_6$** | 1.525 | 8.86 | 0.42 |
| **$Vd_7$** | 1.647 | 9.32 | 0.63 |
| **$Vd_8$** | 1.565 | 10.02 | 0.97 |
| **$Vd_9$** | 1.616 | 2.51 | 0.12 |
| **$Vd_{10}$** | 1.589 | 2.98 | 0.18 |
| **$Vd_{11}$** | 1.599 | 3.45 | 0.28 |
| **$Vd_{12}$** | 1.596 | 3.86 | 0.32 |
| **$Vd_{13}$** | 1.601 | 2.05 | 0.1 |
| **$Vd_{14}$** | 1.551 | 2.49 | 0.1 |
| **$Vd_{15}$** | 1.586 | 2.68 | 0.1 |
| **$Vd_{16}$** | 1.566 | 2.92 | 0.1 |
| **VdM** | 1.654 | 1.6 | 0 |

From the experimental researches carried out on the laboratory stand it has been found that the percentage of broken grains is directly proportional to the rotor speed and inverse proportion to the distance between the two frusto jackets. The most pronounced degree of broken wheat kernels was recorded at a distance of 6 mm between the two drums. This high percentage of broken seeds was maintained for all the four rotor speed variants used in the laboratory tests.

At 8 mm spacing between the two jackets it was observed a decrease in the content of broken grains of more than 60% of the variants in which it was used a distance of 6 mm between the drums. Although in this case it was observed a significant reduction in the percentage of

damaged wheat seeds, the values obtained for the content of broken grains were still high: from 7.74% in the case of setting the rotor speed at 100 [rpm] and at over 10% for the rotor speed set at 250 [rpm].

The lowest values of the percentage of broken grains were recorded at distances of 10 and 12 mm betweed the braided wire jackets at all rotor speeds used in trials.

The lowest content of broken wheat kernels was recorded in the experimental variant $V_{d13}$, where it was used a 12 mm distance between the drums and a rotor speed of 100 [rpm].

The specific ash content of wheat is between 1.5% and 2.00%, of which about 0.35% is found in the endosperm and the rest in the aleurone layer, germ and pericarp. In the laboratory analysis of the witness sample, represented by wheat seeeds that have not been subjected to the debranning operation, it resulted an ash content of 1.654%.

The experimental tests carried out on the debranning machine revealed that in all 16 variants studied, the percentage of ash content has lower values than the witness sample.

Most frequently the lowest ash content was registered at low rotor speeds, namely at 100 and 150 rpm, and at distances between the jackets of 6 and 8 mm. At the same distances between the two drums, but at the rotor speed of 200 rpm were found the highest values of ash content.

Giving the variation of peeled coating quantity, the tests performed on experimental stand found that when adjusting the distance between the machine drums at 12 mm, respectively variants $V_{d13}$, $V_{d14}$, $V_{d15}$, $V_{d16}$, technological effect on grain seeds subjected to the debranning process was nonexistent. On the other hand, the variants $V_{d1}$, $V_{d2}$, $V_{d3}$ and $V_{d4}$, respectively at a distance of 6 mm between drums generators, were obtained high values of peeled coating content: up to 1.42%.

## CONCLUSIONS

The percentage of broken grains, ash content and debranned wheat kernel coating are influenced by the distance between the two frustoconical jackets and the speed of the inner drum.

Percentage of broken grains is directly proportional with inner jacket speed and inversely proportional to the distance between the two frustoconical braided wire drums. Unlike the variation of broken grains content, the percentage of ash obtained from experimental tests has a curve of constant variance depending on the rotor speed and the distance between the two frusto jackets. The percentage of peeled coating increases in direct proportion with the value of the rotor speed and it increases inversely proportional with the distance between the machine drums.

Although the variants $V_{d1}$, $V_{d2}$, $V_{d3}$ and $V_{d4}$ recorded high percentages of peeled coating, they can not be considered optimal for the machine operation because these variants revealed a high degree of broken wheat seeds, between 22 and 27%, which lead to large losses of product.

Also high disposal of debranned coating of wheat kernels was recorded in the variants $V_{d5}$, $V_{d6}$, $V_{d7}$ and $V_{d8}$, but even these may not consider to be the optimum solutions for the debranner because in these experimental variants was obtained an increased degree of damaged seeds (broken grain content was between 7.7% and 10%).

Correlating values of broken grains content, ash percentage and the amount of peeled coating recorded as a result wheat kernels debranning, it appears that the optimum operating regime of the machine is obtained by adjusting the distance between the drums at 10 mm and the rotor speed at 150 or 250 rpm ($V_{d10}$ and $V_{d11}$).

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# THE DISPERSION UNIFORMITY OF A MACHINERY FOR COMBATING DISEASES AND PESTS IN VINEYARDS AND ORCHARDS, EQUIPPED WITH NOZZLES WITH/WITHOUT AIR ABSORPTION

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**Abstract**

The chemical method for the application of phytosanitary treatments in the vineyards is most effective for the control of diseases and pests, but also presents some disadvantages, because the pesticides end up in the water, air and soil, polluting them. Pesticides are transferred to plants, fruit, animals and people, with undesirable repercussions on health. The spraying devices are equipped with nozzles, which disperses plant substance in fine droplets on the plant. Their orifice can be decalibra due to hydroabrasive wear, favoring conducting to an uneven treatment, with untreated or overtreated areas, which also determines an excessive pollution. To determine the nozzles dispersion uniformity it was designed and built a laboratory stand, which allows quantification of the machine dispersion uniformity. In the experimental research conducted in laboratory conditions it was used a vineyards pest and disease control machine TARAL 200 PITON TURBO type, which there were mounted flat-jet air absorption-type nozzles IDK 120-02 from LECHLER and ALBUZ AMT 1.2 full cone spray nozzles. The tests were performed for different working pressures (0.2; 0.4; 0.6; 0.8; 1.0; 1.2 and 1.4 MPa) and mounting distances from stand to the spraying machine axis (1500, 1700, 1900 and 2100 mm). In these circumstances, it is reproduced in laboratory the spraying machine working process and it is determined the solution dispersion uniformity. The analysis results show that the air absorption nozzles have a much better uniformity than those without air absorption for all pressures and working distances. The best results, i.e. the dispersion uniformity of 90.93% were obtained by the stand arrangement at a distance of 1900 mm from the machine's axis and at a pressure of 1.0 MPa, for air absorption nozzles.

**Key words**: dispersion uniformity, nozzles, spraying machine

Pest and disease control from orchards and vineyards is a very important technological component, without which production would not be safe and steady year after year (Kamousantas D. et al., 2000; Tomoiagă L., 2013). Thus, diseases and pests can cause important economic losses. If the pesticide treatments are not applied effectively and on time, total production may be compromised (Berca, 2001).

Proper application of phytosanitary treatments with superior qualitative working indices, reduce production waste, the excess use of pesticides, and not at least it avoids environmental pollution, especially the ground (Nagy E.M. and Coța C., 2007; Diaconu A. *et al*, 2016).

Based on these considerations, there have been made researches in order to determine the best technical solutions to operate a vineyard spraying machine, equipped with two types of nozzles, namely air suction flat spray IDK 120-02, manufactured by LECHLER and full cone classic jet nozzles without air absorption, AMT 1.2, made by ALBUZ company.

## MATERIAL AND METHOD

In order to determine the dispersion uniformity on the working height of the machines used to combat vineyard pests and diseases, in the Laboratory of Horticultural Machinery at the "University of Agricultural Sciences and Veterinary Medicine" in Iaşi, it was designed and made a stand for collecting solution dispersed droplets.

The stand is made of a vertical panel of polycarbonate, with a length of 2350 mm and a width of 830 mm, on which were mounted 18 inclined troughs, made of galvanized steel sheet. During the experimental research, the dispersed solution is collected from each trough, over a period of 60 seconds, after which it is directed in separate containers, laterally arranged, after which the amount of the solution is measured with graduated cylinders (*figure 1*).

The troughs were numbered starting from the base of the panel, from 1 to 18, trough number 1 being at the height of 300 mm from the ground, and number 18 at 2510 mm, the troughs being mounted on panel at 130 mm distance from each other.

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In order to perform experimental tests, it was used a TARAL 200 PITON TURBO vineyards universal pest and disease control machine on which were mounted LECHLER suction air jet flat nozzle IDK 120-02 and ALBUZ AMR. Full cone nozzle without air jet suction. With the specification that the air absorption nozzles prevent drift, due to the fact that it form large drops that contain air in the central zone, and in contact with the surface of the leaves break and carried out a further fragmentation of them, such is achieved under these conditions an efficient plant treatment, with minimum substance loss.

With the proviso that the absorption of air nozzles prevent drift due to the fact that large droplets containing air in the central area and in contact with the leaf surface are broken and achieve a further fragmentation thereof. By making these treatment conditions effective protections with minimum loss of substance.


Figure 1 **The laboratory stand for the dispersed solution distribution uniformity study of the vineyards TARAL 200 PITON TURBO spraying machine**

Determinations were made for different working pressures (0,2; 0,4; 0,6; 0,8; 1,0; 1,2 and 1.4 MPa) and distances between the stand and the spraying machine axis (1500, 1700, 1900 and 2100 mm). The height of the panels layout above ground was 300 mm, and the axial fan speed of 1400 RPM .

The liquid dispersion uniformity (%) on the machine working height must be higher than 85% and has been calculated with the relationship:

$$U_d = \left[ 1 - \frac{\sqrt{\frac{\sum_{i=1}^{i=n} (q_i - q_m)^2}{n(n-1)}}}{q_m} \right] * 100 \ (\%),$$

in which: $q_i$ – the amount of liquid collected from each trough; $q_m$ – the average amount calculated for all the collecting troughs; $n$ – the number of troughs.

## RESULTS AND DISCUSSIONS

The experimental research conducted in laboratory conditions, for each variant, revealed the peculiarities of the working process. Thus, at a distance of 1500 mm from the layout of the stand to the spraying machine axis it is found that, for nozzles without air absorption, the amount of fluid recorded a maximum value up to height of 1000 mm from the ground, after which it decreases more and more towards the top of the stand. Therefore, the dispersed liquid jet of the spraying machine equipped with AMT 1.2 full cone jet nozzles, achieved a larger amount of liquid in the lower zone up to the height of 1000 mm and decreases towards the upper part (*figure 2*).

In the case of IDK 120-02 air absorbtion nozzles, the amount of dispersed liquid recorded a maximum value between 500 and 1000 mm from the ground. Outside this range, the quantities of collected liquid at the level of each trough are smaller, with a more pronounced decrease in the upper part of the stand (*figure 3*).

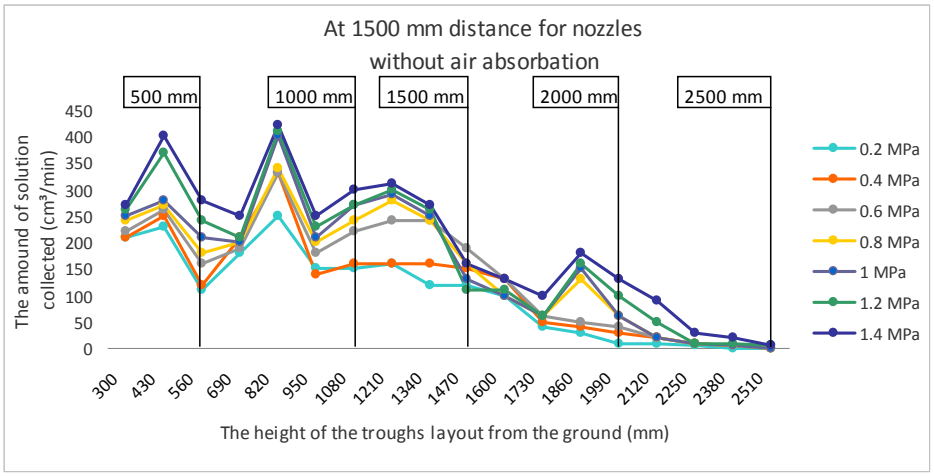


Figure 2 **The amount of liquid collected at each trough level for different working pressures, at 1500 mm distance between stand and the spraying machine axis, using nozzles without the air absorption**

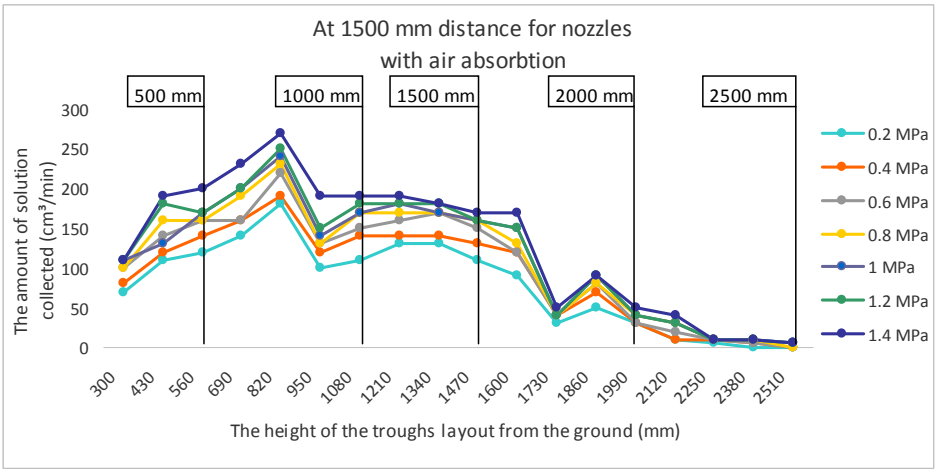


Figure 3 **The amount of liquid collected at each trough level for different working pressures, at 1500 mm distance between stand and the spraying machine axis, using air absorption nozzles**

By increasing the distance of the layout of the stand to the axis of the spraying machine, respectively to 1700 mm, for both types of nozzles there is the same tendency as in the case of the distance of 1500 mm, except that the overall amount of fluid collected is smaller. This is because some of the liquid droplets is evaporated and another part thereof is lost by drift *(figure 4 and 5*).

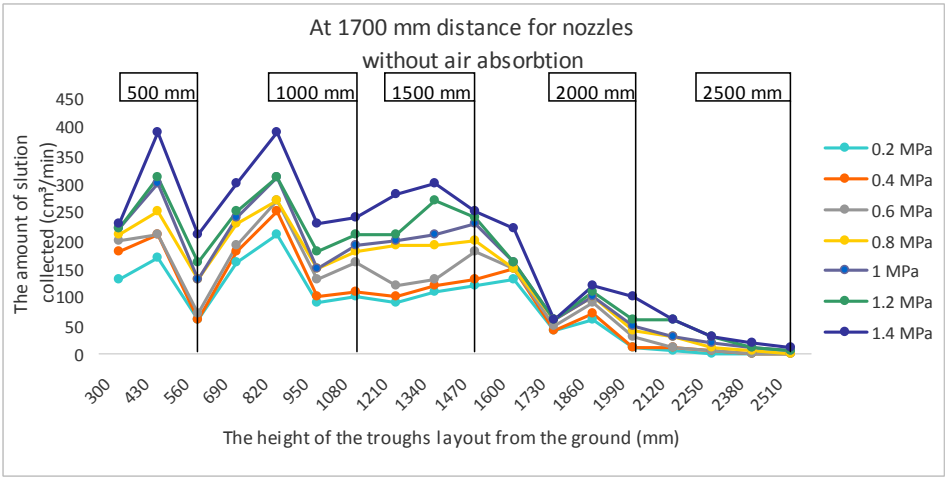


Figure 4 **The amount of liquid collected at each trough level for different working pressures, at 1700 mm distance between stand and the spraying machine axis, using nozzles without the air absorption**

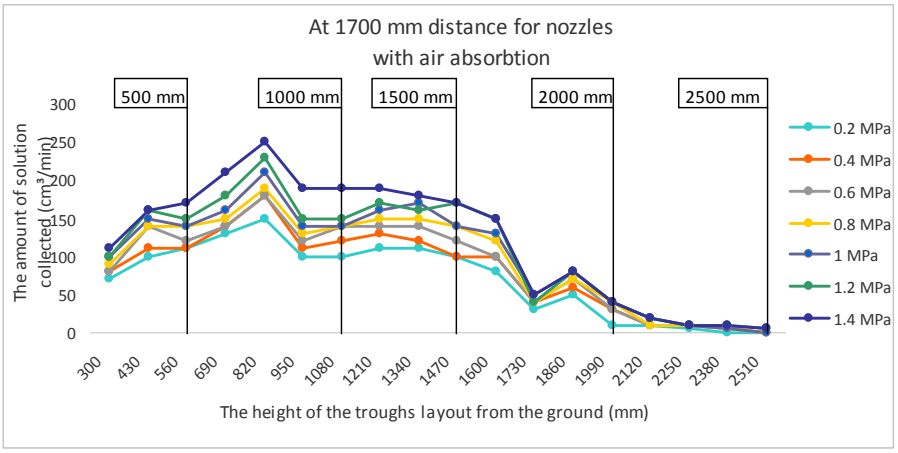


Figure 5 **The amount of liquid collected at each trough level for different working pressures, at 1700 mm distance between stand and the spraying machine axis, using air absorption nozzles**

At the distance from the stand layout to the spraying machine axis of 1900 mm, the amount of fluid collected in each trough declines further due to increasing distance of the layout of the panel, reached by a smaller number of drops. In the case of nozzles without air suction, the amount of fluid decreases from 300- 500 mm to 2500 mm, while in the case of air absorption nozzles maximum amount of dispersed liquid is concentrated to about 1000 mm from the ground and lower 500 and above 1000 mm, exactly as for the other distances of the layout of the stand in relation to the axis of the spraying machine (*figure 6 and 7*).

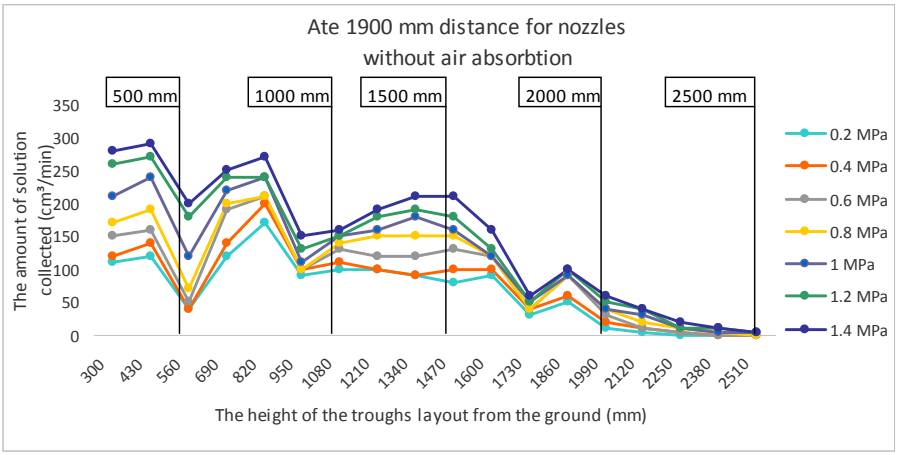


Figure 6 **The amount of liquid collected at each trough level for different working pressures, at 1900 mm distance between stand and the spraying machine axis, using nozzles without the air absorption**

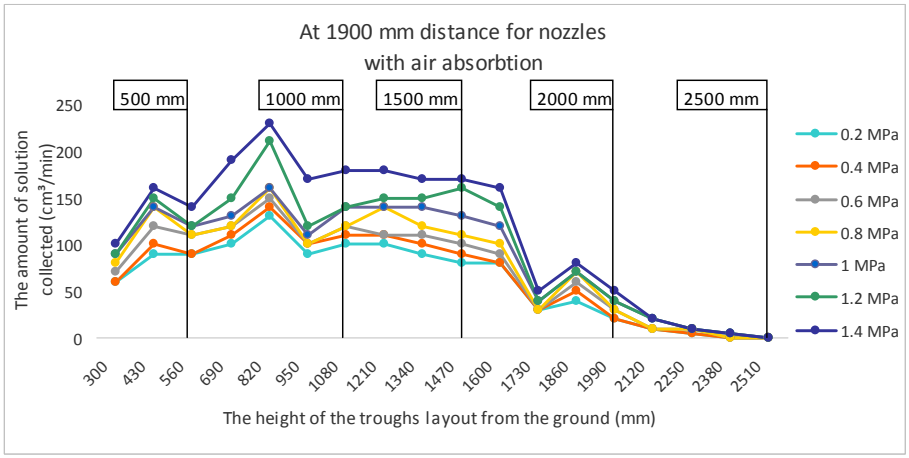


Figure 7 **The amount of liquid collected at each trough level for different working pressures, at 1900 mm distance between stand and the spraying machine axis, using air absorption nozzles**

At a distance of 2100 mm the amounts of solutions collected by stand's troughs are closer to those obtained at a layout distance of 1900 mm from the machine axis. In the case of air suction nozzles it can be seen that the uniformity is achieved in the region from 500 mm to 1500 mm (*figure 8 and 9*).

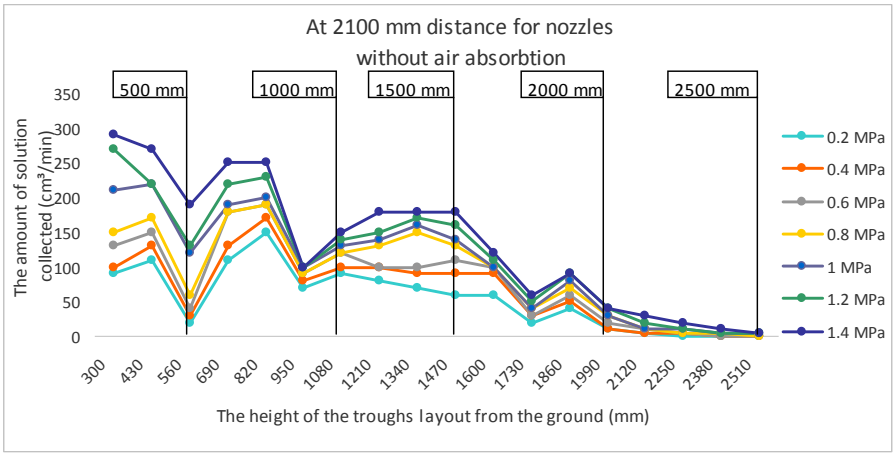


Figure 8 **The amount of liquid collected at each trough level for different working pressures, at 2100 mm distance between stand and the spraying machine axis, using nozzles without the air absorption**

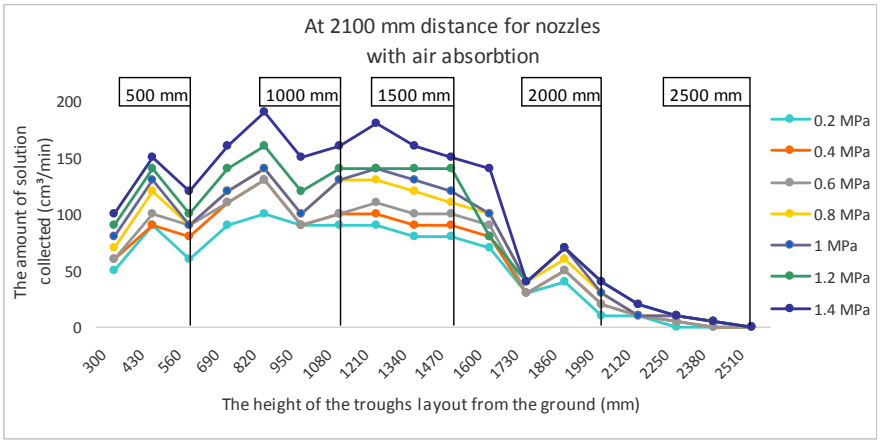


Figure 9 **The amount of liquid collected at each trough level for different working pressures, at 2100 mm distance between stand and the spraying machine axis, using air absorption nozzles**

In order to determine the solution dispersion uniformity $U_d$(%) on the spraying machine working height, using two types of nozzles with or without air absorbtion, there were removed from the calculation troughs from 15 to 18, namely those positioned over 2000 mm height, because over this quota the vineyard vegetation is reduced and the dispersed solution amount is insignificant.

In the case of the nozzle without air absorption it is observed that the obtained dispersion uniformity values were lower, but over 85% for the small working pressures, such as 0.2, 0.4 and 0.6 MPa for all the mounting position of the stand. The best uniformity, obtained for the distance of 1500 mm, is of 89.44% at a pressure of 1.4 MPa, and the other values were 88,40% at 0.8 MPa, 87.47% at 1.2 Mpa, 87, 38% at 1.0 MPa and 87.37% at 0.6 MPa. It is followed by the 1700 mm distance with the following uniformity values: 89.22% to 0.8 MPa, 89.10 % at 1.4 MPa and 89.03 % at 1.2 MPa. At the 1900 mm distance were obtained the optimum levels of uniformity at the 1.4 MPa pressure of 89.10%, at 1.4 Mpa of 88.67% to and 85.37% at 1.2 MPa. At the distance of 2100 mm the obtained values were as follows: 88.02% at 0.8 Mpa, 87.97%, to 1.0 Mpa, 87.64% at 1.2 MPa and 87.43% to 1.4 MPa (*figure 10*).

So, for this type of nozzle, by increasing the stand layout distance, uniformity decreases more and more, and increased pressures are needed to achieve it.

In the absorption air nozzle it has been obtained a good solution dispersion uniformity on the working height of the spraying machine, for all distances between the stand and the the spraying machine axis. At the 1900 mm distance it was obtained the maximum uniformity of 90.93% at

1.0 MPa working pressure, followed by the 2100 mm distance, with a maximum of 90.59% at apressure of 1.0 MPa, then the 1700 mm distance with 90.32% at a pressure of 1.0 MPa and the 1500 mm distance to 89.56% at 0.4 MPa (*figure 11*).

It is noted that for the air absorption nozzle it is not necessary a high pressure is required to achieve a solution flow uniformity over 85%, the optimal pressure of between 0.2 and 0.8 MPa.

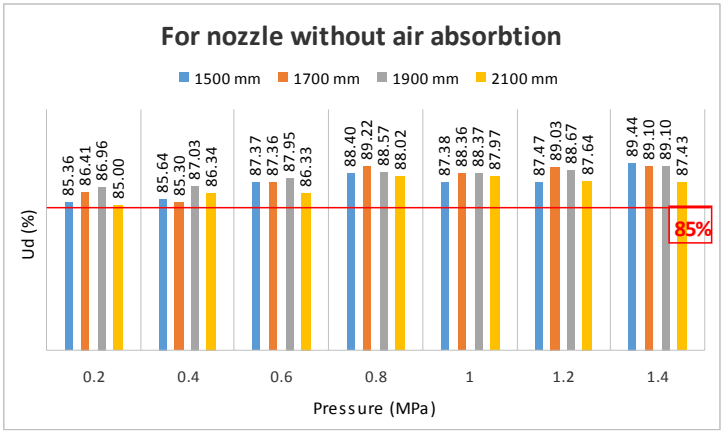


Figure 10 **Solution dispersion uniformity on the working height of the nozzles without air absorption, at different distances from spraying machine axis and different working pressures**

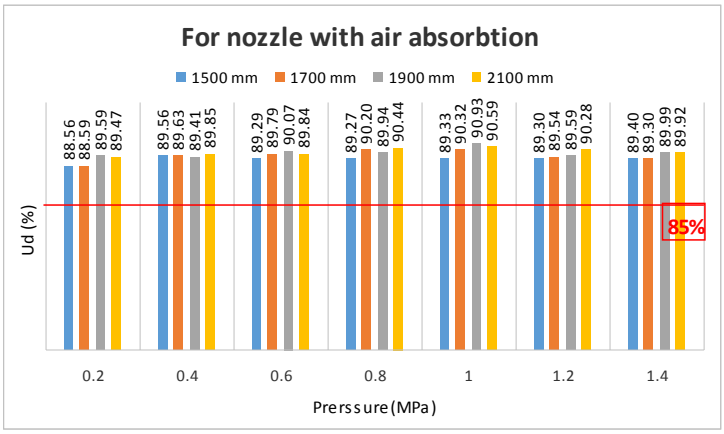


Figure 11 **Solution dispersion uniformity on the working height of the nozzles with air absorption, at different distances from spraying machine axis and different working pressures**

## CONCLUSIONS

From the obtained results, the investigations shows that the nozzles absorption of air, compared to those without absorbing air, makes a better uniformity of dispersion at all work pressures and all distances layout of the stand to the axis machine spraying.

## ACKNOWLEGMENTS

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# SELECTION OF THE *OCIMUM BASILICUM* L. BREEDING MATERIAL AND PROSPECTIVE HYBRIDS IN IMPROVEMENT PROCESS

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**Abstract**

This paper presents the results of research to improve the species Ocimum basilicum L. in the collection of spicy and aromatic plants of Botanical Garden (Institute) ASM, comprising approx. 20 basil varieties of diverse origin. The primary goal of basil improvement is obtaining seasoning forms for fresh consumption and for drying with special taste qualities, pleasant aroma, no stinging shades, properly leafy, small and medium, to be grown in containers, without neglecting productivity and tolerance to diseases and pests. Using the intraspecific hybridization between parental forms *O. basilicum* var. *chamaeleonicum L., O. basilicum* cv. *Siam Queen, O. x citriodorum L., O. basilicum* var. *minimum (L.) Danert, O. basilicum* cv. *Opal-mini, O. basilicum* var. *purpurescens Benth.,O. basilicum* cv. *Purple Ruffles* and the individual and mass selection, eight hybrids have been identified in which improved quality, productivity and appearance are seen, confirmed by the morphometric measuring.

**Key words**: basil, hybrid, improvement, *Ocimum basilicum,* selection.

Compared to achievements in breeding of food, industrial, ornamental plants, improving and selecting culinary varieties in Moldova were not a priority for some time (Chisnicean L., 2012). The multitudes of registered varieties belong to foreign breeders, or the varieties registered earlier in the country have been improved. In coriander, thyme, basil etc. local varieties and populations obtained by cross-pollination are grown, having a poor production potential. The seeds used to produce fresh seasoning material sold in the country are imported or locally produced. Fundamental breeding works were carried out in Georgia, Azerbaijan, Romania, USA (Lawrence B. *et al*, 1980; Plugaru V., 1996). Basil is used fresh or dried as a condiment, for garnishing dishes, preparing vinegar, oil and spiced wine, therefore besides improving productivity, an enhanced quality of basil, *Ocimum basilicum* is sought, obtaining new forms for salad or as a dry condiment, with high taste properties, properly leafy, with high content of active ingredients, with high productivity, resistant to diseases and unfavorable environmental factors (drought, frost), suitable for mechanized harvesting etc. The article contains the description of the results obtained during three years of works to improve the *O. basilicum* variety: initial material used the qualitative value of the resulting hybrids (culinary and technological qualities, appearance).

## MATERIAL AND METHOD

Basil varieties of various origin, including 5 domestic varieties (cv.*Lamaita,* cv. *Frunza verde,* cv.*Cretisor,* cv. *Purpuriu,* cv. *Opal-mini*) (Chisnicean L., 2012), varieties selected abroad *Albahaca* (Mexico), *Ararat* (Georgia), *Filosof* (Ukraine), *Sweet Leaf* (Poland), *Siam Queen*, *Purple Ruffles* and some varieties *O. basilicum* var. *cinammonum* (Turkey, Ukraine, Germany), *O.* x *citriodorum* L. (Germany), *O.basilicum* var. *minimum* (L.) Danert (Italy), O. *basilicum* var. *difforme* Benth. (Poland, Russia), *O. basilicum* var. *purpurescens* Benth. (Poland, Italy). The basil is a material with a very strong genetic variability. The response of basil varieties in the introduction collection was studied by sowing seeds obtained from free pollination over a longer period (Girenko M.N., 1975; Ceapoiu N., Potlog A., 1990). Following the annual selection forms with constant features of adaptation to local climate conditions were selected, which make up nowadays the named collection. Seven parental forms were selected among them *O. basilicum* var. *chamaeleonicum* L., *O. basilicum* cv. *Siam Queen, O.* x *citriodorum* L., *O. basilicum* var. *minimum* (L.) Danert, *O. basilicum* cv. *Opal-mini, O. basilicum* var. *purpurescens* Benth., *O. basilicum* cv. *Purple Ruffles* for intraspecific hybridization. Using forced pollination the female parent flowers were castrated, isolated, pollinated with pollen collected from the parent pattern and isolated again until separate harvesting of hybrid combinations. Further repeated individual and mass selection is used to assess the recombination capacity until constant

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forms are obtained. The produced hybrids have been subject to morphometric measurements for assessing their quality and productivity.

## RESULTS AND DISCUSSIONS

Improvement works started as a selection of the most valuable forms of basil, which have a higher adaptive potential, with the prospect of performing new varieties. Since the aim is to obtain small culinary varieties the following were chosen for hybridization: *O. basilicum* var. *chamaeleonicum*, *O. basilicum* var. *minimum*, *O. basilicum* cv. *Siam Queen*, *O. basilicum* cv. *Opal-mini*, which are small and medium, *O.* x *citriodorum* for increased content of limonene and *O. basilicum* var. *purpurescens*, *O. basilicum* cv. *Purple Ruffles*, for anthocyanin and the increased number of leaves. In the second year all seeds of hybrid combinations were sown and valuable hybrids selected. In the third year, the number of plants allowed the morphometric measurements of these hybrids to assess productivity and qualitative value.

Hybrids $1F_2$ (*figure 1*) and $4F_2$ (*figure 2*) are products of the crossing of *O. basilicum* var. *chamaeleonicum* ♀ x O. *basilicum L.* cv. *Siam Queen* ♂. $1F_2$ is dwarf sized (25.3 cm) has purple inflorescence shades, many leaves, spicy smell and pleasant taste. $4F_2$ is small (45.2 cm), with short pink flowering, round bush, increased number of leaves, a pleasant smell of cloves.

Figure 1 **Hybrid $1F_2$**

Figure 2 **Hybrid 4 $F_2$**

Hybrid $2F_2$ (*figure 3*) with parents *O. basilicum* cv. *Siam Queen* ♀ x *O. basilicum* var. *chamaeleonicum* L. ♂ is small (46.1 cm), with short inflorescences, round-oblong bush, increased number of leaves, pleasant spicy smell and taste.

Hybrid $3F_2$ (*figure 4*) is the result of hybridization of *O. basilicum* var. *chamaeleo-nicum* L. ♀ x *O. basilicum* var. *citriodorum* L. ♂, is short (42.2 cm), with medium inflorescences, increased number of leaves, a pleasant lemon scent. To increase the amount of limonene, up to 4-5 backcrosses will be performed.

Figure 3 **Hybrid $2F_2$**

Figure 4 **Hybrid $3F_2$**

Hybrid $5F_2$ (*figure 5*) has *O. basilicum* var. *minimum* ♀ x *O. basilicum* cv. *Siam Queen* ♂ as parents. The hybrid is short (54.2 cm), has medium pink inflorescences, long bush, increased number of medium leaves, pleasant intense smell of cloves.

Hybrid $6F_2$ (*figure 6*) obtained by crossing *O. basilicum* cv. *Siam Queen* ♀ x *O. basilicum var. minimum* ♂ is medium long (57.1 cm), short pale pink inflorescences, an increased number of medium leaves, pleasant intense smell of cloves and allspice.

Figure 5 **Hybrid $5F_2$**

Figure 6 **Hybrid $6F_2$**

Hybrid $7F_2$ (*figure 7*) resulted from hybridization of *O. basilicum* cv. *Opal-mini* ♀ x *O. basilicum* var. *purpurescens* ♂ is medium long (56.2 cm), with short purple inflorescences, increased number of medium leaves with toothed margins, which provide a decorative aspect, intense fragrance of cloves and allspice. Hybrid $8F_2$ (figure 8) with parental forms *O. basilicum* cv. *Opal-mini* ♀ x *O. basilicum* cv. *Purple Ruffles* ♂- has a medium height (57.8 cm), short purple-violet inflorescences, increased number of medium leaves with a toothed margin, which gives it a decorative aspect, pleasant intense smell of cloves and allspice.

Figure 7 **Hybrid 7F₂**

Figure 8 **Hybrid 8F₂**

Hybrids whose parental forms contain anthocyanin, have inherited this pigmentation, and its intensity varies from pigmented flowering to hybrids with anthocyanin coloration, hybrids with pigmentation on all organs, which have both parents with anthocyanin.

The morphometric measurements show that hybrids $1F_2$, $2F_2$, $3F_2$, $4F_2$ that have *O. basilicum* var. *chamaeleonicum* L., small height, have inherited this feature, their height ranging from 25.3 to 46.1 cm. The other hybrids are midsized (54.2 - 57.8 cm) (*table 1*).

Table 1

**Central stalk height at harvest, cm**

| Hybrid | Min. value | Max. value | Average value X | P% Error | DL05 Limit difference |
|---|---|---|---|---|---|
| $1F_2$ | 24.9 | 25.8 | 25.3 | 4.5 | 2.3 |
| $2F_2$ | 45.9 | 46.5 | 46.1 | 4.7 | 3.1 |
| $3F_2$ | 41.8 | 42.5 | 42.2 | 5.0 | 3.0 |
| $4F_2$ | 45.0 | 45.5 | 45.2 | 5.4 | 3.4 |
| $5F_2$ | 54.0 | 54.5 | 54.2 | 4.5 | 3.4 |
| $6F_2$ | 57.0 | 57.4 | 57.1 | 4.4 | 3.5 |
| $7F_2$ | 56.0 | 56.4 | 56.2 | 4.4 | 3.5 |
| $8F_2$ | 57.6 | 58.0 | 57.8 | 4.3 | 3.5 |

Mass green production of a plant ranges from 102.8 g for $1F_2$ to 110.8 g for $8F_2$. There is no correlation between the plant size and mass green production, since the small hybrids are more branched and leafy than those with average size and are not worse in terms of mass green production per plant (*table 2*).

Table 2

**Mass green production per plant, g**

| Hybrid | Min. value | Max. value | Average value X | P% Error | DL05 Limit difference |
|---|---|---|---|---|---|
| $1F_2$ | 102.1 | 103.2 | 102.8 | 2.2 | 3.2 |
| $2F_2$ | 109.5 | 110.2 | 110.0 | 2.9 | 4.1 |
| $3F_2$ | 104.8 | 105.5 | 105.2 | 3.0 | 4.5 |
| $4F_2$ | 105.5 | 106.0 | 105.6 | 3.2 | 4.5 |
| $5F_2$ | 106.7 | 108.0 | 107.6 | 3.1 | 4.7 |
| $6F_2$ | 107.4 | 107.8 | 107.5 | 3.4 | 4.7 |
| $7F_2$ | 109.9 | 110.6 | 110.4 | 3.0 | 4.7 |
| $8F_2$ | 110.6 | 111.0 | 110.8 | 3.1 | 4.9 |

The production of fresh leaves per plant ranges from 47.5 g at $3F_2$ to 56.1 g at $8F_2$. The largest number of leaves is in the hybrid 6F2 (51.3%), while the lowest one in $3F_2$ (45.1%) (*table 3*).

Table 3

**Fresh leaves production per plant, g**

| Hybrid | Min. value | Max. value | Average value X | P% Error | DL05 Limit difference | Share of leaves, % |
|---|---|---|---|---|---|---|
| $1F_2$ | 48.0 | 48.5 | 48.2 | 2.3 | 3.2 | 46.8 |
| $2F_2$ | 51.2 | 51.6 | 51.4 | 2.6 | 3.9 | 46.7 |
| $3F_2$ | 47.4 | 47.8 | 47.5 | 2.8 | 3.2 | 45.1 |
| $4F_2$ | 50.2 | 50.7 | 50.3 | 2.6 | 2.9 | 47.6 |
| $5F_2$ | 51.9 | 52.6 | 52.3 | 2.5 | 2.9 | 48.6 |
| $6F_2$ | 55.3 | 55.6 | 55.4 | 2.5 | 2.9 | 51.3 |
| $7F_2$ | 55.4 | 55.8 | 55.7 | 2.4 | 3.1 | 50.4 |
| $8F_2$ | 55.9 | 56.4 | 56.1 | 2.1 | 2.9 | 50.6 |

The mass of fresh stalksranges between 52.1 g at $6F_2$ and 58.4 g at $2F_2$. Hybrids ($1F_2$-$5F_2$) whose genitors are *O. basilicum* var. *chamaeleonicum* and *O. basilicum* var. *minimum* (L.) Danert, forms with many branches of the stalk, have a higher share of stalks than leaves (51.4% -54.9%), except the hybrid $6F_2$, in which the leaves prevail (51.3%) *(table 4*).

Table 4

**Fresh stalks production per plant, g**

| Hybrid | Min. value | Max. value | Average value X | P% Error | DL05 Limit difference |
|---|---|---|---|---|---|
| $1F_2$ | 53.9 | 54.9 | 54.3 | 2.4 | 3.3 |
| $2F_2$ | 58,1 | 58.9 | 58.4 | 2.1 | 3.5 |
| $3F_2$ | 57.0 | 57.9 | 57.7 | 2.3 | 3.5 |
| $4F_2$ | 55.0 | 55.7 | 55.3 | 2,4 | 3.3 |
| $5F_2$ | 55.0 | 56.9 | 55.3 | 2.3 | 3.4 |
| $6F_2$ | 51.8 | 52.4 | 52.1 | 2.1 | 3.3 |
| $7F_2$ | 54.2 | 55.1 | 54.8 | 2.4 | 3.5 |
| $8F_2$ | 54.5 | 55.1 | 54.7 | 2.3 | 3.5 |

Hybrids obtained meet the set goals (green mass productivity with outstanding organoleptic qualities, shorter vegetation period, resistance to diseases, pests, drought, etc., but also the appearance of the bush) and will be analyzed further in order to select the forms to be proposed as varieties.

## CONCLUSIONS

The original material for improving *Ocimum basilicum* included basil varieties of diverse geographical origin of the Botanical Garden (Institute) of the Academy of Sciences of Moldova collection.

Following intraspecific hybridization, of the seven selected genitors more hybrids resulted, of which eight were selected as meeting the objectives.

Hybrids are forms for salad, possessing appropriate organoleptic features (pleasant taste and smell with notes of clove, allspice or lemon).

Hybrids have small or medium size, rounded or upward bush, which makes them suitable for growing in containers or using as decorative plants.

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# SOME MEDICINAL PLANTS GATHERED FROM NATURAL AREAS

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**Abstract**

The Black Sea Region located in temperate climate zone of Turkey has quite rich flora and vegetation. In this vegetation, there are many medicinal plants that consumed and collected from the nature by local people. The most common ones are; *Trachystemon orientalis*, *Ornithogalum sigmoideum/O. orthopyllum*, *Oenanthe pimpinelloides*, *Smilax aspera, S. excelsa* and *Urtica dioica*. The plant mixture is defined as "yazı pancarı" by local people who contain several different plant species. The present study gathered data from public market surveys about consumed parts of plants, medicinal properties of them, encountered problems of collectors and consumers, future threats awaiting these plants, the issues to be considered in terms of consumption of some of these gathered plants from nature in villages of Samsun province and districts.

**Key words**: *Trachystemon orientalis*, *Ornithogalum. sigmoideum*, *Smilax aspera*, medicinal properties

The plants collected from Samsun province and consumed by local people are quite different from the ones collected from the other Black Sea coastal provinces. Medicinal characteristics of these plants passed traditionally from one generation to another and reached to today. In previous researches based on such information, it was reported that *Plantago major* and *P. lanceolata*, *Urtica dioica*, *Smilax excelsa*, *Malva slyvestris* were used for eczema, stomach and kidney diseases, asthma, coughing, diabetes, wound healing and various other purposes (Tuzlacı and Tolon, 2000; Tuzlacı and Aymaz, 2001), *Plantago intermedia* and *Trachystemon orientalis* had antimicrobial characteristics (Bown, 2002; Uzun *et al*, 2004), *Ornithogalum* species were used as appetizer, emetic, laxative (Sargın et al, 2013), hearth spasm reliever and hearth regulator (Thaler et al, 2009).

## MATERIAL AND METHOD

The data gathered in this study were composed of partial data of an ongoing research initiated in 2007 about botanical and local names, collection times, collection methods, consumption quantities and consumption methods of the medicinal plants collected from the nature in central and town villages of Samsun province of Eastern Black Sea region and brought to local bazaars. Since the first section of resultant data and detailed information about material and methods were provided in a paper entitled as "The concumption of some plants gathered from nature in Eastern Black Sea Region" published in proceedings of VIII Field Crops Congress held on 19-22 November 2009 in Turkey, these information were not provided in detail in this paper.

## RESULTS AND DISCUSSIONS

Survey and observations revealed that plants were collected and consumed based on climate conditions between the first week of March and solstice on 21 June, plants were collected out of settlement sites mostly from pasture and meadows, forest sites, beneath hazelnut trees, fallow lands, winter plowed lands to be sown in spring. Face-to-face meeting with collectors and consumers revealed that plant consumption modes were generally similar to each other, almost all of them were consumed after boiling and filtering the extract (some consumers prefer steaming), some were consumed through frying with onion and egg, *Trachystemon orientalis, Oenanthe pimpinelloides*, *Ornithogalum* and *Smilax* species were mostly pickled (Arslanoğlu and Yalçın, 2009) and these pickles were sometimes consumed in winter as "fried pickle". Interviews also revealed that local people consume nettle soup with corn flour or farina at least once in spring of each year just because of health benefits they believe in (Anonymous, 2015). Some information about the most common plant species collected from the

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nature, brought to local bazaars in Samsun province and consumed by the local people are provided below:

***Trachystemon orientalis* L. (*Boraginaceae*)**

**Local names:** Kadırayak, Kaldirik, Zılbıt, Deve pancarı, Ispıt, Acı Hodan, Doğu Hodanı, Tomara,

**Plant characteristics:** Flowery, shoots can reach to 30–40 cm heights, with dark rhizomes underground, perennial herbaceous plant. It commonly grows in humid, shadow and semi-shadow sites with high organic matter contents. It propagates with rhizomes.

**Composition:** Chemical composition includes tannin, essential oils, nitrate salts, mucilage, saponin and resin.

**Utilized plant sections and type of consumption:** Rhizomes and flowery fresh shoots, fresh leaves collected in February-March are fired with onion and egg and consumed as a spicy dish or used as patty base. Leaves can be used for stuffing. In May-June, rhizome and shoots become fibrous and mucilage content increases, therefore these sections are not consumed in these months. Only fresh petioles are collected and pickled (Baytop, 1999; Özbucak et al, 2006; Arslanoğlu and Yalçın, 2009; Anonymous, 2015).

**Effects:** Diuretic, blood purifier, reliever, mucolytic, fever reliever and digestion facilitator (Baytop, 1999; Arslanoğlu and Yalçın, 2009).

***Ornithogalum sigmoideum*** Freyn & Sint./***O. orthopyllum*** Ten.

**Local names:** Sakarca, Akyýldýz, Çiđdem, Tükrük otu

**Other species:** *Ornithogalum comosum* L., *Ornithogalum lanceolatum*, *Ornithogalum latifolium* Baker, *Ornithogalum pyrenaicum* L., *Ornithogalum sibthorbii* W. Greuter

**Plant characteristics:** Plant height is around 15-20 cm, perennial herbaceous plant with white flowers. It commonly grows in barren soils without soil tillage, beneath hazelnut trees and natural pastures. Flowery bulbs are collected for 2 months starting from February. It propagates with bulbs and seeds.

**Composition:** Bulbs contain convallatoxin, other glucosides and saponin (Baytop, 1999; Thaler et al, 2009).

**Utilized plant sections and type of consumption:** In March-April, plant is collected from the emergence of leaves aboveground to the end of flowering. Leafy and flowery bulbs are consumed as vegetable. Fresh bulbs and above soil sections are also fried, used as salad or canned food (Arslanođlu and Yalçýn, 2009; Kızılarslan and Özhatay, 2012).

**Effects:** Appetizer, nerve tonic, laxative (Sargın et al, 2013), hearth spams relieving and hearth regulator and protector (Thaler et al, 2009), emetic and suppurate (Baytop, 1999).

***Oenanthe pimpinelloides* L.** (Apiaceae)

**Local names:** Kazayağı, Gazyak, Deli maydanoz

**Plant characteristics:** It is a perennial herbaceous plant. Leaves are similar to parsley, but darker and deeper bladed. White flowers are in umbel form and located at branch tips. It usually grows in barren sites and underneath hazelnut trees. It propagates with seeds.

**Composition:** It contains cymene, germacrene and β-caryophyllene essential oil components (Baldini et al, 2009).

**Utilized plant sections and type of consumption:** The plant is collected and consumed by local people in February-March-April until bolting period through cutting from root canopy. Collected leafy stem is boiled and pickled, salad is made either from fresh or boiled leaves, it is also served with yoghurt or fired. It is also used as patty base with green onion and skim-milk cheese. The plant is also roasted with or without tomato paste and egg (Arslanoğlu and Yalçın, 2009; Baldini et al, 2009).

**Effects:** It is known by local people as appetizer and digestive system stimulant (Anonymous, 2015).

***Smilax aspera L., S. excelsa* L.** (Smilacaceae)

**Local names:** Kırçan, Dikenucu, Melevcan, Özdikeni, Gıcır

**Plant characteristics:** Plant height can reach to 15-20 m, it is a perennial, thorny and climbing plant. It usually grows along field borders, within shrubs along the land borders, macquis sites and forest sides. It is propagated with the seeds extracted from ripened red fruits in autumn, with shoot scions taken in spring or root shoots.

**Composition:** Chemical composition includes phenylpropanolide glucosides, anthocyanins, flavonoid glucosides and steroidal saponin (Dall'Acqua et al, 2008; Bown, 2002).

**Utilized plant sections and type of consumption:** Reddish shoots developed over branch tips are collected from Samsun and surroundings in March-April-May until lignification of the shoots. These young shoot tips are boiled, fried with anion, mixed with yoghurt and consumed as salad. These shoot tips are also pickled or canned for later uses (Arslanoğlu and Yalçın, 2009; Anonymous, 2015).

**Effects:** It is used in treatment of toe cracks (Tuzlacı and Tolon, 2000). The plant has blood

purifying and urine increasing (Anonymous, 2015), wound healing, mucilage, diaphoretic, intestinal disease and cough relieving, anti-inflammatory, anti-rheumatic, anti-spastic and fever reducer effects (Dall'Acqua et al, 2008).

***Urtica dioica*** (Urticaceae)

**Other species:** *Urtica pilulifera* L., *Urtica urens* L.

**Local names:** Büyük Isırgan Otu, Isırgan, Sırgan, Kupriva, Gidişken

**Plant characteristics:** Based on growing conditions, plants can reach to heights of 30-150 cm. It is a perennial herbaceous plant. It has serrate leaves with mordant hairs. The plant has quite strong root system. Small flowers with cream color blossom at beneath the leaves at the beginning of summer. It is propagated with seeds and rhizomes. The plant mostly grows in forest shrubs, rocky and stony sites and gardens, underneath hazelnut trees and almost everywhere.

**Composition:** Plant leaves contain a glucoside called urticosite, potassium salts, calcium nitrate, organic acids, histamine and acetylcholine (mordant substance), vitamin C (Baytop, 1999), flavone, iron, betasitosterin, sterylglucoside, lignin and seeds contain mucilage, proteins, fixed oil, carotenoid and roots contain tannin, sterolen, lignin (Eröztürk, 2004).

**Utilized plant sections and type of consumption:**Generally leaves and shoots are used. Plants are collected from Samsun and surroundings starting from a period of 2-4 leaved stage in spring until flowering period (Arslanoğlu and Yalçın, 2009). The soup made with young shoots and corn flour is consumed at least once in every year by local people. It is also boiled, spiced and puree is mixed with yoghurt, consumed as salad, used as patty base (Anonymous, 2015).

**Effects:** The plants is known with their health benefits in kidney diseases, prevention of some cancer types, respiratory track diseases, prevention of atrichia, paralysis, tension, stomach ache, rheumatism, fungal infections, osteoporosis, eczema and eczema-induced pains, gynecological diseases, kidney stones, digestive and hemorrhoid. It was also stated by collectors and consumers that plants improved immune system, stimulated digestive system and should definitely be consumed in season for rhemutic pains (Anonymous, 2009 and 2015).

**Encountered and expected problems:**

Although plant species grows in places as specified above, *Urtica dioica* L. and *Oenanthe pimpinelloides* L. are commonly encountered at road sides and wastewater sites. These medicinal plants have quite high market values and there aren't any costs of production for them. Since collectors consider only the quantities of plant as much as possible, sometimes plants may come from unclean sites to bazaars.

According to hearsay knowledge, *Urtica dioica* L. species are good for some serious diseases like cancer. However, there is no information about which parts of the plant are good for which cancer of diseases, about how and how much and when to use, about patients to use these plants without any doctor consultations. Such unconscious uses may then result in several undesired/unexpected cases.

Compared to season vegetables, these medicinal plants quite higher market prices (for instance, while spinach is 2.0 TL/kg, *Trachystemon orientalis* and *Ornithogalum* is 5TL/kg). Some medicinal plants are collected while they are flowery with bulb and rhizomes. *Ornithogalum* species are geophyte and they are commonly collected with bulbs when the flower buds are seen. In this way, two propagation materials are consumed together. With these uncontrolled excessive collections, plants are endangered continuously day by day. Another problem is encountered in *Trachystemon orientalis* collected with rhizomes and flowery shoots. The plant propagated with rhizomes and young rhizomes are collected every year. The price of both species are almost twice as much when the first brought to bazaars in mid-February or early March. Thus, collectors collect the plants without leaving any material for propagation. Such cases ultimately end up with significant distortions in nature for *Trachystemon orientalis* and *Ornithogalum* species.

## CONCLUSION

It is quite significant for consumer health and collector income that plants should be collected from clean sites in a controlled fashion as to allow plants to keep their existence. Besides reducing the pressure over natural flora, works should be initiated for standard and sustainable production and culture of these plants to market these valuable plants to other regions apart from local bazaars. Researches already initiated on propagation methods, cultural techniques, proper collection and processing methods for the medicinal plants mentioned in this study.

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# FOOD QUALITY OF SOME VEGETABLES AND FRUITS JUICES

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**Abstract**

Fruits and vegetables juices are those drinks which are obtained by mechanical procedures (pressing, centrifugation) or by diffusion and which are conserved using different methods (concentration, chemical conservation, pasteurization). The juices with pulp or the nectars preserve the nutritional value of the products from which they come, but they are exposed to sedimentation.

Five types of juices with pulp obtained from apples, pears, carrots, tomatoes and a blend (1:1:1 apples, pears, carrots) were analyzed regarding the efficiency of converting in juice, acidity, sugars, the content of C vitamin, nitrates and nitrites. The efficiency in juice for all the utilised variants was within the values found in the speciality literature. The results regarding the acidity and C vitamin revealed smaller values of those characteristics in natural juices with pulp in comparison with the similar juices from the supermarket for with those characteristics are adjusted.

**Key words**: Juices, fruits, pears, blend, efficiency in juice

"Always, human found in nature all the vegetal materials and minerals necessary for keeping his health and beauty. Over millions of years, the therapeutic capacities of the plants were experienced and their extraordinary properties were transmitted from generation to generation, firstly verbally and then in writing. We can say without doubt that the plants were, since ancient times, used as medicine" (Xaël de Sainte-Breuves, 2001).

Vegetables are fresh and edible parts of the herbaceous plants. Those are imporatnt as nutrition, with benefical effects for mentaining health and preventing the diseases. Also, they are known for the carbohydrates, vitamins and minerals content. They can be represented by edible roots, strains, leaves, fruits or seeds. Each group leads to some benefits for the organism. (Robinson DS., 1990, Hanif R. *et al*, 2006).

The natural juices obtained from fruits, vegetables and other green plants, planted or spontaneous, were used since ancient times for preventing and treating the diseases. They are important because of their content full of organic components, which are easy to assimilate.

The advantages of the introduction of fresh juices in our daily menu are indisputable. The juices with pulp or the nectars preserve the nutritional value of the products from which they come. What is considered a problem for this method is avoiding the sedimentation (Stoica F., 2007).

## MATERIAL AND METHOD

The experiences were made in 2015, organized as a bifactorial experience.

**A factor** – ***assortment with five graduation***

- **$a_1$** apple juice
- **$a_2$** pears juice
- **$a_3$** carrots juice
- **$a_4$** tomatoes juice
- **$a_5$** apples+pears+carrots juice(1:1:1)

**B factor** – ***provenance with two graduations***

- **$b_1$** own
- **$b_2$** supermarket

Methods for determining the chemical analysis:

- dry soluble substance from fresh fruits, vegetables and nectar – refractometric method (Bota T.M., 2013)
- acidity – titrimetric method (Bota TM., 2013)
- determining the sugars – Schoorl method (Muste S. and Mureşan, C., 2011)
- C vitamin – iodometric method *(Bratu et al,* 2008)
- nitrates and nitrites content – photometric method (*Bota,T M., 2013*)

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## RESULTS AND DISCUSSIONS

The efficiency in juice (*figure 1*) was determined from converting fresh fruits and vegetables in juice with pulp. The efficiency of the juice was determined from a kilo of fresh product, by squeezing and measuring in cylinder.

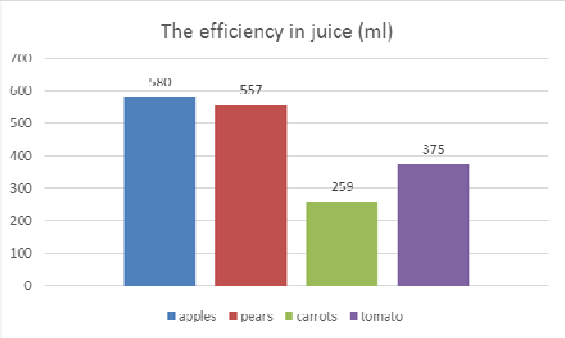


Figure 1 **The efficiency in juice of the studied fruits and vegetables, ml/kg**

It can be observed that the efficiency in juice has high values for all the experimental variants, with a maximum of 580 ml/kg for apples and a minimum of 25 ml/kg for carrot, which have a high content in vegetal fiber (figure 1).

The lowest value for tomatoes is caused by the period when the experience have been made, in october, when the product was processed. In figure 2, it can be observed that the lowest refractometric extract is obtained for the tomatoes juice (5,20 %) and the highest extract is obtained from the pears juice from supermarket (12,2 %); the differences from the assortments of juice from supermarket are caused by the fact that there were not added sugars or glucose syrup, regardless the product used for processing.

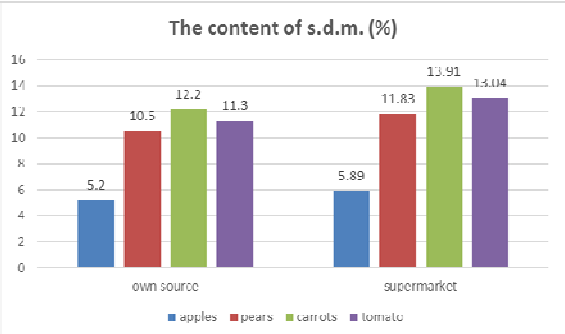


Figure 2. **The content of s.d.m. (%) from the analyzed fruits and vegetables juices**

The lowest value for the juices acidity is registered for carrots, regardless the provenance, followed by the blend and the pears juice (table 1). For the similar assortments of juice from supermarket, the highest acidity is caused by the addition of citric acid, while for the natural juices from own source there were not added acidifiers. The increased acidity of the products contributes to their conservation, decreasing time-temperature value pair to thermal penetration.

Table 1

**The organic acids content of the studied vegetables and fruits juices**

| ACIDITY IN JUICE (malic acid %) | | |
|---|---|---|
| ***Variants*** | ***Provenance*** | |
| | **Own** | **Supermarket** |
| Apple juice | 0.57 | 0.65 |
| Pear juice | 0.46 | 0.62 |
| Carrots juice | 0.40 | 0.50 |
| Tomatoes juice | 0.78* | 0.87* |
| Blend (1:1:1) (apples, pears, carrots) | 0.43 | 0.58 |

(* citric acid%)

The increased content of sugars correlated with the decreased values of acids content sweetens the juices.

It can be observed that even without any addition of sucrose and glucose, the natural vegetables and fruits juices obtained in this study bring a valuable contribution of reducing sugars, the registered valuest being within 5,99 mg/100 g and 11,19 mg/100 g (table 2).

Table 2

**The content of sugar in the studied vegetables and fruits juices**

| SUGAR (mg/100 g) | | |
|---|---|---|
| ***Variants*** | ***Provenance*** | |
| | **Own** | **Supermarket** |
| Apple juice | 10.50 | 11.92 |
| Pears juice | 11.19 | 13.07 |
| Carrots juice | 7.33 | 8.12 |
| Tomatoes juice | 5.99 | 7.25 |
| Blend (1:1:1) (apples, pears, carrots) | 8.60 | 9.62 |

The C vitamin obtained in a natural way is found in important quantities in fresh vegetables and fruits. It is destroyed very easy by exposing to high temperatures, to light, oxygen and water, being a hydrosoluble vitamin (*http://www.realvitaminc.com/ascorbic-acid.html*).

Since the pasteurisation is a usual method in food industry, for conserving food and killing bacteria, it was used the supplementation of ascorbic acid, which were meant to replace the C vitamin from the food where it is destroyed.

The values presented in table 3 show the quantity of ascorbic acid for all the variants from supermarket, which were supplemented with ascorbic acid, to correct their taste, to conserve them well or to prevent light oxidation.

Table 3

**The content of C vitamin (ascorbic acid) in the studied vegetables and fruits juices**

| C VITAMIN (ascorbic acid mg/100 g) | | |
|---|---|---|
| ***Variants*** | ***Provenance*** | |
| | **Own** | **Supermarket** |
| Apple juice | 12.20 | 13.65 |
| Pears juice | 11.63 | 13.06 |
| Carrots juice | 5.32 | 6.89 |
| Tomatoes juice | 6.67 | 8.73 |
| Blend (1:1:1) (apples, pears, carrots) | 6.39 | 8.23 |

The biggest fertilization error is to apply excessive doses of chemical fertilizers based on nitrogen, accumulating, thus, in vegetable products, big quantities of nitrates, wich, in the human body, are converted in nitrites, producing phenomena of intoxication and diseases.

Regarding the toxicity of those substances, the dose established by O.M.S. for nitrates is of 5 mg/kg/body for an adult and of 0.2 mg/kg/body for nitrites (Hura C., 2007).

In *table 4* there are registered the values obtained from the studied vegetables and fruits juices.

Table 4

**The content of nitrates in the studied vegetables and fruits juices**

| NITRATES (mg/1000 ml) | | |
|---|---|---|
| ***Variants*** | ***Provenance*** | |
| | **Own** | **Supermarket** |
| Apple juice | 183.57 | 227.67 |
| Pears juice | 173.33 | 221.20 |
| Carrots juice | 199.60 | 317.06 |
| Tomatoes juice | 143.66 | 450.79 |
| Blend (1:1:1) (apples, pears, carrots) | 167.66 | 201.17 |

Table 5

**The content of nitrites in the studied vegetables and fruits juices**

| NITRITES (mg/1000 ml) | | |
|---|---|---|
| ***Variants*** | ***Provenance*** | |
| | **Own** | **Supermarket** |
| Apple juice | 4.23 | 9.13 |
| Pears juice | 5.00 | 10.40 |
| Carrots juice | 2.49 | 8.01 |
| Tomatoes juice | 5.37 | 7.39 |
| Blend (1:1:1) (apples, pears, carrots) | 6.00 | 9,03 |

Considering the agricultural technologies as a main factor of nitrate pollution has lead to their change in last decades, by promoting a new idea regarding the chemical fertilization based on nitrogen (Skriver, 1990). The content of nitrites is a very important element for the appreciation of the food quality.

The content of nitrites in the studied vegetables and fruits juices, presented in *table 5*, shows that the biggest quantity is registered in the juices from supermarket, regardless the assortment

## CONCLUSIONS

The analysis of some characteristics of quality in the studied vegetables and fruits juices showed that for all the analyzed chemical parameters, the obtained results were very close to the average values found in the speciality literature.

Regarding the efficiency in juice, the values were over the average for all the studied vegetables and fruits.

The content of soluble dry substance (s.d.m.) was constant for the fresh products and in juices;

For the juices from supermarket, there were registered increases regarding the acidity, the sugar content and the C vitamin, in comparison with the natural juices from own source, because of the corrections applied for these parameters in the technological process.

The content of the nitrates and nitrites registered lower values, in comparison with the juices from supermarket.

Due to their composition, the vegetabled and fruits cocktails can be used in the daily menu, being an alternative to the consumption of fresh vegetables and fruits.

It is recomended the consumption of the natural juices obtained from fresh vegetables and fruits, with a low content of additives. Those juices can be consumed both by kids and adults, due to their quality of functional food and their protecting role in the human body.

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# SOME ASPECTS REGARDING THE SOLUBLE DRY SUBSTANCE IN TWO VARIETIES OF CARROTS SOWN IN TRANSILVANIA AFTER DEHYDRATION

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**Abstract**

A good source of elements which are a component of the carrots roots highlight its daily consumption, regardless the age. The food importance of the carrot is given by the energetic value, which is higher than other vegetables, thus, for 100 g of fresh substance it assures a quantity within 39.2-46.4 kcal. Dehydration is the technological process in which the vegetables and the fruits lose a certain quantity of water, leading to a phisico chemical phase proper for maintaining the nutritional values and the qualitative aspects, being good for consumption.
The range of variation of the soluble dry substance was within 8.22 (Nantes variety, April, organic) – 13.04 (Flakker variety, April, chemical). The content of s.u.s./fresh product was influenced by the period of harvest. S.u.s., after rehydration, registered the highest values for Nantes variety, regardless the fertilization method and the harvesting period, being a variety prone to rehydrate.

**Key words**: Crop, carrots, dehydration, dry substance

The vegetables are, without any doubt, a valuable source of fiber, C vitamin, A provitamin and antioxidants (Barański R. *et al,* 2003). Due to their antioxidant properties, the consumption of food rich in carotenoids could prevent some forms of cancer (Pavia B., Concepcion R., 2006).

As a nutritional aspect, the carrot has a big importance as a main source of A provitamin, accessible all year round. The fine cellulose tissue and the presence of the pectic substances make the carrot being irreplaceable in the gastrointestinal disorders (Măniuțiu N D., 2008).

A rich source of elements which are components of the carrots roots, highlight its daily consumption, regardless the age.

The food importance of the carrots is given by the energetic value which is highest than the other vegetables, thus, for 100 g of fresh substance, it assures a value within 39.2-46.4 kcal (Iordăchescu C., 1978).

The food value of the carrot is given by the chemical composition and the intake of the vitamis and the mineral salts, which cause the chemical coordination of the energy and morphological vital processes; the study was carried out quoting different authors and it is presented in *table 1*.

Table 1

**The chemical composition of the carrots roots**

| The chemical components | | The value limits |
|---|---|---|
| Water g/100g | | 86.7-88 |
| s.u. g/100g | dried in drying stove at $105^0$C | 12.4-13.6 |
| | with refractometric method | 11.4-20.42 |
| Carbohydrates g/100g | | 6.0-9.0 |
| Protide g/100g | | 0.7-1.5 |
| Lipids g/100g | | 0.2-0.3 |
| Cellulose g/100g | | 0.58-1.6 |
| Calories kcal/100g | | 44.7-70 |
| **Vitamins (mg/100 g s.p.)** | | |
| A vitamin (carotene) | | 5.0-24 |
| C vitamin | | 2.0-7.0 |
| $B_1$ vitamin | | 0.08-0.16 |
| $B_2$ vitamin | | 0.05-0.10 |
| $B_5$ vitamin | | 0.2-2.0 |
| PP vitamin | | 0.3-0.5 |
| E vitamin | | 2.5-3 |
| **Mineral salts (mg/100 g s.p.)** | | |
| P | | 35-70 |
| K | | 290 |
| Mg | | 18-20 |
| Fe | | 0.3-4.0 |
| Ca | | 30-50 |

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## MATERIAL AND METHOD

The experiences were made in 2015, as a trifactorial experience.

- A factor - ***variety with two graduations***
  - **$a_1$** Nantes
  - **$a_2$** Flakker
- B factor - ***seeding with two graduations***
  - **$b_1$** early (March)
  - **$b_2$** late (April)
- C factor - ***fertilization with two graduations***
  - **$c_1$** organic
  - **$c_2$** chemical

Chemistries: – refractometric method (*Bota,T M., 2013*)

- soluble dry substance befor dehydration;
- soluble dry substance after rehydration

Processing was carried out using ANOVA program (Duncan test and Analysis of variance).

In the dehydration process of the horticultural products, there are three successive stages: (Marca Gh., 2004)

*Heating step or period (preheating)* – this step is the one in which the heat from the dehydration space is consumed almost entirely for heating the product subject to dehydration. The step lenght is short. It depends of the characteristics of the warm air and it is not a step of dehydration.

*Dehydration step or period with constant speed* – in this step there occurs free water removal from the product and it lasts until reaching the critical moisture of the product, when is does not diffuse enough water from inside out. In this period, the evaporation rate does not depend on the product nature and it depends on the method of dehydration and the agent used for this method. Misdirection of the product during this period favor the migration of salts, sugars and surface acids, which when the product has reached a critical moisture content, form a crust on the surface and prevents or delays dehydration (*figure 1*).

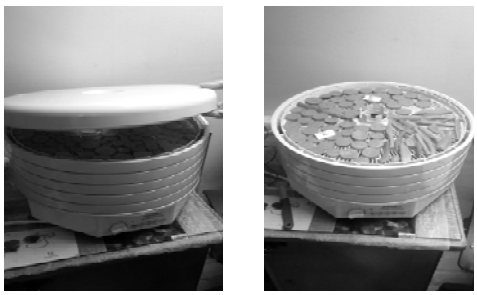

Figure 1 **Dehydration process development**

*Dehydration step or period with decreasing speed* – during this spet, the dehydration rate only depends on the properties of the product (structure and chemical composition) and there is removed from the product a part of the bound water, the colloidal water and partly the absorption water. To this period is given an important attention, because there is a possibility of qualitative degradation (fleshy structure, decreasing the capacity of rehydration). Thus, the temperature of the warm air, in the final phase, must be reduced.

## RESULTS AND DISCUSSIONS

Analysing the combined influence of the three studied factors upon the weight of the carrots befor dehydration (*table 2*), it is found that Flakker variety, sown in March and chemical fertilized, registered the highest weight (46.09 g), with a distinct significant difference of 6.46 g in comparison with the average of the experience.

In decreasing order follows the same variety crop, lately sown and phasial fertilized with chemical fertilizers and the organic fertilized early sown crop.

Regarding Nantes variety, the highest weight is obtained in the early seeding period with organic fertilization, the weight being equal with the average of the experience.

Table 2

**Results regarding the synthesis of the measurements upon the weight of the roots before dehydration according to fertilization/seeding period/cultivar**

| Fertilization Seeding period Cultivar | The weight of the roots before dehydration | | Difference± (t/ha) | Dif. signif. |
|---|---|---|---|---|
| | g | % | | |
| C1 b1 a1 (Mt) | 40.90 | 100 | 0 | Mt |
| **C2 b1 a1** | 38.81 | 94.9 | -2.09 | - |
| C1 b1 a2 (Mt) | 46.09 | 100 | 0 | Mt |
| **C2 b1 a2** | 45.27 | 98.2 | -0.82 | - |
| C1 b2 a1 (Mt) | 41.82 | 100 | 0 | Mt |
| **C2 b2 a1** | 38.52 | 92.1 | -3.30 | 0 |
| C1 b2 a2 (Mt) | 44.46 | 100 | 0 | Mt |
| C2 b2 a2 | 40.61 | 91.3 | -3.86 | 0 |
| DL (p 5%) | | | 3.07 | |
| DL (p 1%) | | | 4.58 | |
| DL (p 0,1%) | | | 7.21 | |

The values obtained upon the weight of the roots after dehydration according to the experimental factors in the experimental year can be seen in *table 2*.

The results regarding the effect of the cultivar show that Flakker variety had, in average, the highest weight, 15.34 g, the differences being significant compared to Nantes variety (*table 2*), thus Flakker variety is superior Nantes variety.

Table 2

**The results regarding the synthesis of the measurements upon the weight of the roots before after dehydration according to the fertilization/seeding period/cultivar**

| Fertilization Seeding period Cultivar | The weight of the bulbs before dehydration | | Difference ± (t/ha) | Difference significance |
|---|---|---|---|---|
| | g | % | | |
| C1 b1 a1 (Mt) | 12.72 | 100 | 0 | Mt |
| C2 b1 a1 | 11.41 | 98.7 | -1.31 | - |
| C1 b1 a2 (Mt) | 15.42 | 100 | 0 | Mt |
| C2 b1 a2 | 15.34 | 99.5 | -0.08 | - |
| C1 b2 a1 (Mt) | 14.94 | 100 | 0 | Mt |
| C2 b2 a1 | 11.54 | 77.2 | -3.40 | - |
| C1 b2 a2 (Mt) | 17.06 | 100 | 0 | Mt |
| C2 b2 a2 | 15.74 | 92.3 | -1.32 | - |
| DL (p 5%) | | | 3,79 | |
| DL (p 1%) | | | 5,96 | |
| DL (p 0,1%) | | | 10,25 | |

The carrots roots (*Daucus carota* L.) are widely used for industrial processing. The carrots produced for the food industry, especialyy those wich are used for the food for kids, must meet strict quality requirements.

The population choice to consume carrots is based on the perceptions regarding their qualities, wich include organoleptic, sensory and nutritive factors (Rubatzky V.E. *et al*, 1999).

In *table 3* it is presented the influence of the experimental factors upon the content of soluble dry substance before dehydration. The values were within 8,22% (Nantes/April/organic) and 13,04% (Flakker/April/chemical), existing statistically differences between the experimental variants.

Table 3

**The combined influence of the experimental factors upon s.u.s. before dehydration**

| Variant | s.u.s before dehydration | Significance |
|---|---|---|
| | % | |
| Flakker/Aprili/chemical | 13.04 | A |
| Flakker/March/organic | 12.99 | A |
| Nantes/April/chemical | 12.00 | B |
| Nantes/March/organic | 11.41 | BC |
| Flakker/March/chemical | 11.23 | BC |
| Flakker/April/organic | 10.80 | BC |
| Nantes/\march/chemical | 8.42 | C |
| Nantes/April/organic | 8.22 | C |
| DS | 1.92-2.11 | |

Analysing the combined influence of the studied factors upon the quantity of soluble dry substance after rehydration accumulated in the carrots roots (*table 4*) there are distinguished the following:

⇒ the variants in the bottom of Duncan league, which have low values of the content of soluble dry substance after rehydration are found in Flakker variety.

⇒ the best variant, regarding this aspect, is Nantes/April/chemical, followed by Nantes/March/organic, with a statistically significant difference

⇒ Flakker variety, lately sown and organic fertilized, accumulates the highest amount of soluble dry substance after rehydration with significant differences compared with the other variants.

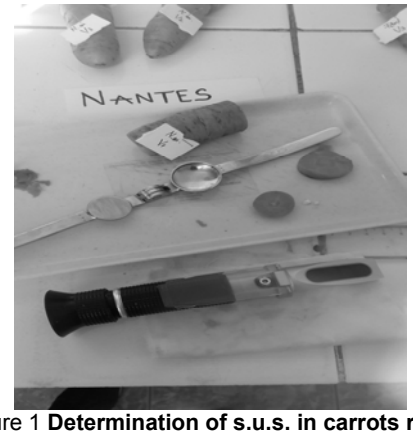


Figure 1 **Determination of s.u.s. in carrots roots before dehydration**

Table 4

**The combined influene of the experimental factors upon s.u.s. after rehydration**

| Variant | s.u.s after rehydration | Significance |
|---|---|---|
| | % | |
| Flakker/April/chemical | 8.84 | A |
| Flakker/March/organic | 8.54 | AB |
| Nantes/Aprili/chemical | 7.05 | BC |
| Nantes/March/organic | 7.00 | BCD |
| Flakker/Aprili/organic | 6.70 | CD |
| Flakker/March/chemical | 5.90 | CD |
| Nantes/Aprili/chemical | 4.45 | D |
| Nantes/Aprili/organic | 3.07 | D |
| DS | 2,33-2,56 | |

## CONCLUSIONS

- The dehydration process is influenced by the cultivar and the content of s.u.s.;
- The studied varieties behave differently in the dehydration process according to the chemical composition (the content of soluble dry substance) of the raw material and of the dehydration factors.
- In the carrots crop with autumn harvesting, for direct consumption, long preservind or industrialization, it is recomenden Flakker variety, sown in first period (March);
- The phasial fertilization for Flakker variety in the early sown crop can be made efficienlty with chemical fertilizers. It is recomended, for phasial fertilizations with fertilizers, Complex III

(16:16:16) applied in total dose of 256 kg/ha, in May-June, every two weeks.

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# RASCH ANALYSIS APPLICATION IN AGRICULTURE

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**Abstract**

Rasch model belongs to Latent Trait Theory and is preferred in survey studies due to its superior properties that convert ordinal scale to interval scale. Most of the surveys and scales used in education, health and social sciences have ordinal scale. In this case the researcher may encounters many problems. For instance; when the raw scores obtained by summing the items used and the correct answers to the survey or scale evaluation it will be plausible to encounter a problem. Thus in order to solve these problems Rash analysis is used. As mentioned, Rasch analyses is commonly used in education, psychometry and rehabilitation fields due to its superior properties. However its application in Agriculture data that are obtained by ordinal scale (*for example, milk and meat quality*) are almost nonexistent. Material of this study consists of ordinal scale data obtained from animal farms. Data generated by RUMM2030 package program are evaluated in Rasch model. As a result, purpose of this study is to show applicability of Rasch analyses which is commonly used health, education and social sciences in agriculture that may also have ordinal scale data.

**Key words**: Rasch analysis, ordınal scale, ıtem characteristic curves.

Rasch model which analysis created by statistician Georg Rasch. Rasch analysis is usually known for specific objectivity and separately parameters. Rasch analysis of the likelihood of an individual to select a category in item and item difficulty level and the difference between the level of people skills it accept that there is a logistic function.

Rasch analysis utilizes both items and the people situated on the only one measurement scale. Subsequently Rasch model examines between people and items interaction.

There are some theories that are used when analyzing the measurement results. When these theories are collected under two main headings; the properties of the Latent Trait Models and Classical Test Theory are specified as (Berberoğlu, 1988; Van der Linden and Hambleton, 1997; Engelhardt, 1992).

Classical test theory against the theory of the properties of implicit methods developed under the 'item response Theory' *(Item response theory)* and 'Rasch', including the development of open, today is still worked to develop two different models.

Rasch analysis of ordinal scale measurements is one of the models used in making the measurements overly intermittent. Items that are obtained by summing the raw scores given responses in case of using the correct scaling, there are some problems. These issues are:

a. Lack of the equal differences between the categories in the surveys or test

Standard analysis method accepts equally between categories difference and scores of responses collects and calculates but in fact the differences are not always equal. So that it means to accept that is equal to the difference between items use raw scores. The distances between items will create a more realistic Rasch Analysis of the actual interval by calculating.

b. All items lacks of equal difficulty situation

As measured on surveys or tests; skill, knowledge, measuring the degree of disability and concepts such as this, all of the items in the test or survey is not on the same point on the scale.

c. Unable to cope with lost data

When calculating raw scores to the item which item unanswered or category has not response, we may came across new problem. Rasch analysis conducts process only with observed values and losses in value are skipped. As a result, no need for correction.

d. Items given unexpected responses may not be determined

Unexpected answers given items generally does not take into account in the analysis. In Rasch analysis determines item difficulty levels and considering individual skill levels due to fit tests (*Infit ve Outfit*) with unexpected answers and

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additional analyses can be made on the cause of unexpected answers.

e. Rasch analysis is creates independent item difficulty index from the sample and independent individuals ability levels from the test

Rasch measurement model according to Classical test theory as different from are able to obtain this data and use these parameters.

Rasch measurement model is a known objective model therefore raw scores is converted to logit values by Rasch analysis which model uses to these values.(*Linacre, 1993*). In this way, the observed values obtained with the logit values based on the ranking of the results of the measurement become with these values of proportional comparison operations as well as multiplication, division, subtraction, and aggregation operations can also be performed.

## MATERIAL AND METHOD

Rasch model is a model created in the framework of the implicit theory(*Latent trait theory*) of features and has its own assumptions (*Rasch, 1966*).These assumptions:

1.The group performed on the talent scale should show normal distribution.

2.In the same proficiency level, items of possibility response on the test are independent of each other and this feature is called ´local independence´.

3.All items in the test is a measure of one-dimensionality and is called `unidimensionality´.

4. In item of tests with luck the probability of finding the right answer is `zero´.

Four model still have developed by the Rasch model

1. Binary (*dual*) Model: The question in the response category 2 of the test (*if available*); For instance; I agree/ I don`t agree or Yes/No.

2. Partial credit model: Each item has its own ordinal scale structure and that give us information at an ever-increasing level of the test item has the answers. This model can predict the parameters of the individual independent is a model that allows us to obtain useful statistics.

3. Many-facet Rasch Measurement Model: Individuals with multiple skill levels + Rigidity/Generosity, the difficulty level of the questions surface, the surface expressions are important in terms of Rasch.

An impartial and effective for measurement makes the standard for combining surfaces in a common plane. Capabilities of persons to perform the task, the difficulty of the question and allows you to compare the behavior of the rigidity and generosity of individuals simultaneously.

4. Ordinal model: For item on any behavior survey or test that the means to identify the n-th step in item the (n-1)-th category to prefer 1st category are considered.

The material of our study consists of ordinal scale obtained from 223 animal farms in the provinces of Isparta and Antalya in the Mediterranean region. In this survey has 83 question and 7 ordinal category. All data was arranged in the SPSS. Then the data were subjected to Rumm2030 program for Rasch analysis.

## RESULTS AND DISCUSSION

The researcher can utilize from Rasch analysis for dicoton response and politon response data. Politon data has 2 alternative model. In this study is based on politon data due to apply to Rating Scale model or Partial Credit model. Distance between thresholds can be equals. In this case the researcher can be used Rating scale model which is determined a threshold and adding the others. Providing that partial credit model is compared to rating model, credit model has superior features. Partial credit model predicts more parameters than rating scale model. Partical credit model assumptions that all distance between thresholds can´t be equal. Therefore in the partial credit model is predicted for each items category threshold. This situation can be tested by ´Likelihood Ratio Test´. As a matter of fact that likelihood ratio test result is significant, can be uses Partical Credit model. Otherwise, used to rating scale model. In this study, Likelihood Ratio Test result is significiant so that used to partial credit model.

In the table 1 shows that Likelihood ratio test probability is 0.00.

Table 1

**Likelihood ratio test**

| Likelihood-Ratio Test | | |
|---|---|---|
| Analysis 1 | Likelihood of | -28,259.02 |
| Analysis 2 | Likelihood of | -28,929.70 |
| Chi Square | | 1,341.37800 |
| Degrees of Freedom | | 245.0 |
| Probability | | 0.000000 |

Examined summary statistics, expected values of item fit residual and person fit residual should be 0 and 1 or the these values should be close each other. Means that it's good adapt to Rasch model. In this study, item residual fit and person fit residual values has almost same values. So in data of this study is well fit to model. Item location and person location indicates capacity of the instrument at hand and measured of data how approximately fit each other. It means that model fits to the items and persons. In the case of Item location result is 0 and person location result is 3, is called miss target.

Table 2

**Summary Statistics**

| Item-Person Interactıon - Includes Extreme Persons | | | | |
|---|---|---|---|---|
| | Items [N=83] | | Persons [N=223] | |
| | Locatio n | Fit Residual | Location | Fit Residual |
| Mean | 0.0000 | 0.9007 | 0.4518 | -0.4880 |
| SD | 0.3112 | 2.3266 | 0.5838 | 3.3245 |
| Skewnes | 0.5161 | 0.1348 | 4.5268 | -0.2298 |
| Kurtosis | 0.2301 | -0.3363 | 36.8843 | -0.5762 |
| | Corr. [locn / Std Resid] | 0.6037 | Corre. [locn / Std Resid | 0.2666 |

Item location and person location results are 1, is called well target .If Item and person mismatch one another, that means is ceiling effect. If Item and person is convergent one another, that means is floor effect. In this study shows that well target and floor effects.

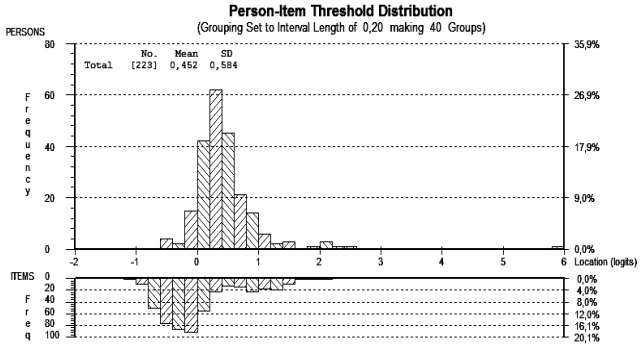


Figure 1 **Person-Item Threshold Distribution**

Summary statistics item table demonstrates power of analysis fit results. Power of analysis of fit is **Excellent** *[Based on SepnIndex of: 0.96150.* Person reliability indicates shows reliability level on the basis of the group and persons with extreme person or without extreme person.

Table 3

**Summary Statistics**

| Total Item Chi Squ | 574.8708 | Person seperation index | |
|---|---|---|---|
| Total Deg of reedom | 166 | with extms | 0.95793 |
| Total Chi Squ Prob | 0 | no extms | 0.9615 |
| | | Coeffalpha | 0.95203 |
| | | With xtms | 0.95044 |

Table 4

**Item and Person/Item Separation Indices**

| | Item | Person/Item |
|---|---|---|
| İndex | 0.77909 | 0.82400 |
| Variance | 0.27758 | 183.38560 |
| Error | 0.06132 | 32.27578 |

Cronbach alphas reliability level (*Coeffalpha*) result is 0.95203 without extreme persons. In this way determined measurement reability levels. If in the study has missing data, Rumm2030 can`t be compute cronbach's alpha result. In this situation, the researcher should be considered reliability of person seperation index. Because cronbach alpha result to corresponding of rasch is person separation index.

Each item fit can examine individual item section. This part shows that whether item fit to model or not. The researcher can select sort item by ´Chisquare probability order´**.** If item has missfit, the researcher should examines its reasons. Differential item functioning can cause to missfit. Therefore highlight probabilities below the bonferroni adjustment values is made 0.02. Then if item still shows missfit, these items removes. After highlight probabilities below the bonferroni adjustment values edited, study did not show missfit items. So this study need not remove items.

Individual person fit demonstrates that person ability level and extreme persons. Extreme person who can give response to all items maximum value or minimum value. The researcher can select sort item by location order. Analysis using to interpolation calculates standard deviation and locations (*Q*). That means these results fit or not to model. In this way enables to see extreme person`s location. In our study has only one extreme person. 130 th company shows extreme features. Also table 5 demonstrates extreme person and its raw scores. Extreme person gives to all item maximum score because total ham score is 498.

Table 5

**Extreme person table**

| | |
|---|---|
| ID | 130 |
| Itms | 83 |
| totSc | 498 |
| Defaul tID | 498 |
| Max Sc | 0 |
| TotSc extm | extm |
| Miss Itm Extrm | 5,981 |
| Locn | 1,208 |
| Default ID | 130 |

Residual correlation part shows the errors in the data relations with each other. The researcher can determine linkage of items each other. Highlight above can be selected and value is changed 0.3. Then examines to relation of items. If the relation of item is high (*for example; 0.6*), these items should be unify with each other. For instance; if someone walks 10km, can walk 5km. In our study is determined correlation between item 13 and item 23 is 0.47.This value isn`t high. Therefore needn`t unify to items each other.

Residual principal components indicated used the the instrument whether of the only one type measuring or not (*for example; only kg or height*). If the significance is 0.05, is called unidimensionality. In this study result is significant so unidimensionality is provided. The researcher can select Pc loadings part and then select sort Pc1. The purpose of this process, divides to 2 categories set item *(positive and negative data*). In this way the researcher can compare person's location (*Q*)

and predicts level ability of person. If the result is not close to 0.05, it means unidimensional is broken down. In this situation the researcher should be examined its reasons. Because items can be connected each other. Figure 2, Figure 3 and Figure 4 show item characteristic curves. If the item does not coincide with graphic, it means nonuniform. In this case, the item may not be fit to model. In this situation the result of anova should be checked. If the interaction is not meaningful, it can be ignored. In our study, the anova result is not meaningful so nonuniform item hasn't been mentioned. *Figure 2*, *Figure 3* and *Figure* 4 indicate examples (*for item 39 and item 47).*

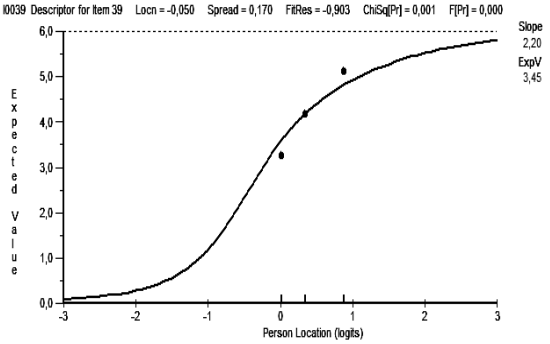


Figure 2 **Item characteristic curves(item 39)**

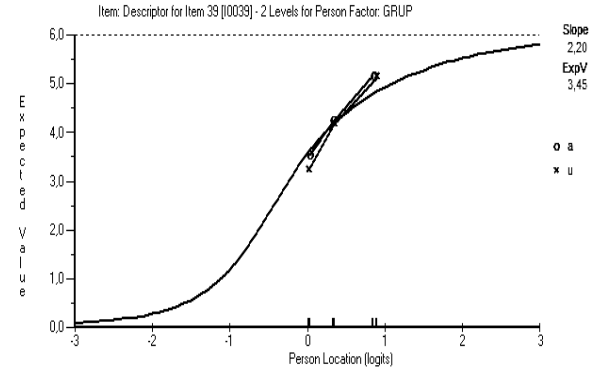


Figure 3 **Item characteristic curves(item 39 with anova)**

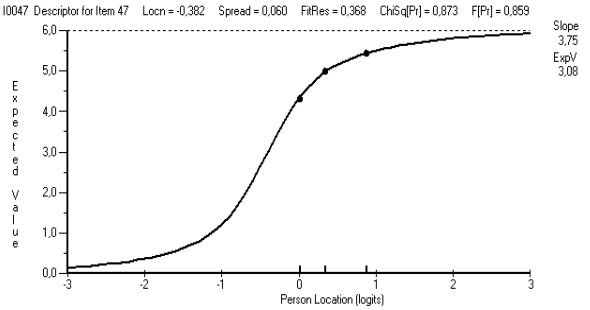


Figure 4 **Item characteristic curves(item 47)**

Thresholds item curves show threshold graph value of each item and this way orders to threshold of item. In this way possible to sort by threshold values of item. If the item does not to fit model, the thresholds should unify. That means item does not fit to model due to response category changes or unifies each other. This processing is not necessary for our study. *Figure 5* shows threshold item curves examples.

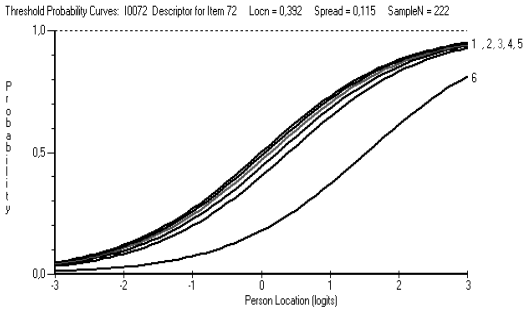


Figure 5 **Threshold item curves**

## CONCLUSIONS

As a result, purpose of this study is to show applicability of Rasch analysis which is commonly used health, education and social sciences in agriculture that may also have ordinal scale data.

According to this study the researcher can utilize reliably from Rasch analysis for ordinal scale in Agriculture surveys. In this study, health, education and social sciences with ordinal scales in Rasch analysis used is intended to bring a new perspective in the field of Agriculture.

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# IMPORTANCE OF CROP ROTATION IN POTATO PRODUCTION

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**Abstract**

Cropping sequence and length of rotation play an important role in potato production. Potato yield are very sensitive to the selection and sequence of rotation crop. Usually minimum 3-4 years rotation is used, however often growers allay for short-term, cropping system or monoculture. This is happening due to limited irrigated areas, or respective predecessor crop, but some time also due to quick economical interest which potato crop offer. In researches with 3 and 4 years crop rotation gradually was increase a percentage of potato from 25-33 till 100%. This led to yield reduction with 13 and 19% comparing with rotation 33% of potato, and with 9.17 and 26% comparing with 25% of potato. Shorter rotation drive up production cost, reduce yield and tuber quality, and increase the percentage of tuber attacked by *Fusarium, Rhisoctonia, Streptomyces scabies,* in special using low class planting material.

**Key words**: crop rotation, productivity, yield, tuber quality, diseases

Crop rotation was and continue to remain one of the main factor in agriculture, and there importance cannot be ignored or changed by others measures, also in the case if the pedoclimatic and growing condition are favorable for potato plants. From general and superficial point of view crop rotation means distribution of crops in space and time, but from special, scientific and practical point of view crop rotation means a good orchestrated system of deferent's production and technological crop systems. Crop rotation means a good planning which aloud the farm better to use sources for production.

Crop rotations, in general, provide numerous benefits to potato production, and serve multiple functions. First of all it help to conserve, maintain, or replenish soil resources, including organic matter, nitrogen and other nutrient inputs, and physical and chemical properties. Crop rotations have been associated with increased soil fertility, increased soil tilts and aggregate stability, improved soil water management, and reduced erosion. Probably most importantly, for potatoes as well as many other crops, rotations are essential to maintain crop productivity and reduce the build-up of soil borne plant pathogens and diseases, and weeds, which can devastate crops grown in multiple consecutive years.

Plants productivity and yield quality growth up, parallel with degrees of optimizing and harmonizing vegetative factors. So, high and stable yield could be obtained only having a positive interaction of growing conditions. This led to better consume and use of fertilizers, pesticides, energetically resources etc.

An important role for potato in crop rotation system play a soil structure, quantities of organic and mineral matter needed for plant nutrition, water supply, fitosanitary conditions etc. and of courses using potato as a successor crop.

Usually a common practice is applied to use 3 years rotation in table potato production and 4 years in seed potato production. The best successor's crops are those which left the field with les weeds, soil borne pathogens and pests. These are the legumes plants (bean, peas, soya), corn for animals nutrition and grain production, cereals, multiannual forages (alfalfa and clover), vegetables (onion, early cabbage, crucifiers). Following a respective rotation of the crops could be obtained a important supplementary yield advantage without others financials and materials efforts. A good successor crop can increase the yield by 15 – 30% (Măzăreanu H. et al, 1981; Vos J., Van Loon C., 1988; Смирнов А., 2001; Ianoşi I. et al, 2002; Зейрук, 2015).

Is not recommended to plant potato after the crops from the same botanical family, such as tomato, eggs plant sweet papers which have common diseases, pests and consume the same nutrition elements in the same quantities. From this point of view should be avoid the crops such as sun flower, tobacco, carrots, beets for animal feeding.

In function of the soil type and production

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zone it is necessary to create special systems of crop rotation which have to increase productivity, quality and optimizing technological processes.

In the same time potato is considered as a good successor for many others crops, due to leaving clean fields from weeds and quite rich quantities of the nutrition elements in special nitrogen in nitrates form, which remain in soil after harvest.

Cropping sequence and rotation impacts soil chemical, physical, and biological properties, such as nutrient cycling, erosion potential, compaction, organic matter, and biological diversity and activity.

However, the different crops and rotation practices used vary considerably and can greatly affect the efficacy of crop rotations in enhancing potato production. Shorter rotations can drive up input costs and reduce yield and tuber quality

Cropping sequence and length of rotation play an important role in potato production, but to often, growers are forced to base their cropping system decisions on short-term economic survival.

Factors of constraining and limiting crop rotation in Republic of Moldova are the following:

- High dispersion and field fragmentation;
- Good profit growing potato and small profit doing others crops;
- Insufficiencies of irrigated areas in potato production zones;
- Using rented fields for the more profitable crops;
- Reduction or eliminating from crop rotations forages plants.

One of the major problems of potato producers is quite a high production costs, and insufficiencies of favorable plots in special of irrigated fields, which are constrained by limited quantities of water in the lakes using for local irrigation. These facts push growers to growers to return often on the same field or even to grow potato in monoculture. As a result soil become pour in organic matter, nutrition, tired, accumulate weeds, soil borne pathogens and pests, specifically for potato, productivity and quality goes dawn, production costs rise up.

Taking into the consideration the above mentions facts one of the our major task vas not to demonstrate the advantage of crop rotation but to determine the effect of potato cropping frequency on marketable potato yield, the disadvantage and problems which appeared if cropping sequence and rotation are not respected.

**Limited available** areas for potato production with soil and climatic conditions

More frequent potato cropping, 2 years in 3 (66%) and especially continuous potatoes (100%), the soil and lowers both total and marketable potato yields.

## MATERIAL AND METHOD

Two crop rotation system where studied in two location in different climatic zone of the country. In the south part potato vas cultivated in 3 years crop rotation system on relative easy soils on bench of Dnester river (village Talmaz, district Stefan Vodă). Traditionally in this zone is produced early potato and potato in second crop. The 4 years crop rotation system was studied in the north part of the republic, the largest area of potato production, on black relative heavy soil (village Corjeuti, district Briceni). Traditionally this zone produces potato for autumn and winter compsumtion and partial seed potato. In 3 years rotation system 3, this included: potato, winter wheat, and peas. In 4 years rotation system: potato, peas, rape, and winter wheat. In the both rotation was studied different frequency of potato, from 33% till 100% in 3 years system (*table 1*), and from 25% till 100% in 4 years system (*table 2*)

Table 1

**Scheme of potato production with 3 years crop rotation**

| Number of crop rotation | Years | | | Frequent of potato in crop rotation,% |
|---|---|---|---|---|
| | 2004 | 2005 | 2006 | |
| 1 | Potato | Green peas | Winter wheat | 33 |
| 2 | Potato | Wheat/Peas | Potato | 67 |
| 3 | Potato | Potato | Potato | 100 |

During the vegetation period water condition were assured by using irrigation. Fertilizers, weeds, pests and diseases control vas done according local recommendation (Iliev P., Ilieva I., 2003). Monitorizing a plant growing, yield, quality, pest and disease control was done according to the methodologies in potato research, 1999, 2002).

Table 2

**Scheme of potato production whith 4 years crop rotation**

| Number of crop rotation | Years | | | | Frequent of potato in crop rotation,% |
|---|---|---|---|---|---|
| | 2004 | 2005 | 2006 | 2007 | |
| 1 | Potato | Peas | Ripe | Winter wheat | 25 |
| 2 | Potato | Winter wheat | Potato | Winter wheat | 50 |
| 3 | Potato | Potato | Whinter wheat | Potato | 75 |
| 4 | Potato | Potato | Potato | Potato | 100 |

## RESULTS AND DICUSSIONS

Analyses of the results of early potato production in 3 years crop rotation system demonstrate a surplus of 7 t/ha or 19 % in comparison with more frequent potato cropping, one time in two years (66%) or especially in continuous potatoes (100%). Increasing frequent and using potato into the rotation two years and only one year cereals or peas decrease the productivity, by 2 t/ha or 6% in comparison with rotation including 33% of potato. In the same tames crop rotation system with potato frequent 66 % and using one times in 3 years a cereals or peas, under the irrigation conditions, guaranteed a yield growing till 5 t/ha or 13 % in comparison with monoculture (*table 3*). South zone usually is used to produce under the irrigation the green peas and a part of field are used to produce potato in the second crop. Including in to the rotation of legumes contributed on soil riche in nitrogen by fix it from the atmosphere with the help of nitrobacteria's (Vos J., Van Loon C., 1988; Petrescu,1999; Boincean B.,1999). In view of the above we can remark that only a simple introduction of potato in crop rotation has a positive effect on total yield by 13-19%.

Table 3

**Productivity of potato in 3 years crop rotation (v.Talmaz, Stefan Vodă)**

| Nr. | Crop rotation | Frequent of potato in crop rotation,% | Productivity of potato | | |
|---|---|---|---|---|---|
| | | | t/ha | Diferences | |
| | | | | t/ha | % |
| 1 | Potato, Green peas, Winter wheat | 33 | 37 | 7 | 19 |
| 2 | Potato, wheat/Peas, Potato | 67 | 35 | 5 | 13 |
| 3 | Potato monoculture | 100 | 31 | 0 | 0 |
| DL | 0.95 | | 3.1 | | |

In the north part of the Republic in Briceni, Ocnița and Edineț districts are planted quite big areas with potato and a frequent of potato in crop structure is relative high. In the same times the tentative to place or to increase potato areas on irrigated and riche fields, or closely to the basic storages, in cases the charging of rather week crop rotation systems and in many cases potato is cultivated 2-3 years on the same field or in monoculture.

Results obtained in our researches in different cropping rotations demonstrate a substantial yield increase till 9 t/ha or 26%, when potato is growing in 4 years crop rotation in compared with monoculture. Increasing frequency of potato in crop rotation till 50%, using the scheme: potato, winter wheat, potato winter wheat increase the yield with 6 t/ha in compared with continuous potatoes or 17%, but reduce the yield by 3 t or 9% in compared with 4 years crop rotation. In cases of planting potato 2 years on the same field plant productivity is 6 t/ha less in compared with normal 4 years crop rotation, and only 3 t/ha more than in monoculture.

Introduction in to the rotation of cereals after 2 years continuous potato stimulated microbiological soil process, refresh it and show the tendency of yield grow (table 4).

Table 4

**Productivity of potato in 4 years crop rotation (v.Corjeuți, 2004-2009)**

| Nr. | Crop rotation | Frequent of potato in crop rotation,% | Productivity of potato | | |
|---|---|---|---|---|---|
| | | | t/ha | Differences | |
| | | | | t/ha | % |
| 1 | Potato, Peas, Ripe, Winter Wheat | 25 | 44 | 9 | 26 |
| 2 | Potato, Winter Wheat | 50 | 41 | 6 | 17 |
| 3 | Potato, Potato, Winter wheat, Potato | 75 | 38/40 | 3/5 | 9/14 |
| 4 | Potato, monoculture | 100 | 35 | 0 | 0 |
| DL | 0.95 | | 2.3 | | |

Results obtained in different crop systems in the north part in 4 years rotation as in the south part in 3 years rotation clearly pointed the necessity to place potato in crop rotation which served as an important factor in productivity increasing.

In the modern agriculture the roll of crop rotation is not limited only on plants productivity but in specially as an effective method of controlling weeds insects, disease, and fungi in potato production systems (Иванюк В. и др. 2005; R.P. Larkin *et al*, 2011, 2012).

Probably it may not be possible to eliminate these pests through rotations with cereals, grasses, legumes, but rotating these crops with potatoes can reduce the pest damage caused to potatoes thereby decreasing the need for costly alternative control measure.

There are some opines that potato grow well even in monoculture, but also they remarks that

this practice could led to increasing diseases and pests in special of potato beetle. Tubers remained in soil after harvest can produce a varieties mixture. In one of the scientific report (Barada, 1963, cited by Ianosi, 2002) mentioned that after 14 years potato growing in monoculture productivity results was sufficient, but in the same time the number of plants attached by Verticillium spp. increased by each year's till 98%, when in to the rotation of 3 years numbers of affected plans vas only 35%. According to the (Mărgineanu T., 1969) potato production in monoculture reduced yield starting with the second year. In the researches done by (Смирнов А., 2002) monoculture not only reduce the productivity, but also degrades the soil quality by reducing humus amount, which become less with 0.16% after 4 years and 0.44% after 8 years. Potato cultivation with limited crop rotation and using relative low quality of the tubers for planting, more than two replication, (practice still common for some growers) increased much more the number of affected plants and new yield tubers. Our studies confirm this phenomenon of yield reduction and infection accumulations in soil and plants (table 5). In case of using good quality seeds (class A), from Holland or local production, and 3 years crop rotation there are only around 1% of diseases infected tubers. Lower quality seed used for planting increase the number of infected tubers till 7.5%, in normal crop rotation. Increasing potato frequent in to production system till 66% or monoculture led to much more tubers infection, in special using for planting lower quality seeds.

Table 5

**Influence of cropp rotation and sequence on fitosanitary status and tubers quality in 3 years cropp system c. Agata (average 2004-2009)**

| Nr. | Crop rotation | Quality of the planting material | Tubers attached by Common scab, % | Tubers attached by *Fusarium*, % | Tubers attached by *Rhizoctonia*, % | Total affected tubers,% |
|---|---|---|---|---|---|---|
| 1 | Peas, Wheat, Potato | 1 repr. import | 0.5 | 0 | 0.3 | 0.8 |
| | | 2 repr. loc. | 3 | 2 | 2.5 | 7.5 |
| 2 | Potato, Wheat, Potato | 1 repr. import | 1.5 | 0 | 1.2 | 2.7 |
| | | 2 repr. loc. | 5 | 4 | 4.3 | 13.3 |
| 3 | Potato, Potato, Potato | 1 repr. import | 6 | 2 | 3.4 | 11.4 |
| | | 2 repr. loc. | 10 | 6 | 5.8 | 21.8 |

Practically the same situation where observed in the 4 years crop rotation system. There are one small difference, when the potato frequent is less - 25% the number of affected tubers are lower in compared with 3 years crop rotation, increasing frequent of potato into rotation till 100%, number of affected tubers rise till 17% in case of using class A seeds and till 30 % in case of using local seeds which is much higher in compared with 3 years crop rotations. This don't means that 3 years rotation system is better, this means that the longer times potato grow in monoculture the more soil and tuber born infection is accumulated.

Table 6

**Influence of cropp rotation and sequence on fitosanitary status and tubers quality in 4 years cropp system c. Roko (average 2004-2009)**

| Nr. | Crop rotation | Quality of the planting material | Tubers attached by Common scab, % | Tubers attached by *Fusarium*,% | Tubers attached by *Rihzoctonia*,% | Total affected tubers,% |
|---|---|---|---|---|---|---|
| 1 | Potato, Peas, Ripe, Winter Wheat | 1 repr. import | 0 | 0.1 | 0.1 | 0.2 |
| | | 2repr. loc. | 1.8 | 3 | 2.1 | 6.9 |
| 2 | Potato, Winter Wheat | 1 repr. import | 0.9 | 0,3 | 2.9 | 4.1 |
| | | 2repr. loc. | 5.6 | 3.8 | 3.4 | 12.8 |
| 3 | Potato, Potato, Winter wheat, Potato | 1 repr. import | 3.7 | 2.3 | 3.4 | 9.4 |
| | | 2repr. loc. | 7.5 | 8.2 | 4.1 | 19.8 |
| 4 | Potato, monoculture | 1 repr. import | 6.2 | 4.7 | 6.2 | 17.1 |
| | | 2repr. loc. | 12.3 | 9.8 | 8.3 | 30.4 |

During the vegetation period plants permanently are under the pressure of deferent diseases. Respecting crop rotation and using good quality seeds the health status of the plants and normal growing condition are assured. Increasing potato frequent in crop rotation and planting non certified seeds led to increasing a number of the plants attached by deferent holms diseases (*table 7*).

Table 7

**Diseases manifestation during the growing period in dependence of sequency and planting material category before flowiering (average 2004-2009)**

| Nr. | Crop rotation | Quality of the planting material | *Erwinia*,% | *Alternaria solani*, % | *Rhizoctonia*, % | Total, % |
|---|---|---|---|---|---|---|
| 1 | Potato, Green peas, Winter wheat | 1 repr. import | 0 | 2.1 | 1.2 | 3.3 |
| | | 2repr. loc. | 1.2 | 4.1 | 1.8 | 7.1 |
| 2 | Potato, Wheat/Peas, Potato | 1 repr. import | 0.1 | 3.6 | 1.5 | 5.2 |
| | | 2repr. loc. | 2.3 | 7.5 | 5.1 | 14.9 |
| 3 | Potato, monoculture | 1 repr. import | 2.6 | 9.7 | 4.1 | 16.4 |
| | | 2repr. loc. | 5.4 | 16.1 | 8.3 | 31.9 |

Rotation plays an important role in reducing pests number. In result of our observations we can remarks the following when the 3 or 4 years rotation is respected potato Colorado beetle appeared in 10-14 days after plant emergence. In case of using the same field 2-3 years for potato planting the first adults of potato beetle appeared on plants emergent time, because the insect spend the winter time in the same field. That is why the first beetle eggs are observed 8-12 days earlier, and first larvs with 5-7 days earlier that in normal crop rotation. So ignorance or limiting crop rotation, using low quality seeds and others possible lacks in technology reduce quantity and quality of the yield and grow up costs for production. For example in the last years potato production in Republic of Moldova has been constrained by deferens factors such as over production and low market price, climatic conditions (long term high temperatures) devaluation of local currency or these means automatically high price for imported seeds etc. and as a result many farmers in special small and medium farmers use for planting their own seeds multiplied several years. The recent dates obtained in 2015 production year in one of the farm from the north region where potato vas cultivated in two years rotation (potato –cereals) and planted with local seeds after two years multiplication was obtained the yield of 31,3 t/ha and from this more than 5 t of tubers or approximately. 16% remain in to the field because of strong attack of *Fusarium* spp.

Taking in to the considerations a main idea that potato can't be excluded from the context of crop rotation, but for limited the negative effects when it's happen we recommended to be introducing the organic fertilizers.

## CONCLUSIONS

Analyzing the results obtained by us and others researches (Barada. L., 1963; Mărgineanu T., 1969; Немчин Ф., Глянько Г., 1975; Vos J. şi al., 1988; Боинчян Б., 1999 ; Смирнов А., 2002; Ianoşi I., 2002; R.P. Larkin *et al*, 2011, 2012; Зейрук В., 2015) we can formulate the following conclusions that economical and energetically efficiency of crop rotation are the results of organizing, agronomic and ecological advantages:

- maintain or improving the soil characteristics;
- improve the soil water and nutrition distribution mechanism;
- maintain the better balance between mineralization and humification;
- soil layers are used more uniformly;
- reduce the fenomem of sol tiredness;
- reduce soil erosion;
- reduce the number of weeds, pest and diseases pathogens without any others investments;
- improve yield and quality of the tubers and others crops used in to the rotation.

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# MONITORING OF FUNGAL AEROSOLS IN URBAN AND RURAL SCHOOLS FROM IAŞI COUNTY, ROMANIA

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**Abstract**

The densities and distributions of airborne fungal spores known to cause respiratory tract disorders were monitored in three educational buildings located in urban and rural areas from Iaşi, Romania. Air samples from all locations were collected monthly over a period of 3 months (April-June 2016), using the Petri plate gravitational settling (passive) method. Petri plates containing nutrient media were exposed to room air for a 15-minute period, face upwards, to collect particles settling by gravity. A total of 4358 microfungal colonies were counted on 628 plates. During the sampling period 11 fungal genera were isolated and identified. Fungal spores density in the educational institution's air was within the sanitary level accepted for public buildings, with the exception of one high school classroom, which has the potential to put the occupants at risk of developing adverse health effects. Indoor results show differences for fungal genera distribution between the educational buildings. The dominant genera were represented by *Aspergillus*, *Penicillium* and *Fusarium* with 40.4, 26.3 and 9,8% of the total, respectively

**Key words**: air sampling, educational buildings, fungal aerosols, health effects

Microbial contamination inside educational institutions is of great interest because fungal spores and other airborne structures, which are ubiquitous in the indoor environments, represent a risk for human health and/or a cause for the biodeterioration of building constructions and different materials stored inside (Lipsa *et al*, 2016; Daisey *et al*, 2003; Ulea *et al*, 2009, 2013). Fungal spores are often reported to be hazardous for human health in indoor environment, because their possibilities to cause allergies, respiratory diseases (including asthma) and symptoms of sick building syndrome (SBS).

The purpose of this study was to evaluate and compare fungal biodiversity in the indoor air of urban and rural schools from Iaşi County, Romania. Also, we have estimated the levels of fungal contamination and discussed about the potential health risk incidences associated with this flora.

## MATERIAL AND METHOD

The densities and distributions of airborne fungal spores known to cause respiratory tract disorders were monitored in educational buildings located in urban and rural areas from Iaşi, Romania. Air samples from all locations were collected monthly over a period of 3 months (April-June 2016), using the Petri plate gravitational settling (passive) method.

Potato dextrose agar (PDA) and Peptone glucose agar (PGA) media were used for the sampling and quantification of fungi. To these media streptomycin and rose-bengal stain was added in certain quantities. Czapek-Dox agar media was used for filamentous fungi identification.

Microbiological media plates were prepared using Masterclave 09 plate maker and an aliquot portion of 15mL of media was poured using APS 320 automated Petri plate filler (AES Laboratoire, France).

The experiment was conducted with a threefold repetition for each microbiological determination and the counts obtained were averaged. The fungal colony number was counted after 5 days of incubation at 28ºC.

After incubation, the fungal concentration per cubic meters of air (CFU/$m^3$) was calculated according to Omelyansky (1940) using the following formula:

$$N = a \cdot 10000/p \cdot t \cdot 0.2$$

where:
N = fungal CFU/$m^3$ of air;
a = number of colonies per Petri plate;
p = area of Petri plate in $cm^2$;
t = exposure time in min.

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Light microscopy (1000x magnification) was used to determine the colonial features and the morphological structures of the fungi.

Regarding the permissible limits for exposure to fungal spores to assess health impact are some recommended concentrations for indoor environments (Mănescu, 1989; World Health Organization, 1990):

For clean area, level of air contamination should be lower than 500 CFU/$m^3$.

For area with intermediate level of air contamination should be between 500 and 700 CFU/$m^3$.

For area with high level of air contamination (not acceptable) should be upper 700 CFU/$m^3$.

Statistical analysis was conducted with SPSS 16.0 for Windows. Quantitative data are presented as mean ± standard deviation. Results with $p < 0.05$ were considered statistically significant.

## RESULTS AND DISCUSSIONS

Petri plates containing nutrient media were exposed to room air for a 15-minute period, face upwards, to collect particles settling by gravity. A total of 4358 microfungal colonies were counted on 628 plates. During the sampling period 11 fungal genera were isolated and identified.

The dominant genera were represented by *Aspergillus*, *Penicillium* and *Fusarium* with 40.4, 26.3 and 9,8% of the total, respectively (*figure 1*).

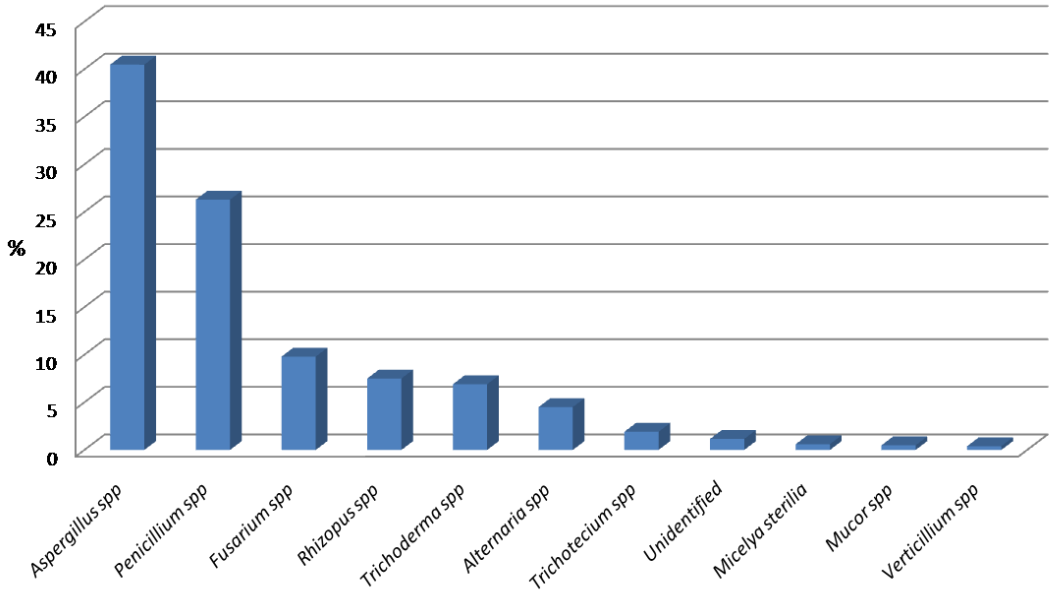


Figure 1 **Taxonomical composition of fungi isolated from the indoor air of urban and rural schools**

The results reported for fungal flora in every sampling site are the average (arithmetic mean concentration) and standard deviation of the counts obtained during the sampling period. Concentration of airborne mycota varied at different locations from 187 to 468 CFU/$m^3$ in April, from 256 to 758 CFU/$m^3$ in May and from 143 to 798 CFU/$m^3$ in June, respectively. The peak of total fungal prevalence was recorded in May (39%), followed by June and April (data not show).

Correlation between the fungal density and some parameters such as temperature, sampling month and the different locations were calculated. Significant correlation was found in case fungal colony numbers versus indoor temperature ($p < 0.001$). Chi-square ($\chi^2$) test was applied to determine if there were any differences between the sampling period (April - June 2016) and fungal densities. Statistical significantly difference was found only in case of a school classroom from rural area ($p < 0.05$).

The general results showed that in all locations from rural and urban areas were differences in the distribution of fungal genera, but *Aspergillus* and *Penicillium* were the most prevalent. More exactly, the dominant genus in the rural schools was represented by *Aspergillus*, while in the urban schools the *Penicillium* spp. was predominant (*figure 2, 3 and 4*).

*Aspergillus* and *Penicillium* spores are the most frequent and predominant aeroallergens in the world. These two genera are significant indoor air allergens, while *Alternaria* and *Cladosporium* species are considered the most important fungal allergens in outdoor air (Aydogdu *et al*, 2005; Fischer G., Dott W., 2003; Sarica *et al*, 2002).

These results are compatible with our findings; the above mentioned genera were found in high frequency in our work (66.7%).

In April 2016, fungal concentrations were minimal in both areas, and varied in the range of minimal level. In this month the obtained data showed that the fungal contamination has no potential to develop adverse health effects to the occupants. Airborne fungal genera prevailed in both areas are presented qualitatively in *figure 2*. Numbers of isolated fungal genera are different: in rural area were isolated 6 genera (most prevalent *Aspergillus*, *Penicillium* and *Fusarium*), while in the urban area 11 genera were found (*Penicillium*, *Aspergillus* and *Rhizopus*).

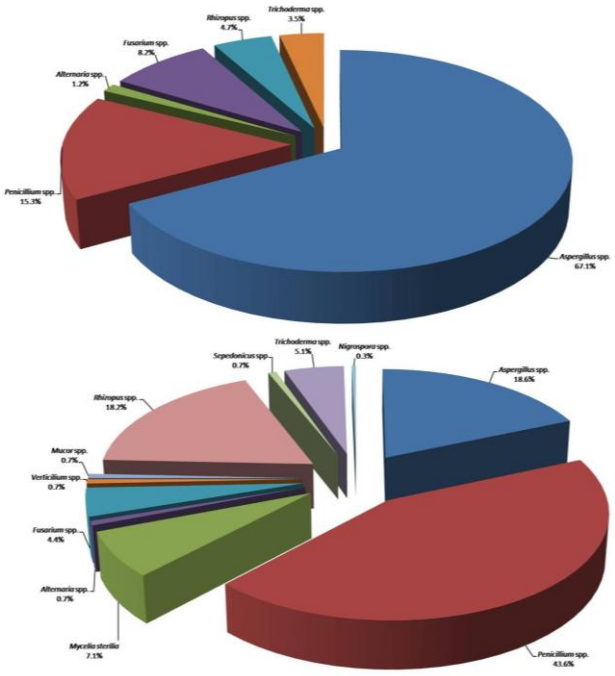


Figure 2 **Frequency of isolated fungi from rural (top) and urban (bottom) schools in April 2016**

In May 2016, fungal concentrations varied between minimal and intermediate level in case of the urban schools.

The fungal contamination in rural classrooms was found to be higher as the recommended concentration (>700 CFU/m$^3$) in Mogoşeşti-Siret, and at this location has potential to develop adverse health effects to the occupants. One explanation for this high concentration could be the fact, that the school is located close to the agricultural areas (tractors and other agricultural machines were present during the air sampling).

Airborne fungal genera prevailed in both areas are presented qualitatively in *figure 3*. Numbers of isolated fungal genera decrease qualitatively, but increase quantitatively: in rural area were isolated 4 genera (most prevalent *Aspergillus*, *Penicillium* and *Trichoderma*), while in the urban area 6 genera were found (most prevalent *Rhizopus*, *Penicillium* and *Aspergillus*).

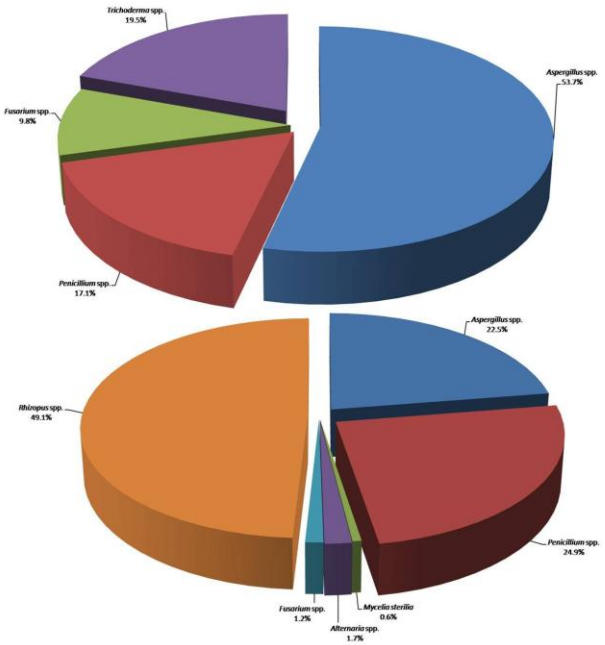


Figure 3 **Frequency of isolated fungi from rural (top) and urban (bottom) schools in May 2016**

In June 2016, fungal concentrations varied between minimal level in case of urban schools and high level of air contamination in case of the Mogoşeşti-Siret school.

Airborne fungal genera prevailed in both areas are presented qualitatively in *figure 4*. Numbers of isolated fungal genera remain as in May: in rural area were isolated 4 genera (most prevalent *Aspergillus*, *Rhizopus* and *Trichoderma*), while in the urban area 6 genera were found (most prevalent *Trichotecium*, *Penicillium*, *Aspergillus*).

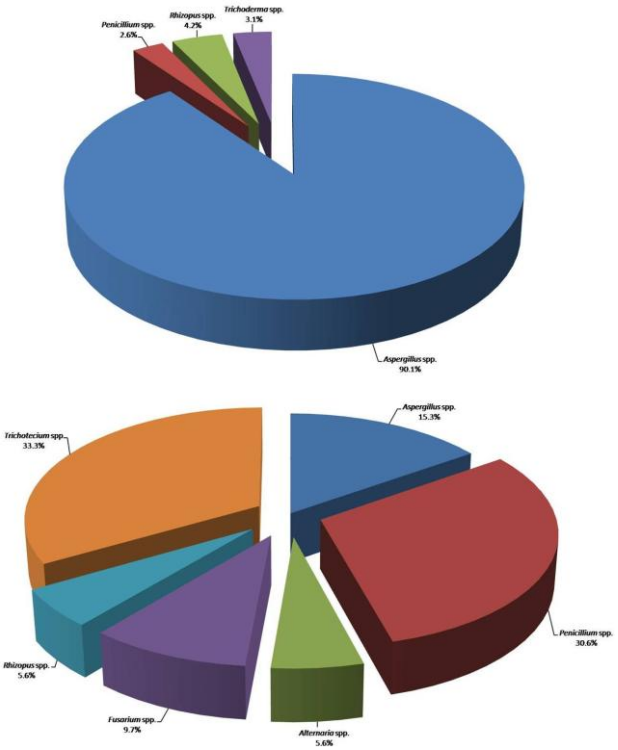


Figure 4 **Frequency of isolated fungi from rural (top) and urban (bottom) schools in June 2016**

Numbers of fungal genera decrease during the 3-month sampling period from eleven to six in urban location, and from six to four in rural location. *Aspergillus* spp *Penicillium* spp., *Rhizopus* spp, *Fusarium* spp., plus *Trichoderma* spp. were commonly isolated in the locations.

The quality of indoor air from the educational institutions depends on many factors, including cleaning procedures, air ventilation, temperature, relative humidity, geographical region and specific reservoirs of contamination (e.g. agricultural activities). Statistical significant correlation between temperature and fungal colony numbers was found. Corden J.M. and Millington W.M. (2001) reported that higher temperatures can induce fungal spore concentrations and increasing of fungal contamination risk.

The fungal flora in indoor air may affect human health, especially in rural areas, and as a consequence many clinical and epidemiological investigations must be undertaken.

## CONCLUSIONS

It has been shown that total fungal spores exceeded the recommended upper limit for indoor concentrations (>700 CFU/$m^3$) only in case of one classroom environment from rural area, in May and June 2016. The fungal contamination has potential to develop negative health effects to the occupants. The presence of a good ventilation system to eliminate some indoor sources inside building is required. In case of one classroom from the primary school located in the urban area the airborne fungal spore concentrations was between 500 and 700 CFU/$m^3$, and is registered with intermediate level of contamination.

In all other location from urban and rural areas, the airborne fungal spore concentrations were under 500 CFU/$m^3$, so that no negative health effects for occupants were expected.

The dominant genus in the rural schools was represented by *Aspergillus*, while in the urban schools *Penicillium* was the predominant genus.

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# MICROBIOLOGICAL ANALYSIS AND THE ANTIOXIDANT CAPACITY OF EDIBLE BIOFILMS ENCLOSING *BACILLUS SUBTILIS*

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**Abstract**

The aim of this research was to design edible biofilms on a basic matrix of sodium alginate (Al) and other hydrocolloids in which different proportions of onion extract (OE), yeast extract (YE) and *Bacillus subtilis (B. subtilis)* was introduced. These biofilms were evaluated from microbiological and antioxidant perspective.
The $EC_{50}$ (mg sample/ml DPPH solution $6\times10^{-5}$ mol/L) value was calculated, representing the active compound concentration which inactivates 50% of the total radicals DPPH. For the YE the $EC_{50}$ value resulted 0.88 mg/ml and for the OE resulted with 30% smaller (0.60 mg/ml). The microbiological study targeted the influence of the OE and YE on cell viability of *B. subtilis* used as inoculum. A standardized inoculum of *B. subtilis* with a concentration of more than $10^{11}$ spores/g was used and a base culture of Luria Bertani Agar, Miller. After 48 hours of thermostating at $37^{\circ}$ C the number of CFU/g resulted over $10^{10}$ in all experimental variations. A quantitative evaluation was made through indirect culture methods for a period of 8 days time in which the samples were preserved in refrigerated conditions at $4^{0}$ C. After analyzing the data we observed a constant behavior of the probiotic bacteria *B. subtilis* through all the conservation period. The *B. subtilis* + OE sample presented a reduction of CFU/g with one unit after 24 hours until the value of $9.85\times10^{7}$ CFU/g was reached most probably due to the OE which has an antimicrobial effect. The best behavior over the preservation period was observed in case of *B. subtilis* + YE ($4.51\times10^{8}$ CFU/g) sample as we consider due to the YE which offers a good source of nitrogen and vitamin content that is necessary to maintain the viability of *B. subtilis* cells. Similar values have been obtained for *B. subtilis* + OE + YE ($3.57\times10^{8}$ CFU/g) with both extracts included onion and yeast that manifest a prebiotic effect for the bacterial cells.
This study showed that obtaining Al based films and incorporating distinct active ingredients with unique properties provide a „clean" solution and a future reference to healthy packaging materials. An edible biofilm which contains a mixture of YE, OE and a number of more than $10^{8}$ CFU/g probiotic bacteria even after 8 days in refrigerated conditions can be considered as an efficient solution of bio conservation and more than that could manifest a nutraceutical effect for consumer's immune system stimulation.

**Key words:** edible biofilm, *Bacillus subtilis*, yeast extract, onion extract, antioxidant activity.

The usage of bioactive extracts and specific probiotic microorganisms with the purpose of enhancing the intrinsic value of food is a rapidly spreading practice for food products. The research in food industry is focusing on incorporating active biological compounds in edible films with the goal of shelf life extension (Guilbert S. *et al*, 1996). These films are defined as thin and flexible layers obtained from animal or vegetal polymers which represent a functional matrix for active ingredients. Most biopharmaceutical production platforms are base on cell culture protocols, which can support high productivity while maintaining low operational complexity (Fike R., 2009). To be competitive, the food industry is challenging new techniques in developing or refining new processes to meet increasing market demands and reduce manufacturing costs while providing innovative healthy solutions. In this regard we imagined an edible biofilm matrix composed of four main hydrocolloids: Sodium Alginate (Al), Refined Carrageenan (RC), Carboxymethil cellulose (CMC) and Konjak Gum (KG), which should have superior individual properties and could influence the properties of the film in a positive way.

Furthermore, these films have proven to be excellent biomaterials for use as carriers of other natural active ingredients as antioxidants, antimicrobials, colorants, flavors, fortifying nutrients and spices: these additives improve the functionality of the packaging by bringing novel features (Pranoto Y. *et al*, 2005). In particular, addition of antimicrobial agents may enable

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extension of the shelf life and safety of packaged foods, by reducing (or even preventing) growth of pathogenic and spoilage microorganisms (Franssen R.L., Krochta J.M., 2003).

Moreover, their relatively low, but stable rates of diffusion from the packaging material onto the product assists in keeping the concentration of active ingredient relatively high as time elapses (Kristo E. *et al*, 2008). The antimicrobials more often incorporated in food packaging films are organic acids (lactic, acetic, citric and propionic acids), enzymes (lysozyme), bacteriocins (nisin), polysaccharides (chitosan) and some plant extracts and their essential oils (Cagri A. *et al*, 2004). Although extensive information on the antimicrobial properties of the above mentioned compounds are available in the literature, scarce data exists pertaining to the activity of OE and YE (Manab A. *et al*, 2011) when incorporated into Al films; and essentially no data at all regarding incorporation of *B. subtilis* in Al based films. Furthermore, a lack of information is apparent on the effect of those antimicrobial compounds upon the physical properties of Al based films. On the other hand, selection of an antimicrobial agent entails not only assessment of its effectiveness against target microorganism but also of interactions with the film-forming biopolymers; such interactions may indeed hamper the actual antimicrobial activity further to the characteristics of the film itself- both of which are key factors for development of commercially successful active films (Campos C.A. *et al*, 2011).

Therefore, the main purpose of this research was to obtain an optimum biopolymer film matrix which could be presented as a functional film that could protect a fresh meat product (fresh sausage) and provide an improved shelf life and a potential health benefit to the end product on an established period of 8 days in refrigerated conditions.

The effect of incorporating such compounds (natural preservative and a natural antioxidant source: onion extract and yeast extract) on the biofilm and the viable cell count of *B. subtilis* after 8 days were also assessed in this study.

## MATERIAL AND METHOD

*Materials*

Probisis® *B. subtilis*, was obtained from LeSaffre Human Care, France and registered with CNCM no. I-2745; the selective medium of Luria Bertani Agar, Miller was provided by Titan Biotech Ltd., Rajasthan, India. The Yeast extract was acquired from Bio Springer, Maison Allfort, France and the Onion extract was supplied from Fi&S, Nethererland. High purity polymers from different EU suppliers were used in the experiment**:** (Carboxymethyl cellulose from Ashland, UK, type Blanose 7H9); (Sodium Alginate from Caldic Ingredients, Nd, type Ferwo F400); (Reffined Carrageenan and Konjac Gum from Fi&S, Netherland, type BLK 1120 and MRA). Glycerol used as plasticizer and $CaCl_2$ used as cross-linking agent were manufactured by Sigma-Aldrich. All materials were used based on certificate of analysis (CoA) and technical data sheets (TDS), reagent-grade or better and were used without further purification.

*Characterization*

The antioxidant potential of Yeast extract and Onion extract was assessed by determining the DPPH scavenging activity. A Spectrophotometer UV- Vis Zuzi was used to read the absorbance level at 517 nm of the 2 extract solutions. The surface morphology of Al based films and of composite films with active ingredients (Yeast extract, Onion extract and *B. subtilis*) was characterized by field-emission scanning electron microscope (SEM; Quanta 200) with 1.2 nm resolution and low voltage. Readings were made with magnification between 100x and 5000x.

*Antioxidant activity*

The DPPH radical-scavenging capacity of onion extract and yeast extract was determined according to the method described by (Gyamafi *et al*, 1999). For our study we used one milliliter of liquid onion extract (1 g powder for yeast extract) and 5 ml of 0.1 mM DPPH ethanolic solution and mixed them intensively. After this procedure we kept the solution in a dark space for 35 minutes at room temperature. The absorbance was then read at 517 nm by a spectrophotometer UV-Vis. The blank sample was prepared by replacing the extract with ethanol or water. The percentage of free radical scavenging activity was calculated with the formula described below:

$$\text{Scavenging activity, (\%)} = [1 - \frac{A_{517\ nm\ sample}}{A_{517\ nm\ blank}}] \times 100$$

The decrease in absorbance, which was induced by the tested sample and illustrated by a change in color from violet to yellow, was compared to that of the positive control used as standard. The $EC_{50}$ value, representing the concentration of extract that requires the inhibition of 50% DPPH radicals, was also determined by calculation. The assay was carried out in duplicate and results were averaged.

*Film and culture preparation system*

The viability of *B. subtilis* was carried out on Luria Bertani Agar (LBA) medium using two complementary approaches: a first study was made by simple mixture of the active ingredients (1.4.1.) and a second study, were the active ingredients have been inserted into the Alginate based film composition (1.4.2.). Both studies were

carried out over a period of 7-8 days to see the development and interactions between *B. subtilis* and the other components. The tests were performed in duplicate, in two separate experimental runs for safety data readings.

*The active ingredients mix*

The experiment started by taking in consideration that the producer of *B. subtilis* pure culture declared on the TDS and CoA for this microorganism: $>10^{11}$ CFU (viable spores) of *B. subtilis* /1g. The calculated amount of BS to start for each tube was $0.25x10^{9}$ CFU which was important for the viability after 8 days. Into four sterile tubes labeled: M, P1, P2, P3, a quantity of 10 ml Luria Bertani broth was evenly distributed. In each tube were, aseptically added, at the laminar air flow hood, the active ingredients in the amount and combinations mentioned in (*Table 1*). All tubes were fully stirred using a shaker for a complete homogenization of the aliquot and were maintained throughout the experiment at 4°C.

Daily, for each sample, we made tenfold serial dilution until $10^{-9}$, of which we inoculated each 1 mL in sterile Petri dishes on LBA medium in order to count the colony forming units. The plates were incubated at 37°C (Sanyo Incubator MIR-153) for 24-48h. The *B. subtilis* living cells were daily counted in plates which contain 30 to 300 colonies over a period of 7-8 days, according to EN ISO 7218.

Table 1

**Sample preparation system for active ingredients. (Amounts for 100 ml tube sample solution)**

| Sample | *Probisis*® | YE(g) | OE(g) |
|---|---|---|---|
| M | 0.25g | - | - |
| P1 | 0.25g | - | 1g |
| P2 | 0.25g | 1g | - |
| P3 | 0.25g | 1g | 1g |

*Alginate based films with active ingredients*

The Al base film 1 and 2 recipe is illustrated bellow (*Table 2*). All measurements and equipment were done in aseptic conditions. The active ingredients were integrated into the film forming solutions following the procedure. Film forming gels were prepared according to the method of (Zactiti, Kieckbusch, 2006); were cross-linking of the polymeric structure with calcium ions considerably reduces the solubility in water of alginate based films, as well as the flexibility. Plasticizer (glycerol) is added to these films in order to obtain a reduction in brittleness and increase in flexibility, toughness traction and impact resistance.

Table 2

**Film recipe 1 and film recipe 2 with incorporated active ingredients for 100 ml solution**

| Film Recipe 1 | *Probisis*® | YE (g) | OE (g) |
|---|---|---|---|
| 1A: Al + KG + CMC | 0.5g | 0.5g | 0.5g |
| 1B: Al + KG + CMC | 0.625g | 1g | 1g |
| 1C: Al + KG + CMC | 0.75g | 1.5g | 1.5g |
| **Film Recipe 2** | | | |
| 2A:Al+ KG+ CMC+ RC | 0.5g | 0.5g | 0.5g |
| 2B:Al+ KG+ CMC+ RC | 0.625g | 1g | 1g |
| 2C:Al+ KG+ CMC+ RC | 0.75g | 1.5g | 1.5g |

The experiment started from two optimized simple film recipes with different compositions: **(1)** Al [4.5g] + KG [0.75g] + CMC [0.75g] = 6 g and **(2)** Al [4.11g] + KG [0.63g] + CMC [0.63g] + RC [0.63g] = 6 g. Both compositions were mixed individually in 400 ml double distillate (DD) water under constant stirring until complete solubilization. Then 3.6 g of plasticizer was added to the solution and continued stirring. At this point the three active ingredients were added into the film forming solution after measuring the correct amount which must be introduced. Films were then obtained by casting technique when 5 g of gel was measured into a square Plexiglas pan (area = 225 $cm^2$) and outspread on the whole surface. Slowly a 10 ml solution ($CaCl_2$, 7% concentration) was added on the Plexiglas pan margins with a dropper; moment when the alginate cross-linking took place and the film was obtained. Each film was then peeled off and put onto Petri dish to dry. For the films containing CMC and KG we also used an ultrasonic water bath were we applied oscillations to eliminate the air bubbles formed while stirring for gel formation. The quantitative microbiological analysis of each Al based film used the (AATCC test method 100-2004, 1961), method originally designed for determining antimicrobial activity of textile materials, and further adapted for edible films.

Each film was cut in a 5 cm diameter disk shape with a sterile scalpel and placed into a sterile Flask disk. The flask disks were incubated at 37°C using a Sanyo equipment. Then 99.0 ml of DD water was aseptically added to each flask at different time frames 24, 48, 72, 96 h. The content was then transferred to a 400 ml homogenizing bag (300x180 mm) and blended in a bag homogenizer for 1 minute. Afterwards dilutions were made of the homogenate in DD water and plated onto Agar plates for the bacteria. The plates were incubated as described above.

Enumeration of colonies was performed, and inhibition of microorganism growth was expressed as reduction of cell number using log ($N/N_0$)- where N is the viable cell number at a given time and $N_0$ is its counterpart at time zero (Fernandes J.C. *et al*, 2008). The test was performed in duplicate, for safety reasons.

*Design of experiments (DoE)*

Using DoE, makes it possible to find one or several best fit solutions for a particular problem. We can accomplish this by using mathematical models to predict the outcome of an infinite number of combinations of the three samples selected. For this we used a Mixture Design I-Optimal Quadratic model with the help of State Ease Trial program. The aim was to find an optimum solution mix for the 3 active ingredients used in order to standardize and create an efficient protection layer. In this case, DoE laid out a „recipe sheet" with a total of 16 blends, of which one was replicated for estimation of pure error.

For the **Components**, the following constraints were respected:

- For the major components (OE and YE) the range was between 0.5-1.5 units.
- For the BS the range was 0.5-0.75 units.
- All the components must sum 3.5 units: A+B+C=3.5.

For the **Response**, the following data were introduced:

- Shelf life :7-8 days
- Color difference (ΔE): 93.82-95.00
- Viability of BS cells: $9.85E^{7}$-$1.75E^{9}$

## RESULTS AND DISCUSSIONS

*Antioxidant potential of the active ingredients*

The antioxidant activity of YE and OE was measured using a distinctive assay: a quantitative method based on DPPH activity. As we concluded the antioxidant activity of YE has a significant value of 33.33%; compared to the OE which has a value of 21.85%. These two ingredients thus they are inserted into the film matrix for their antioxidant and natural preservative effect they assure a synergistic joint venture in protecting the film layer from the pro-oxidative external and internal factors. The $EC_{50}$ value of the YE and OE have a value of 0.88 and 0.60 mg/ml in this case, which represent optimum values for these ingredients. Similar values have been stated by (Huang Z. *et al*, 2009).

*Film characterization*

Alginate based films color is usually neutral; they are transparent thin layers of polysaccharides used as packaging material to protect the intrinsic value of the food product.

Keeping in mind that we added *B. subtilis*, OE and YE in order to increase the functionality and value of the package, the color of these films also changed: simple films inoculated only with BS are thin (0.08 mm), transparent and flexible; films inoculated with BS and OE are thin (0.09 mm), open brown in color and flexible; films inoculated with BS and YE are medium thin (0.11 mm, Figure 1.a.), yellowish and medium flexible; films inoculated with BS+ OE+ YE are: medium thin (0.12 mm), yellowish-brown and medium flexible. In the film section captured with SEM technology we can observe the different polymer layers which incorporate the bioactive components. The film surface is irregular and rough in aspect with small wrinkles.

The biofilm has a uniform, compact, dense structure. From the interactions of the chemical elements, salts result which crystallize under cubic form with dimensions between 2.47-3.47 µm Figure 1. b. Sometimes these crystals stick together and form uneven cross structures like in Figure 1. c. In the network matrix we can observe immobilized the *B. subtilis* culture cells.

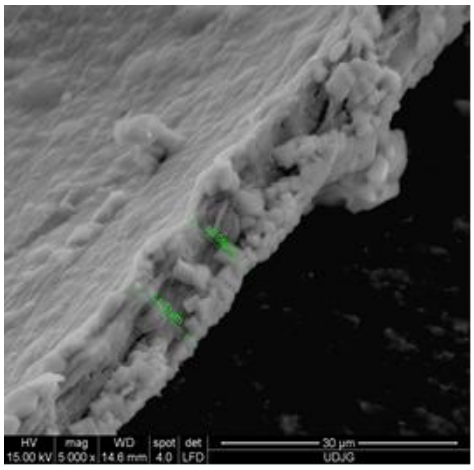


Figure 1.a **SEM images of edible biofilm section**

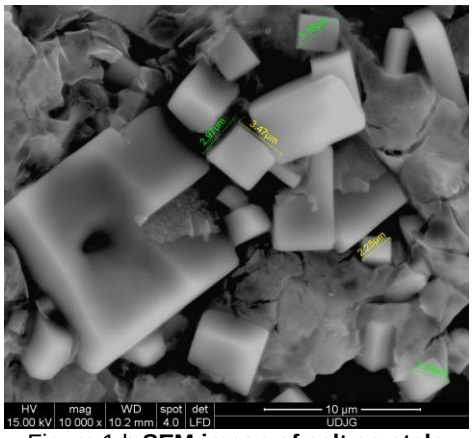


Figure 1.b **SEM image of salt crystals**

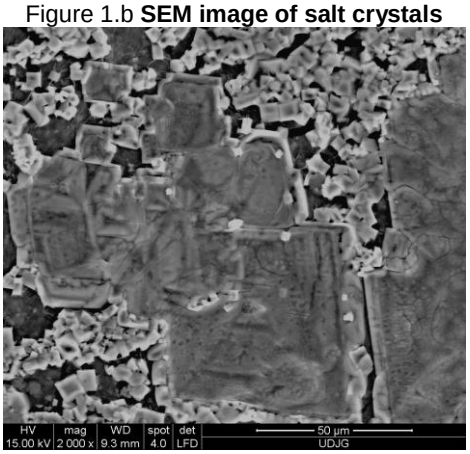


Figure 1.c **SEM image of structure colonies**

*1.1. Microbiological analysis*

Microbial growth in food is complex. It is governed by genetic, biochemical and environmental factors. The change in bacterial number over time is represented by growth curves showing the lag, exponential, stationary, and death phases of the population. The growth curves

can be plotted as the number of cells (CFU /mL) on a logarithmic scale or $\log_{10}$ CFU /mL versus time. Growth curves graphs represent the state of microbial population rather than individual microbes. Thus, both the lag phase and stationary phase of growth represent periods when the growth rate equals death rate to produce no net change in cell numbers. Table 3 illustrates the resistance of several microorganisms to temperature.

Table 3

**Heat resistance of spore-formers of importance in foods (Setlow and Johnson, 2001)**

| Type of spore | Approx $D_{100}$ (min) |
|---|---|
| **Spores of public health significance** | |
| Group I *Clostridium botulinum* types A and B | 7-30 |
| *C. botulinum* type E | 0.01 |
| *Bacillus cereus* | 3-200 |
| *Clostridium perfringens* | 0.3-18 |
| **Mesophilic aerobes** | |
| *Bacillus subtilis* | 7-70 |
| *Bacillus licheniformis* | 13.5 |
| **Thermophilic aerobes** | |
| *Geobacillus stearothermophilus* | 100-1,600 |
| *Bacillus coagulans* | 20-300 |
| **Mesophilic anaerobes** | |
| *Clostridium sporogenes* | 80-100 |
| **Thermophilic anaerobes** | |
| *Desulfotomaculum nigrificans* | <480 |
| *Clostridium thermosaccharolyticum* | 400 |

*B. subtilis* strain is present in soil and grass, non-pathogen, used for health benefits, ubiquitous and easy to isolate, resistant in spore form to extreme external factors: temperature, pressure, pH. The *B. subtilis* colonies are generally 3-8 mm in diameter, round, opaque, cream color. Two types of colonies might be observed either small colonies (2mm diameter), white pale with smooth surface or bigger colonies (3-5 mm diameter) with uneven surface wrinkled.

*B. subtilis* are rod shape bacteria that are Gram positive (Perez A.R. *et al*, 2000). They are about 4-10 μm long and 0.25–1.0 μm in diameter, with a cell volume of about 4.6 fL at stationary phase (Yu Allen Chi-Shing *et al*, 2013). The cell wall is a rigid structure outside the cell. It is composed of peptidoglycan which is a polymer of sugars and amino acids. Figure 2 depicts the microscopic aspect of *B. subtilis* strain that we used in our experiments above.

The data reveals that practically every mix performs well for cell multiplication. Of course there are some small variations between the studied samples, but in acceptable limits.

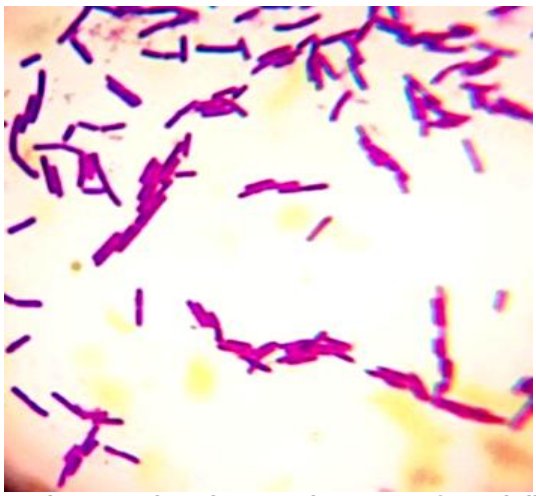

**Figure 2. The microscopic aspect of *B subtilis* strain stained with Fuschin, 100x objective (oil)**

For the control sample (M) were we have inoculated the plate only with *B. subtilis* the viability over more than 7 days is reaching a level of $7.2x10^8$ CFU/g, which is much considering that there is no other interactions. This simple solution presents also a natural lantibiotic, subtilin, which is produced by *B. subtilis*. This bacteriocin contains five lanthionine rings and has a conformation similar to nisin. For P1 sample which represents a mixture of BS and OE the results are lean in the sense that we obtained a population of only $9.85x10^7$ CFU/g. This can be logically explained due to the onion extract which can be characterized as one of the best plant antimicrobials, going hand in hand with garlic.

The onion extract inhibits *B. subtilis* and many other microorganism developments due to the bacteriocins contained who target the cell membrane of sensitive bacteria. They disrupt the membrane by making pores.This increases permeability to small compounds, causing a rapid efflux of preaccumulated ions, amino acids, and, in some cases, adenosine 5-triphosphate (ATP) molecules. A major reaction occurs while using onion extracts, forming thiopropanal-S-oxide.

Onion extract contains also antimicrobial phenolic compounds, protocathechuic acid and

cathechol (Montville T.J. *et al*, 2012). Therefore, their modes of action are probably related to those of other phenolic compounds which interfere with the membrane function of the microorganism. For P2 sample we have a mixture of BS and YE which manage to provide outstanding results in CFU value.

The cell growth of *B.subtillis* incorporated in Al based films were plotted in Figure 4. For film recipe 1, Al+ KG+ CMC were used as base film materials in which we incorporated the active ingredients. Sample 1A shows a poor result in CFU/g value reaching the level of $8.4x10^8$ after 8

days. This result can occur due to the fact that sample 1A had been inoculated with the smallest amount of BS. For samples 1B and 1C the results

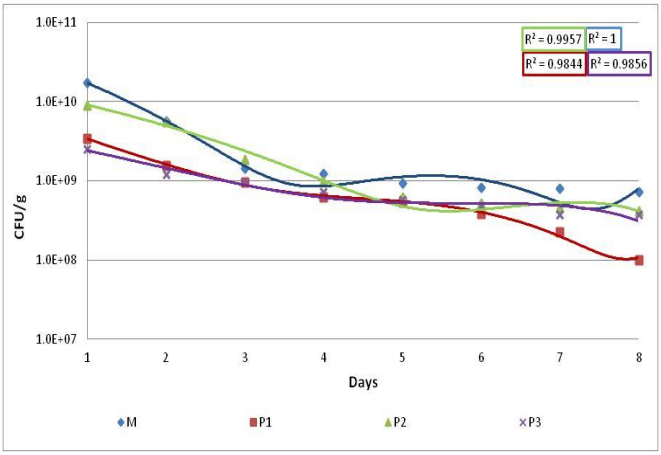


Figure 3 **The influence of active elements from OE and YE over probiotic viability of *B. subtilis* in 8 days preservation at 4°C**

Here we reach a maximum of $4.15x10^8$ CFU/g due to YE which potentiates the BS development due to the high amount of nitrogen which is necessary in microbial metabolism. This YE has in composition a minimum of 55% protein and is rich in glutathione. GSH is capable of preventing damage to important cellular components caused by reactive oxygen species such as free radicals, peroxides, lipid peroxides and heavy metals (Pompella A. *et al*, 2003). Another big advantage is that this YE obtained from *Saccharomices cerevisae* provides a taste and color benefit: specific Kokumi taste and yellowish color due to the sulfur rich content.

For P3 sample which represents a mixture of BS+ YE+ OE we have achieved an optimum result in the growth of the microbial population. This represents a balance point were OE and YE somehow act synergicaly and potentiate the development of BS which reaches a value of $3.75x10^8$ CFU/g.

For film recipe 2; Al+ KG +CMC+ RC were used as base film materials in which we incorporated the active ingredients. Samples 2B and 2C show similar values of $1.3\text{-}1.4x10^9$ CFU/g after 8 days which represent interesting data for the microorganism encapsulated into the film matrix. For sample 2C we get the highest result of $1.8x10^9$ CFU/g of BS which is normal to the fact that 2C has been inoculated with the higher concentration of the microorganism.

*Microbiological aspect of edible films*

To determine the quality of alginate based composite films, we used the SEM equipment Quanta 200 in order to observe the morphology and dispersion of the polymers and the active ingredients and bacterial cells into sheets. Figure 5. illustrates the images of alginate based films

are promising reaching CFU values of $1.1\text{-}1.3x10^9$ CFU/g. These similar results are usual for the active ingredients inside.

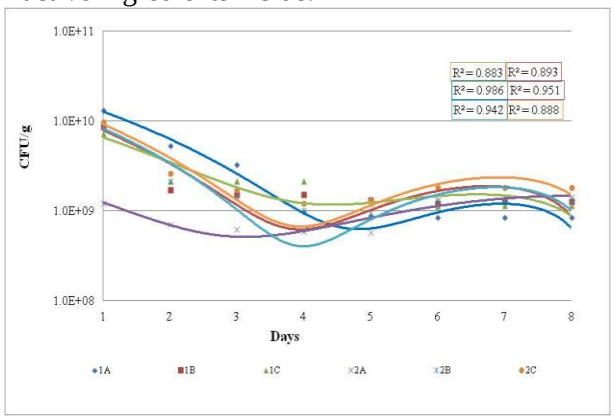


Figure 4 ***B. subtilis* cell growth in Alginate based films**

from different perspectives. The *B. subtilis* is a rod shape bacteria that typically forms small clumps, short chains or single cells. During biofilm development, *B. subtilis* switches from being flagellated, motile single cells to growing in long chains of nonmotile cells that form parallel bundles (Branda SS. *et al*, 2006). Once this matrix is produced, the community develops a high degree of spatiotemporal organization culminating with sporulation occurring preferentially at the tips of aerial structures.

Images (1A, 1B and 1C) provide a clear perspective over the surface of the Al based films which incorporated the active ingredients and how the microorganism developed by creating snow flake small colonies (1A) or overlap each other in big colonies with cross-shape and irregular surface.

These are uniformly distributed in the film structure (1B and 1C). Images (1A', 1B' and 1C') are taken with the magnitude of 5000x and illustrate the *B. subtilis* population density which is homogeneously distributed. (1A') is more sporadically in numbers while (1B') and (1C') is very consistent; this being directly correlated with the amount of *B. subtilis* inoculated into the recipe.

For images (2A, 2B and 2C) the situation is similar like to film recipe 1 described above. (2A') illustrates at 10.000x, a heterogeneous display of the cells into the polysaccharide film matrix. In this case a thin layer of gel surrounds the rod shape walls of the grown culture. Image (2B') shows a great abundance of crystal structures with cuboids shapes and different dimensions. We assume that these crystals represent salt residues which are used to standardize the polysaccharides for the film

matrix. For film sample (2C') images provide good details about the agglomeration and stickiness of the pure culture. In this case the reading has been realized with 2000x magnification.

*Design of experiments (DoE)*

DoE provides five possibilities for a "Goal" to construct desirability indices ($d_i$): none (to disregard any given response), maximize, minimize, target, in range (simple constraint) and equal to (components only). Desirability's range from zero to one for any given response. The program combines individual desirability's into a single number and then searches for the greatest overall desirability. A value of one represents the ideal case. A zero indicates that one or more responses fall outside desirable limits. DoE uses an optimization method developed by Derringer and Suich, described by (Myers R.H. *et al*, 2009).

For the components of the mix there are no changes and every "Goal" is set to "In range" option.

For the response we set the "Goal" to **Target** and maximum importance for the following

-Shelf life, target 8 days;

-Color difference, to in range;

-Viability of BS cells, target $1x10^9$ cfu/g.

A desirability formula was used to determine the optimized solution were a **92,60%** desirability was a little better than the screening experiment. Also the active mix performance was actually much closer to the benchmark within the margin of error. For the other three Optimized contour graphs, the Design is strictly correlated between: time, ph value and growth rate factors.

This happens due to a direct connection between these elements and the development of *Bacillus subtilis.* For Shelf life contour graph the program flagged a prediction of 7.9 days. If we increase the targeted value to a value of 9 or more days we risk to fall out of the targeted settings and influence the experiment.

At a second look in the Shelf Life the chances of BS evolution, increase if we aim for 9 or more days, which is normal for this bacteria. For the Color difference contour graph the value predicted by the program is around 93.84 which is important because the films have a more brownish color. Here we can observe a color gap between the two active ingredients onion extract and yeast extract. They are situated in opposite corners. If the OE provides a clear brownish color to the films on the other side the YE provides a more yellowish aspect. In the Viability contour graph an increase in cfu units is visible if we increase the amount of BS and EC. These 2 ingredients repeal each other. This is why the whole picture must be studied and not base our results only on a contour graph. Mixture design provides an understanding of interactions between all of the ingredients with respect to the desired properties so that future formulation development becomes less reliant on trial and error.

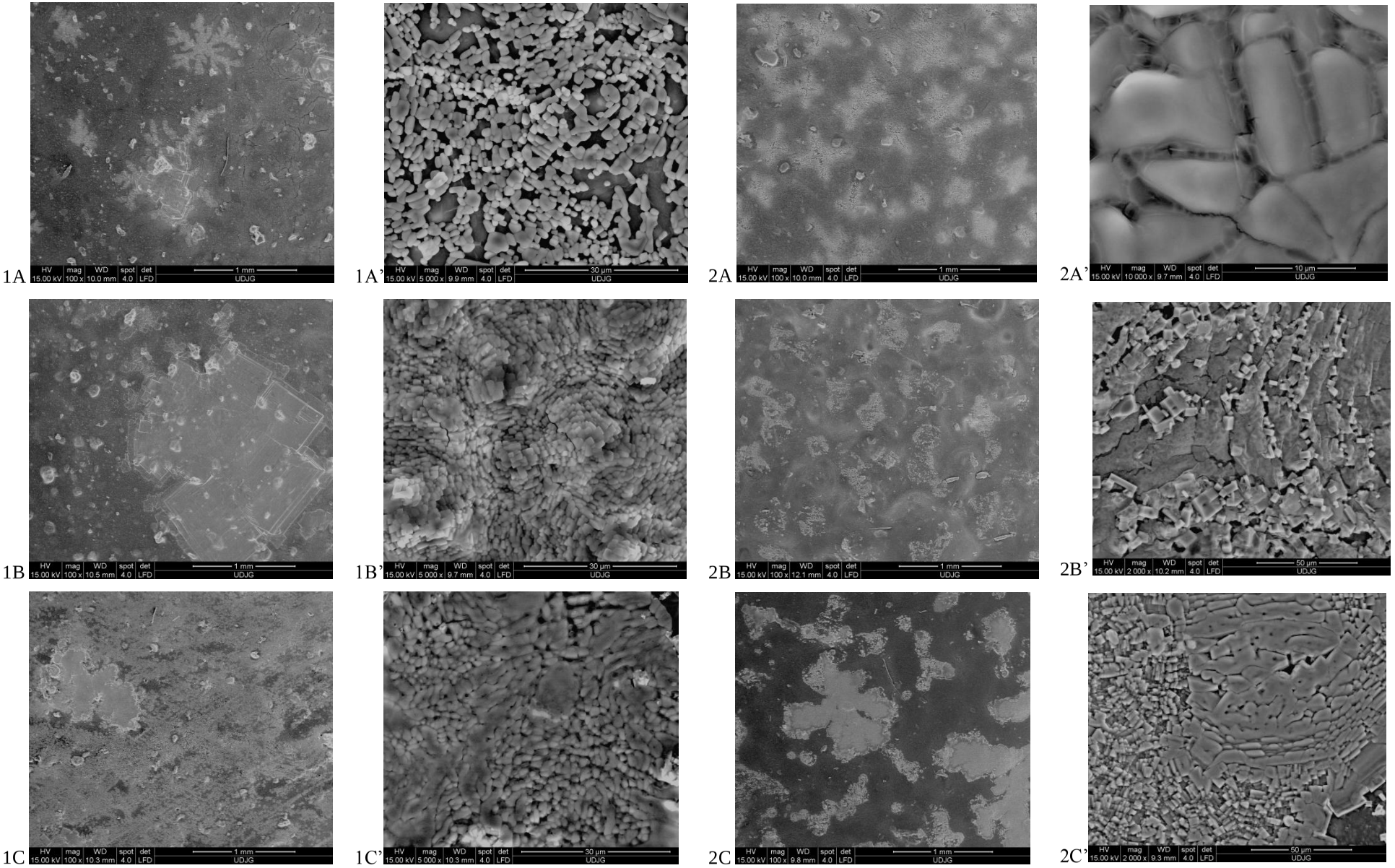


Figure 5 **Electron microscope images for recipe 1 and recipe 2**

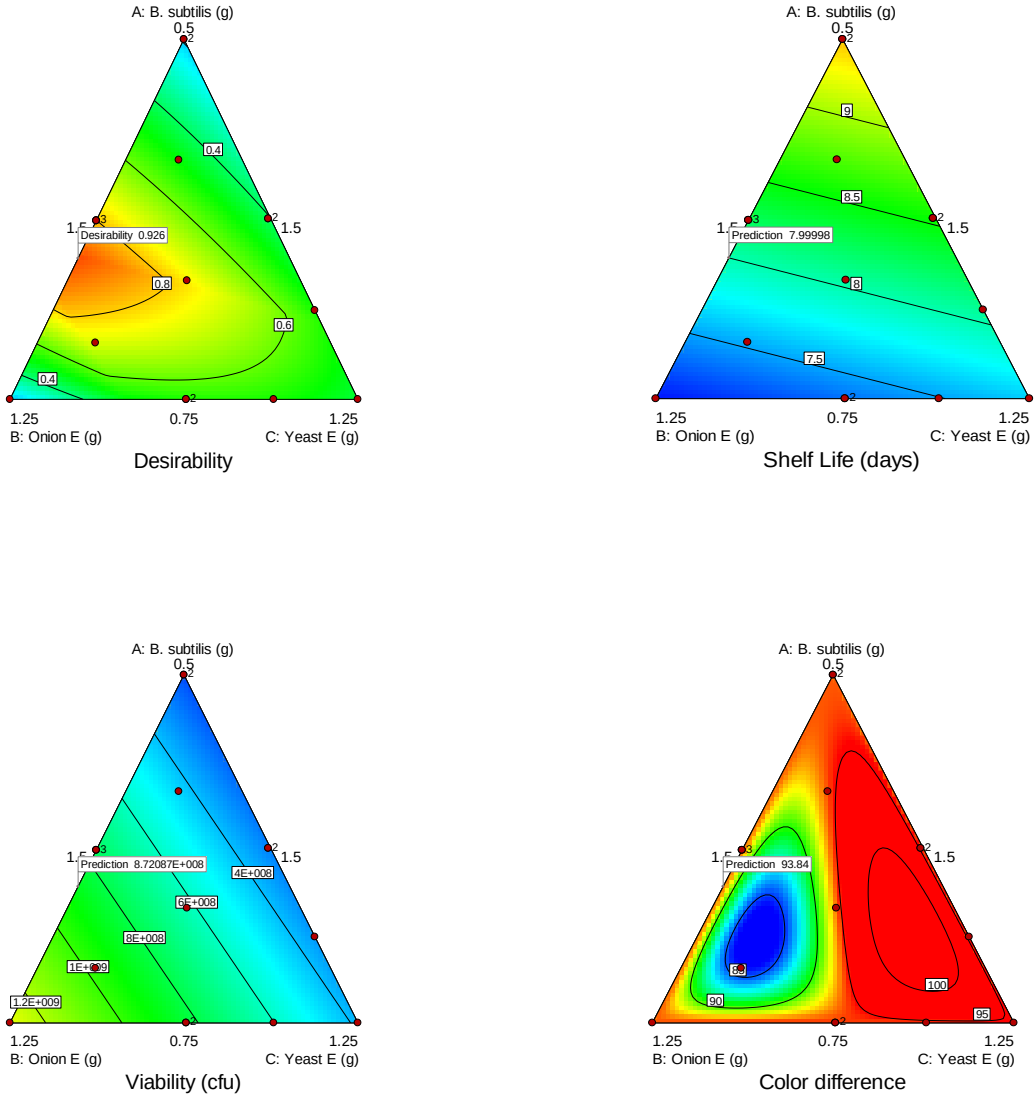


Figure 6 **Desirability, Shelf life, Color difference and Viability of BS cells –Optimized contour graphs**

## CONCLUSIONS

This study demonstrates that obtaining Al based films and incorporating distinct active ingredients with unique properties provide a „clean" solution and a future reference to healthy packaging materials. An interesting approach was made in the sense that we could study the interactions between YE, OE and the development of *B. subtilis.* Most of the *B. subtilis* biofilm data comes from studies on the development of complex, wrinkled colonies and from the development of pellicles at an air-liquid interface.

Through SEM analysis we could gather information about how the polysaccharide matrix incorporates the cells of probiotic culture and the conformation which this takes after the sporulation process during the preservation of the In both studies, we focused on the time frame of minimum 8 days to examine the development and resistance of *B. subtilis.*

In both cases the results are promising. For the single active ingredients used the best result came from sample $P_2$ (*B. subtilis* + yeast extract) were the number of CFU reached a maximum of $4.15x10^8$. In the second case for the Al based films the best solution was established with Al + CMC + RC + KG and a mixture of *B. subtilis* + yeast extract + onion extract. Here we had a number of $1.8x10^9$ CFU/g.

Last but not least we can optimize our results and mixtures by using DoE which combines statistic and mathematical analysis in obtaining an optimum recipe for our film. All this data represent a big advantage for future development of active packaging for fresh products.

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# BROOMRAPE (*OROBANCHE CUMANA* WALLR.), THE MOST IMPORTANT PARASITE IN SUNFLOWER CROP IN ROMANIA

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**Abstract**

Broomrape (*Orobanche cumana* Wallr.) is a parasitic angiosperm that has been causing a great deal of damage to sunflower production for more than a century. There has been a constant tug-of-war between sunflower breeders and *Orobanche cumana*, with frequent changes in which side has the upper hand. Almost as soon as the breeders find a source of resistance to the latest race of the parasite, broomrape responds by evolving another virulent race. Russian researchers identified the first two races of this parasite (A and B), after that, being identified other four races (C, D, E and F) as well as the sunflower differentials carrying the dominant genes for resistance, by the researchers in Romania and Spain. In the last years, some authors have communicated the appearance of the new, very virulent populations of broomrape, in different regions cultivated with sunflower, over the world.

Sunflower selection for broomrape resistance makes use of different methods for testing breeding materials (in the field or in greenhouse), looks for resistance sources and has so far produced significant results. Dominant genes for resistance to races A, B, C, D, E and F have been found and incorporated into cultivated sunflower genotypes. The resistant hybrids having resistance to the broomrape populations more virulent than race F have been produced by incorporating genes of resistance, coming specially from wild *Helianthus* species.

The aim of our investigation was to compare the virulence of broomrape samples collected in different areas cultivated with sunflower and infested with broomrape, from Romania. The same, we studied the dissemination of these populations in time and territory, in relation with different sunflower resistant genotypes. It was evaluated the influence of the parasite populations on the sunflower hybrids seed yield.

Ten populations of broomrape collected from different locations in Romania have been used in the artificial infestation conditions, for establishing the presence of different broomrape (*Orobanche cumana* Wallr.) races in these areas. The broomrape samples were stored in saved conditions and used for artificial infestation in the green house and phytotron. There have been tested sunflower differentials for the broomrape races until the sixth one and, different hybrids with different resistance to the newest virulent populations of the parasite.

Results of evaluation of sunflower differentials for different races or populations of the parasite *Orobanche cumana* have demonstrated that in Romania, the three more spread broomrape populations in the largest area cultivated with sunflower, are very different regarding the virulence and dissemination of the parasite.

The influence of the parasite on sunflower seed yield was very high, depending by the hybrid type of resistance.

**Key words**: sunflower, broomrape, races, resistant genotypes

Sunflower is one of the most important annual oilseed crops in the world. *Orobanche cumana* Wallr. (sunflower broomrape), a holoparasitic angiosperm plant that infects sunflower roots, is regarded as one of the main constraints on sunflower production in Southern Europe, Spain, Black Sea region, Ukraine, China and the Middle East (Molinero-Ruiz *et al*, 2015 ).

According to Morozov (1947), the first reports of broomrape in sunflower came from Saratov in Russia and date back to the 1890s expanding to Moldova and Romania by the beginning of 20$^{th}$ century (Iliescu, 1974). Morozov (1947) mentions that it was identified the first race of broomrape (race A) in the breeding station of Saratov area (communicated by Placek, 1918) and the second race (B), communicated by Zdanov (1926), in Rostov area.

Soon, after being discovered the two races of the parasite, it was developed a number of sunflower varieties resistant to them. Later on, a new race that could not be controlled by the genes for resistance to races A and B was identified in Moldova by Sharova (1968). Through genetic research, Vranceanu *et al* (1980) established that there were five broomrape races (A, B, C, D, E) in Romania and identified dominant genes controlling resistance to them. They also identified a set of

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differential lines that had cumulative resistance to the five successive races, conferred by the dominant genes *Or1*, *Or2*, *Or3*, *Or4* and *Or5*, respectively. Alonso et al. (1996) found a new, virulent race (race F) of the parasite, in Spain. The race F was found in Romania too, being identified and the dominant gene *Or6* in the inbred line LC 1093, which confers resistance to this race (Pacureanu-Joita, 1998). Changes of the broomrape race composition in Romania have been reviewed (Pacureanu-Joita *et al*, 2009). The findings of the study show that a new virulent population of the parasite has appeared in the country, started with 2006 year.

The aim of our investigation was to compare the virulence of broomrape samples collected in different areas cultivated with sunflower and infested with broomrape, from Romania. The same, we studied the dissemination of these populations in time and territory, in relation with different sunflower resistant genotypes.

## MATERIAL AND METHOD

Ten broomrape populations collected from different fields cultivated with sunflower, in Romania have been studied in the artificial infestation conditions, in the greenhouse or in phytotron. The seeds collected in 2012, 2013, 2014 and 2015 years were stored in refrigerator at the temperature of four degree.

In the experiments for the broomrape virulence evaluation there have been used the differential lines for the races D (S-1358 line), E (P-1380 line) and F (LC 1093), as well as some hybrids resistant to the new populations of the parasite. It was used as check for sensitivity the inbred line AD-66. These hybrids have been tested before, in the natural infested fields in Romania, In Turkey or in Spain.

Some experiments have been done in field conditions, some others in the artificial infestation conditions.

Broomrape tests in the artificial infestation conditions were performed using two methods. For test in phytotron wooden cases 1.0x0.5x0.01 m in size, have been used, in which a soil-sand mixture (50:50) is laid, this being thoroughly mixed with 5 g broomrape seeds and 500 g sand. In this case 9 sunflower rows are sown, 10 cm apart. Starting with 26 days from emergence, plants can be removed, in order to note occurrence or absence of broomrape attack on sunflower plant roots. In the greenhouse, vegetation pots of 10 l in capacity have been used, and a homogenous mixture of earth, sand and broomrape seeds is poured inside, infestation being carried out with 0.5 g broomrape seeds, mixed with sand (1:9). The broomrape attack was noted after sunflower blossoming, when broomrape plants appear on soil surface. The attack degree was calculated using McKinney formula (quoted by Acimovic, 1979).

## RESULTS AND DISCUSSIONS

The parasite *Orobanche cumana* has developped very fast, new virulent populations in sunflower crop in Romania. So, in the last 10 years, there have been identified two or three new races of the parasite (*figure 1*). We named these races G and H, taking into consideration their virulence but, there are not differential lines for these races, the inheritance of resistance to these races being more complicate, comparing with races A to F.

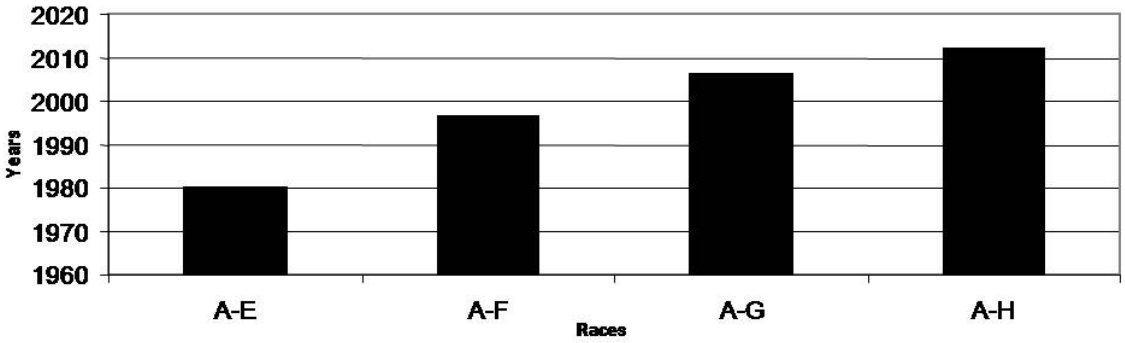


Figure 1 **The evolution of broomrape (*Orobanche cumana*) parasite races, in sunflower crop, in Romania**

Ten populations of broomrape (*Orobanche cumana* Wallr.), collected from different areas are presented in *table 1*. The seeds have been collected in different four years.

These populations have been used for testing in the artificial infestation condition, using differential lines for different broomrape races.

Table 1

**The broomrape populations collected from different infested fields, in different years**

| Area | Location | Year |
|---|---|---|
| Braila 1 | Valea Canepii | 2013; 2015 |
| Braila 2 | Scarlatesti | 2013;2015 |
| Braila 3 | Tufesti | 2013;2015 |
| Constanta 1 | Cuza Voda | 2012;2014 |
| Constanta 2 | Stupina | 2013, 2015 |
| Constanta 3 | Pantelimon-Gradina | 2012; 2015 |
| Tulcea 1 | Topolog | 2013;2015 |
| Tulcea 2 | Traianu | 2012;2015 |
| Ialomita 1 | Baraganu | 2012;2014 |
| Ialomita 2 | Iazu | 2013;2015 |

The results presented in the *figure 2* are showing that the differential line for the race E of the parasite (line P-1380) was attacked by all broomrape populations used in this experiment. The attack degree on this line was higher in case of source of broomrape Braila 3, as well as Tulcea 2 and Ialomita 2. The differential line for the race F (line LC 1093) was not attacked in Braila 3 and Ialomita 2, having a very low attack degree in Tulcea 2 and Ialomita 1 locations. The higher attack of the parasite on this line is in case of Braila 1 and Constanta 2 locations. This it means that the new virulent population of the parasite is still not present in two locations and it has low attack (below 10%) in three locations.

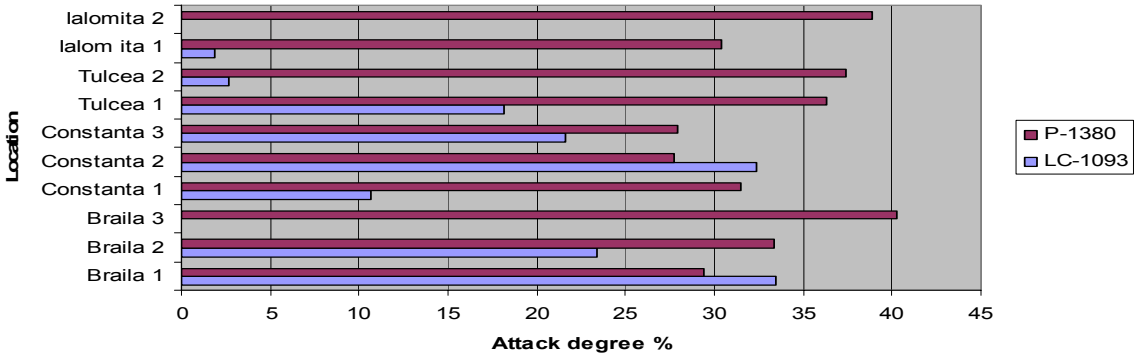


Figure 2 **Attack degree of ten populations of broomrape (*Orobanche cumana*) on the differential lines for the races E and F of the parasite**

Taking into consideration these results, it was made a study of these ten populations of broomrape, using the differential line for the race D of the parasite. The results presented in *figure 3* show that this line was attacked in all cases, the attack degree being not so high comparing with the check for sensitivity. The hybrid PR644LE19, which is known as resistant to the race E of the parasite, was attacked, the attack degree being lower in two locations, Braila 3 and Ialomita 2.

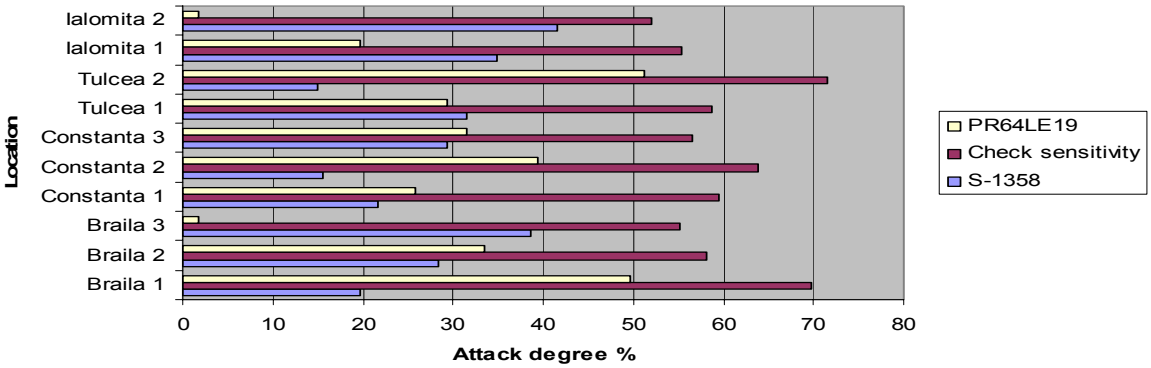


Figure 3 **Attack degree of ten populations of broomrape (*Orobanche cumana*) on the differential line for the race D of the parasite**

In *figure 4* are presented results regarding the behavior of the hybrids Favorit (resistant to race F) and PR64LE20 (resistant to race G) to the attack of the ten populations of broomrape parasite. The hybrid Favorite was not attacked in case of tow populations: Braila 3 and Ialomita 2. The attack degree on this hybrid is high, taking into consideration that some years ago this hybrid was full resistant in all areas infested with broomrape in Romania. The hybrid PR64LE20 is full resistant in three locations ( Braila 3, Ialomita 1 and Ialomita 2), having a low attack degree (below 10%) in other 4 locations. The highest attack of broomrape on this hybrid was in Braila 3 location. This it means that the new race, overcoming the resistance to race G is present in all locations were this hybrid was attacked.

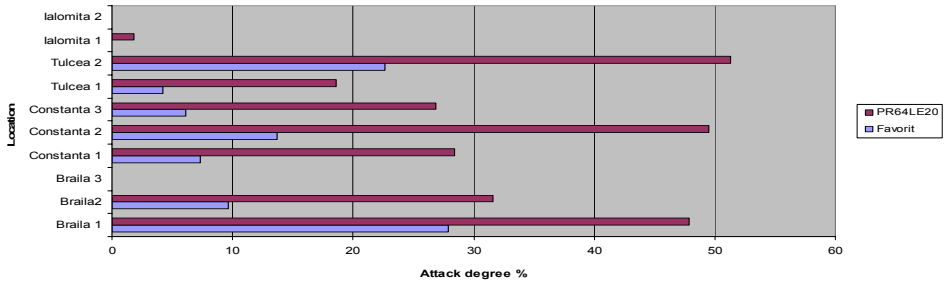


Figure 4 **Attack degree of ten populations of broomrape on the two hybrids resistant to the races F**

In *figure 5* are presented the results regarding the seed yield released by the hybrids Favorit and PR64LE20, in six locations from the four areas infested with broomrape, in year 2015. These are showing that in locations (Tufesti-Braila and Iazu-Ialomita) were the new races of the parasite are not still present, the two hybrids have released good seed yield. In locations as Valea Canepii-Braila and Stupina- Constanta, were the infestation degree with the new races is high there is a big difference between these two hybrids, regarding the seed yield. This it means that in these areas were the new races of the parasite have been spread in the last years must to be cultivated sunflower hybrids resistant to them.

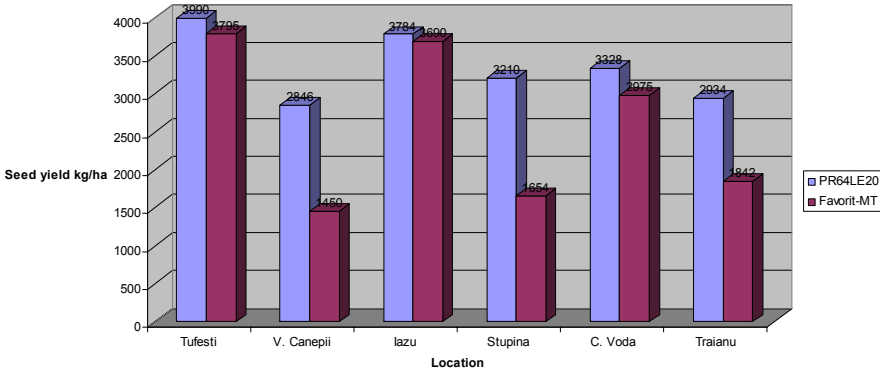


Figure 5 **Realized seed yield for the hybrids Favorit and PR64LE20, in six locations in Romania, in 2015 year**

## CONCLUSIONS

Parasite broomrape (*Orobanche Cumana*) has developed in the last years, new virulence in sunflower crop in Romania. These new races have overcome the resistance of the hybrids which have been resistant to the race F of the parasite. The new virulent populations of the parasite are different in some areas like Braila, Tulcea or Constanta. In Ialomita area the new races are not still present. There is a high difference between the seed yield released by the hybrids having resistance to the race F, respectively to the race G, in the areas with high infestation of the parasite.

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# DRYDOWN COEFFICIENT ANALYSIS IN SOME COMMERCIAL CORN HYBRIDS

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**Abstract**

The concept of drydown or loss of water from the corn grain has been little studied in Romania. Hybrid seed manufacturer's recommendations are not always complete in terms of water loss rate of the grain, than may cause additional costs for farmers, represented by drying after harvest. Choosing a hybrid for a farm must also consider the possibilities of artificial drying, if the selection does not considering an analysis of the rate of water loss of the grain. Also having knowledge about the rhytm of loss of water from grain grown hybrids, we can expect early harvest and a harvest schedul. Based on these considerations, in the spring of 2015, in the village Lovrin, Timisoara, was placed an experimental field that was aimed to evaluate the rate of water loss of the corn grain. It was analyzed a set of 18 commercial hybrids in Romania, assigned in groups of maturity FAO 260-510. Moisture determinations occurred in the first phase to identify physiological maturity stage (humidity 30%) of 3 in 3 days (black layer). Subsequently, determinations were made daily up to a humidity of 15% for each hybrid. Results indicate a percentage of water loss from the grain from 0.28 to 1.1% daily depending on the hybrid. Thus, early hybrids lose water more uniformly than late hybrids (0.58%/day and 0.86%/day). Immediately after reaching physiological maturity, the rate of water loss from early grain hybrids is slower than late hybrids values being 0.47%/day and 0.79%/day respectively. With the synthesis of dry matter in kernel of physiological mautiry value for technological maturity (15%), the rate of water loss in grain presenting values of 0.38%/day for early hybrids and 0.43%/day for late hybrids. Another aspect experimentation was seized after concluding that hybrids flint grain lose water more slowly than dent grain hybrids, averaged 0.33%/day and 0.73%/day respectively.

**Key words**: drydown, later loss in corn, black layer

Corn kernels lose moisture through the grain filling period due to a combination of evaporative water loss and accumulation of kernel dry matter. Corn that is mature will have a "black layer" that appears at the base of the kernel. The appearance of this black layer designates the end of dry matter accumulation (Geyer A., Thomison P., 2006). Although corn is harvested at high grain moistures for silage and seed corn, ideal harvest moistures for field corn range from 15 to 20% (R. Elmore, L. Abendroth, 2007). Several factors impact the rate of dry down: weather, hybrid, planting date, and ear characteristics.

On average, typical seasonal drying rates range from 0.4 to 0.8% moisture loss per day (B. de Jager *et al,* 2004; Brooking I.R., 1990; Duncan W.G., Hatfield A.L., 1964). If the fall months vary from normal in terms of temperature or moisture, the rate of dry down will differ. For example, wet and cool weather will delay drying.

Up to Hellevang K.J., 2004, they have recorded seasonal dry down rates less than 0.3 % per day. On the other hand, warm dry weather speeds drying rates. Kernels could lose up to 1.0% moisture per day. Considering that corn at maturity has about 30% water content it can be easily take 14-25 days for grain moisture of 15% (Filipenco A. *et al,* 2013). Tarter *et al* (2004) and Goodman M.M. (2005), report that tropical germplasm, when directly introduced in temperate environments, has high grain moisture content at harvest.

Typical for cobs corn hybrids are important in the rate of loss of water from grain. They have a larger effect when outside conditions are unfavorable to a rapid loss of water (Sweeney P.M. et all., 1994).

- *The number and thickness of husk leaves*. "A good cob dressed" can lead to a slower loss of water from grain.
- *Senescence of husk leaves*. The faster dryed of husk leaves may favors a rapid loss of water.
- *The "covered" of the ear*. A cob well covered, compact, losing harder water than a cob with husk lax, allowing a "breathing".
- *Position the ear*. It is preferable to have a semibent cob, allowing drainage of rainwater. Erected maturity cobs are not desirable, that may accumulate water from rainfall. Total bent ears

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favors their fall from husks, the losses can be sometimes significant.

- *Properties of pericarp*. A flint lose water harder than a dent grain.

Conform to Reid L.M. *et al.,* 2010, **e**xternal factors can positively or negatively influence the rate of loss of water from grain. Thus, the positive factors that favor water loss grain are: sunlight intensity, temperature at ground level, air temperature, wind speed and evapotranspiration. Negative impact on the rate of water loss of the grain may be: air relative humidity, soil moisture and plant density.

## MATERIAL AND METHOD

### Study guidelines

A field experiment in a split-plot design, with three replicates, was conducted in 2015, at the Agro Marincus SRL, Lovrin, Timis. (45°59`07.2``N, 20°45`19.0``W). Precursory plant was winter wheat (fertilized with complex 2:1:1, 600 kg/ha). Date sowing took place on 05/05/2015 and harvests were held according to established protocol. Basic fertilization took place in seedbed preparation with 200 kg/ha, with complex 2:1:1. During the growing season was carried out a single tillage that has been applied a dose of 200 kg/ha 2:1:1. To combat pathogens, it was applied at a dose of 1.2 l/ha fungicide Opera, with foliar fertilization with 1.5 l/ha YaraVita Zintrac. Weed control was performed by herbicide Nicosulfuros 40g / l and 600g SDMA acid from 2.4D l/ha.

The experimental protocol on moisture determinations had two phases, as follows:

**1.** Transitions field of 3 in 3 days to assess physiological maturity stage. When a variety was noted, transitioning field from two in two days to determine the exact humidity of 30%.

**2.** After a maturity of 30 %, daily passage for determining the rate of loss of water from the grain, to maturity of 15 %.

For moisture determinations were harvested five cobs for each determination in each set; seeds were mixed making a sample to be analyzed. Moisture content was determined using the analyzer Pfeuffer E50.

### Materials

Hybrids analyzed are from group of maturity FAO 260-510. Of these, 15 hybrids are dent grain and 3 are flint grain. At the 15% moisture were harvested 10 cobs of each variant for analyzing biometric cob. After flowering-silking period, when vegetative stage stopped, were determined by measuring the 10 plants for each variant, plant size and height of insertion of ear (*table 1*).

### Climate conditions

The climate of Lovrin zone is temperate continental one, with shades of excessively during the summer. Excessivity climate is due to very high temperatures during the day, from early morning until after sunset. Often, the high temperatures associated with the heat (*figure 1*). The hail storms are often too.

The soil where the trial was conducted is a cambic chernozem in class 2 source of evaluation according to the National Research-Development Institute for Soil Science and Agricultural Chemistry Environmental Protection (ICPA).

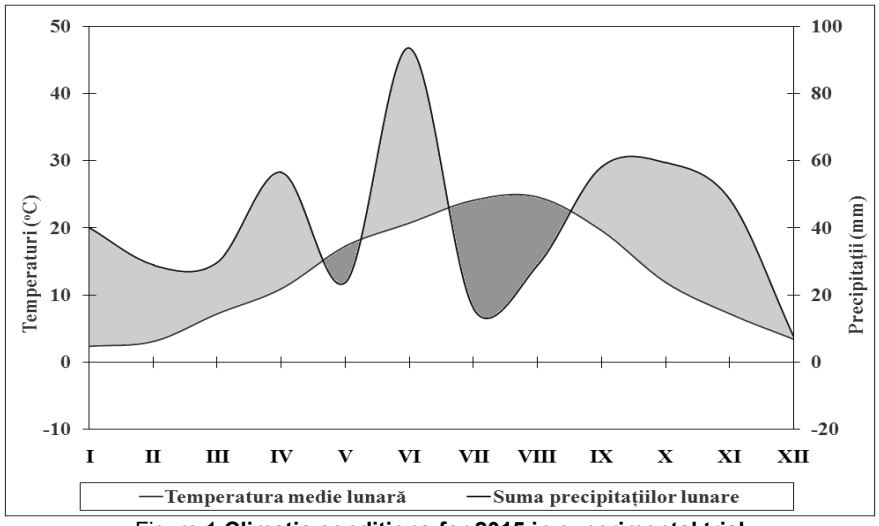


Figure 1 **Climatic conditions for 2015 in experimental trial**

## RESULTS AND DISCUSSION

The main limiting factor is the temperature in corn production. In 2015, during the growing season of maize, constant heat on a widely varied values ranging from 6°C at night to 38°C during the day. During the growing season corn accumulate a growing number of thermal units (GDU) differently depending on minimum and maximum temperatures recorded during the day (Cavalieri A.J. and Smith O.S., 1985).

Theoretical predictions inclined to anticipate the rate of loss of water from grain according to this indicator. So, when GDU daily amount is around 12, the rate of water loss in grain is 0.5%. The situations in which the daily amount GDU is located around 17, the amount of water lost from the grain is 0.6%, while values of 22 GDU day lead to a rate to slow water loss of the grain, the 0.75%/day (Lana M.R. *et al,* 2014).

In a study undertaken in 2015 have been determined using Duncan test for differences between the versions on silk and physiological maturity. We also configured data in a range of 2 weeks from silky to physiological maturity, which was established corn moisture level, as outlined in *table 2*.

Thus, they highlighted the number of days from vegetative emergence to flowered-silk and from vegetative emergence to physiological maturity (30% moisture). Duncan test confirms both silking data and for physiological maturity, also, that the maturity group has significant influence over these periods. The earliest hybrids silky faster than later hybrids, amount of GDU being lower than those last mentioned.

The results are confirmed by Hellevang K, 2004, which states that hybrids FAO 260-340 GDU 1350 are required for the onset of flowering, grain filling beginning of 1890 and 2710 GDU to reach physiological maturity. For hybrids 350-550, 1350-1375 GDU needed early flowering and 2790-2870 GDU to physiological maturity

Table 1

**The characteristics of studied hybrids**

| Hybrid | FAO* | Kernel type** | Plant height (cm) | Ear insertion (cm) | No of rows/ear | No of seeds/row | Ear length (cm) | Yield grain/cob (%) |
|---|---|---|---|---|---|---|---|---|
| Hyb1S | 290 | D | 229 | 113 | 16 | 41 | 19.9 | 0.87 |
| Hyb2E | 350 | F | 251 | 102 | 18 | 34 | 19.6 | 0.81 |
| Hyb3P | 350 | D | 252 | 93 | 18 | 37 | 20.8 | 0.82 |
| Hyb4L | 380 | D | 261 | 89 | 20 | 41 | 21.2 | 0.83 |
| Hyb5D | 450 | D | 260 | 87 | 18 | 35 | 20 | 0.81 |
| Hyb6O | 430 | D | 273 | 91 | 18 | 45 | 21.8 | 0.84 |
| Hyb7M | 400 | D | 262 | 105 | 18 | 41 | 23.8 | 0.81 |
| Hyb8SA | 490 | D | 253 | 90 | 18 | 37 | 23.2 | 0.80 |
| Hyb9M | 400 | F | 248 | 111 | 18 | 33 | 18.3 | 0.77 |
| Hyb10P | 310 | D | 257 | 98 | 16 | 38 | 20.6 | 0.86 |
| Hyb11K | 350 | D | 252 | 98 | 16 | 35 | 21.8 | 0.81 |
| Hyb12M | 400 | D | 256 | 97 | 16 | 30 | 18.2 | 0.86 |
| Hyb13O | 400 | D | 278 | 103 | 14 | 39 | 21.5 | 0.83 |
| Hyb14A | 490 | D | 253 | 113 | 18 | 39 | 21.6 | 0.83 |
| Hyb15L | 510 | D | 271 | 102 | 14 | 39 | 20.8 | 0.80 |
| Hyb16C | 260 | D | 268 | 109 | 18 | 35 | 21.5 | 0.86 |
| Hyb17E | 350 | F | 263 | 98 | 16 | 37 | 21.8 | 0.84 |
| Hyb18R | 340 | D | 259 | 108 | 18 | 37 | 19.5 | 0.85 |

*FAO-conform to seeds provider; **D-dent; F-flint

Weeks sampling to identify moisture from the cob bring more information to farmers in the Lovrin area. Knowing this data the farmers can prepare a plan for irrigation, so grain filling to be done faster and in a greater amount. The rate of water loss in grain after physiological maturity is strongly influenced by the rate of accumulation of dry matter during flowering - physiological maturity.

Evaluating the days on which a hybrid reach physiological maturity and the difference between them and the days to flowering - silking, conditions of excessively in period of August-September, when there were high temperatures lead to reducing the filling grain and default the rate of water loss of the grain, as can be seen in *figure 2*.

The corn hybrids with flint pericarp lose hardest water at physiological maturity of grain. Water losses of the grain are 0.33% and 0.46% for hybrids and Hyb9M, respectively Hyb17E. With special purpose in food or feed for higher protein content (up to producers of these 2 hybrids), productions were 5.8 t/ha, respectively 8.57 t/ha.

Research conducted by Milomi F. *et al.*, 2013, confirms that flint hybrids are less productive than dente ones, average productions in 2001-2004 being 6.20 t/ha, respectively 6.39 t/ha in favor of dent hybrids.

Table 2

**Evaluating cob moisture during the filling of grain; silking and physiological date**

| Genotype | FAO | Silking date* | Cob moisture value | | | | Physiological maturity** |
|---|---|---|---|---|---|---|---|
| | | | Week 1 | Week 3 | Week 5 | Week 8 | |
| Hyb1S | 290 | 58 a | 60.8 abcd | 50.4 cd | 39.6 de | 30.7 h | 114 a |
| Hyb2E | 350 | 59 b | 61.4 cde | 50.2 cd | 38.8 def | 27.9 d | 113 a |
| Hyb3P | 350 | 60 bc | 61.2 bcde | 50 cd | 38.6 de | 27.7 c | 114 a |
| Hyb4L | 380 | 61 cd | 61.8 bcde | 50.6 cd | 39.2 def | 28.3 d | 116 b |
| Hyb5D | 450 | 67 g | 59.8 a | 48.6 ab | 37.2 c | 26.3 ab | 120 ef |
| Hyb6O | 430 | 66 fg | 61.7 bcde | 50.5 cd | 39.1 def | 28.2 d | 119 de |
| Hyb7M | 400 | 63 e | 62.8 ef | 51.6 d | 40.2 h | 29.3 def | 119 de |
| Hyb8SA | 490 | 69 h | 61.2 bcde | 47.7 a | 33.8 a | 25.6 abc | 120 ef |
| Hyb9M | 400 | 65 f | 63.1 f | 51.9 d | 40.5 fgh | 29.6 fgh | 121 f |
| Hyb10P | 310 | 61 cd | 62.5 ef | 52.1 d | 41.3 i | 32.4 i | 117 bc |
| Hyb11K | 350 | 62 de | 62.8 def | 51.6 d | 40.2 gh | 29.3 efg | 118 d |
| Hyb12M | 400 | 66 f | 62.4 ef | 51.2 d | 39.8 efg | 28.9 de | 121 f |
| Hyb13O | 400 | 63 e | 63.2 f | 52 d | 40.6 h | 29.7 fgh | 119 de |
| Hyb14A | 490 | 70 hi | 62.7 ef | 49.2 ab | 35.3 b | 27.1 bc | 124 g |
| Hyb15L | 510 | 71 i | 61.7 cde | 48.2 ab | 34.3 a | 26.1 a | 124 g |
| Hyb16C | 260 | 56 a | 59.9 ab | 49.5 bc | 38.7 d | 29.8 fgh | 112 a |
| Hyb17E | 350 | 60 bc | 60.1 abcd | 48.9 ab | 37.5 c | 26.6 abc | 113 a |
| Hyb18R | 340 | 62 de | 60 abc | 49.6 bc | 38.8 d | 29.9 gh | 118 cd |

*number of days from emergence until 50% of the plants with silk;
**number of days from emergence until physiological maturity (30% moisture)
***the same letter means that there is no significat differences between values conform to Duncan test

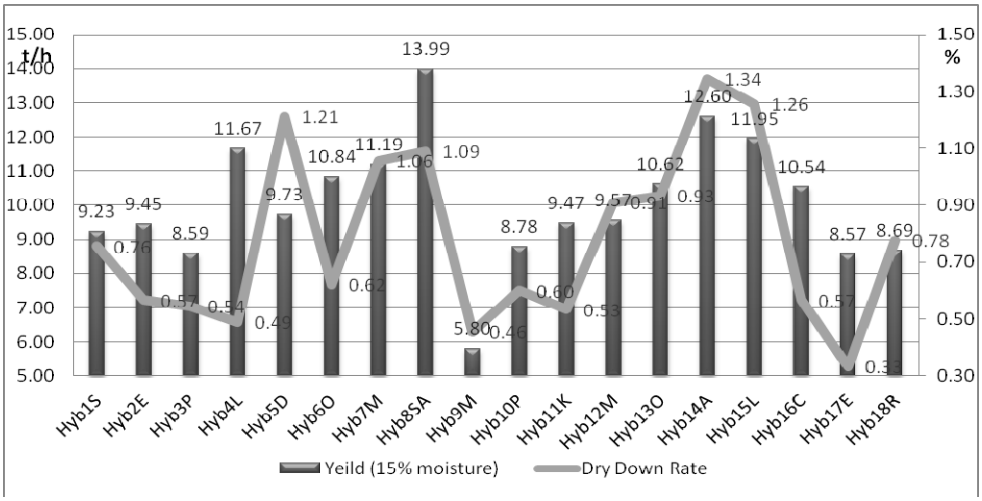


Figure 2 **Yield obtained (t/ha) and daily dry down rate (%)**

An interesting thing to come into effect noted in research Planinica, Serbia by staff previously mentioned, is that in the years to incidents climate (drought and excessive rainfall), flint hybrids appear to be more tolerant of the vagaries of weather.

In terms of corn, in Romania the loses of water from grain at physiological maturity rather

quickly, allowing early harvesting and preparing the ground for sowing grain cereals, wheat-corn-wheat rotation is most commonly used by romanian farmers.

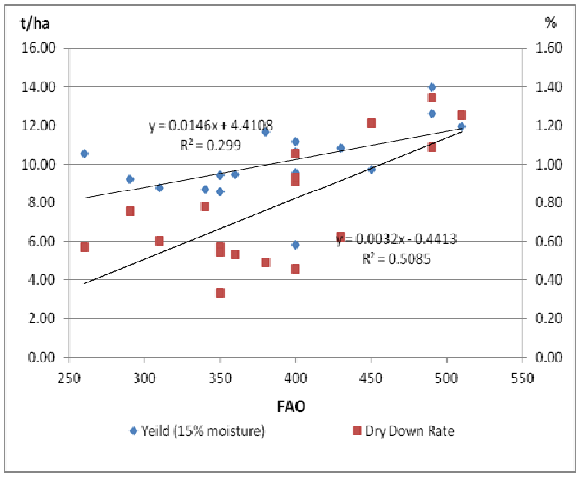


Figure 3 **Correlation between yield, DDR and FAO group in experimental trial**

The chart in figure 3 clearly observe positive correlations between yield capacity for hybrids and water loss rate of grain from them, according to the FAO maturity group. The yield capacity of hybrids FAO group is influenced, but not significantly.

This becomes an important in choosing a hybrid maize genetic fingerprint, that is more important than FAO chosen group.

If productivity is greatly influenced, FAO group becomes more influential in water losses of the grain. Thus, a hybrid corn loses water faster than another, if it belongs to a group of lesser maturity. This becomes important especially for large farms where harvesting can organize phased knowing this element and preventing a delay in the works fall and even the vagaries of the weather.

The graphical representation of the results emphasizes individual exceptions of hybrids tested. The good results of the rate of water loss in grain is assigned to FAO 450-510 range, while hybrids of FAO 350-450 maturity values shows the rate of water loss of the grain on a larger scale.

Clustered near linear axis, hybrids FAO 250-350 shows small amplitudes, insignificant statistically. Thus, the analysis of correlation coefficient, that originates with increasing maturity group hybrids grown in the Lovrin area, individual value increases and the rate of water loss of the grain, but the difference is not significant. Explanation of this correlation is based on the fact that the physiological maturity of 30% to 15% technological maturity, a late hybrid has the ability to lose water faster than a hybrid or early-early.

The results show a consistent intuitive hypothesis primary, but the difference makes the filling time of the grains immediately after flowering–silking and up to physiological maturity of 30%, individual values making exceptions (such as grain glassy losing water harder than dent hybrids).

## CONCLUSIONS

In local conditions of Romania, the loses of water from grain at physiological maturity rather quickly, allowing early harvesting and preparing the ground for sowing grain cereals, wheat-corn-wheat rotation is most commonly used by romanian farmers.

The corn hybrids with flint pericarp lose harder water at physiological maturity of grain. There is a positive correlation between yield and water loss rate of grain, according to the FAO maturity group. The yield is influenced by FAO group, but not significantly.

Duncan test confirms both silking data and for physiological maturity, also, that the maturity group has significant influence over these periods. The earliest hybrids silky faster than later hybrids, amount of GDU being lower than those last mentioned.

The good results of the rate of water loss in grain is assigned to FAO 450-510 range, while hybrids of FAO 350-450 maturity values shows the rate of water loss of the grain on a larger scale.

## ACKNOWLEGMENTS

This study was conducted as a motivation of collaboration with APPR (Romanian Association of Corn Producers), showing a deciding factor in choosing a corn hybrid.

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# ASPECTS OF THE BANKING SYSTEM IN THE PROCESS OF MONEY CREATION IN THE REPUBLIC OF MOLDOVA

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**Abstract**

The saying "banks create money" can be often heard nowadays. The issue is particularly relevant at present because the idea that banks can create money from nothing has generated social anger. Without a proper understanding, the misconception that banks create money from nothing will continue to influence business patterns in the financial sector and interventions of the monetary policy. The ability of the banking system to create money is influenced by a number of factors. The banking system of the Republic of Moldova faces numerous problems in the process of money creation, and namely: banks eagerly invest in securities only for a short period of time; a significant share of loans in foreign currency in the total of loans; dollarization of the currency and economies; a large share of cash in the money supply structure; an increased degree of risk associated with loan services of the real sector of the national economy – all these factors determine the amount of money created.

**Key words**: banking system, money, money stock.

The framework of the monetary policy often related to the money supply began in 1993 with the introduction of the national currency. During the period 1993-2006 we observed the influence on the amount of currency in circulation and the banking system's ability to generate this money in the Republic of Moldova. As the monetary policy is directed towards fund raising, the National Bank is focused on the quantitative factors that exist at the money market and influence mainly the functional capacity of the banks' ability to create money.

In 2006, as they signed the Action Plan the Republic of Moldova – the European Union and there was a need to correlate the national legislation with the legislation of the European Union, the National Bank of Moldova refocused its monetary policy on prices and the ultimate objective was changed from "achieving and maintaining the stability of the national currency" to "ensuring and maintaining the stability of prices". Thus, the monetary policy changed its focus from the money supply to the money demand in the economy.

All these actions have also changed the environment of money creation, i.e. the conditions under which banks used to create currency in the Republic of Moldova. Thus, before 2006 they were under immediate subordination of the National Bank and their ability to create money was directly influenced by the money stock stipulated by the NB, well, since 2006 they are already under its indirect control and some tools to regulate the banking activity are applied.

The new objective of the monetary policy in the Republic of Moldova was adopted along with the increase of the share of cash in circulation in the structure of the monetary base as well as the excessive inflow of foreign currency and its dollarization. At the same time the control of monetary aggregates under the conditions of long-term inflation becomes rather difficult.

## MATERIAL AND METHOD

The objective of the given research is the banking system of the Republic of Moldova in the process of money creation. The research methodology is based on the following methods: logical and dialectical methods, analysis, synthesis, scientific abstraction. We studied the data provided by both the National Bureau of Statistics of the Republic of Moldova and the National Bank of Moldova.

## RESULTS AND DISCUSSIONS

The Republic of Moldova has a banking system with a money market which offers a very narrow range of tools. Only government securities are traded there and there is no other circulation of capital in the short term, the incidence of tools

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related to the cost is very low (the basic rate). Therefore, there is a strong correlation between the share of mandatory reserves and the amount of money supply in circulation. Discrepancy between the fundamental objective of the monetary policy and sound sustainability of the banking sector influenced the pace of monetary expansion. Although the volume of money supply used to increase throughout the period (2000-2015), the increase of money supply in the post crisis period has slowed considerably (*figure 1*). The smallest indices of the money stock increase was registered in 2009, when the national economy assimilated the consequences of the global financial crisis

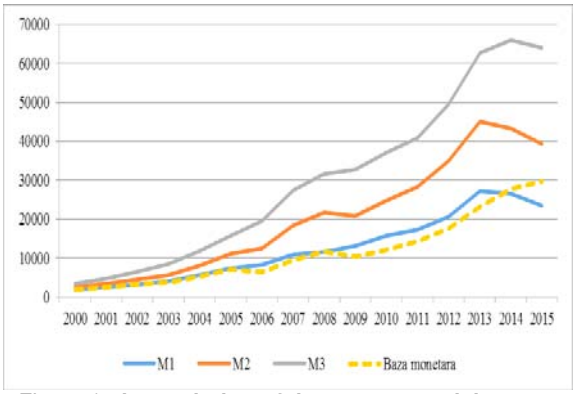


Figure 1 **The evolution of the money stock in 2000-2015, mln. MDL**

Following the influence of the monetary policy tools on the money supply, we can observe that it is uneven as related to the structure of the quantity of money in circulation, being influenced by certain specific factors.

The amount of money created by the banking system of the Republic of Moldova has been subject to the following tools, applied by the NB with disruption of money supply: basic interest rate and the ratio of minimum mandatory reserves.

Along with the transition to the inflation targeting regime, the basic interest rate became the main tool of the monetary policy, by means of which the central bank influences directly interest rates on interbank deposits, balancing both supply and demand at the money market (*figure 2*).

In 2001-2015 the NBM changed basic rates several times. The highest level of the basic rate was registered in early 2001 (21%), afterwards it was gradually lowered to 3.5% by the second half of 2013 and remained at this level until December 2014, when the NBM increased it again under the influence of inflation expectations.

The next tool applied to regulate the process of money creation is the ratio of minimum cash reserve. It is an active instrument of the NBM monetary policy. In 2000-2015 the mechanism was changed many times as compared to the European Central Bank, where the minimum cash reserve is no longer an active instrument of the monetary policy. The NBM appeals to the change of the minimum cash reserve to influence both short-term money demand and interest rate, increasing – to constrain money stock in circulation, and decreasing – to ease monetary conditions.

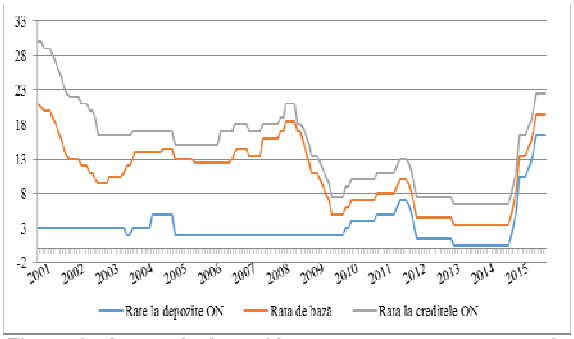


Figure 2 **The evolution of interest rates on NBM tools of monetary regulation in 2001-2015, %**

The efficiency of the process of money creation for the economy can be transmitted, calculating the effect of money supply propulsion created by the central bank on the economy by banks. The propulsion effect is also useful if we decide to analyze the behavior of banks in various monetary policy impulses (Hayek F. A. 1937).

The propulsion effect can be calculated by relating the credits in the economy to the money supply in the economy, and is an effectiveness indicator of the monetary policy on the banks' ability to create money, stimulating the economy.

The propulsion indicator may provide an insight into the evolution of the amount of money in the economy, financing the economy by banks. The uneven development of these two indices may prove the existence of some endogenous factors which influence the banks' ability to transmit impulses of the monetary policy to the economy. The identification of these factors and their impact on the banks' ability to create money in terms of the economic growth is a key task of this paper taking into account the formulation of some proposals to correlate the activity of monetary authorities and the banking system with the needs of the real economy.

The diverse evolution of the propulsion indicator during different time periods (*figure 3*) demonstrates the change of the banks' behavior of banks in creating and providing funds for the economy, depending on the action of various factors.

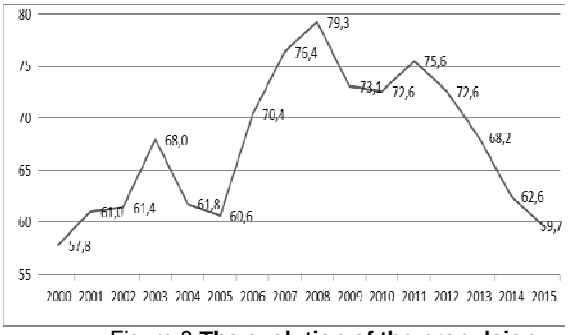


Figure 3 **The evolution of the propulsion indicator in the Republic of Moldova in 2000-2015**

Having analyzed the figures of the propulsion indicator evolution, we notice that the peak value of the propulsion indicator during the studied years was about 79% (*figure 3*). This level can be considered very close to the maximum level, based on prudential requirements imposed on banks, related to the maintaince of liquidity. According to principle II of liquidity, imposed on banks by the NBM, they must maintain 20% of its assets liquid, depending on risks. Based on this prudential requirement, we may conclude that the propulsion indicator in the Republic of Moldova may tend to about maximum 80%.

The evolution of the propulsion indicator in the Republic of Moldova (*figure 3*) it is observed that during the studied period one can identify three specific periods:

- It was noticed that banks' ability to create and propulse money was significantly low in 2000-2006.

- In 2007 - 2008 banks' ability to create and propulse was utmost advantageous, reaching 74.4%.

- Since 2009 banks' ability to create and provide the real sector with money again decreased and reached low levels regardless of the fact that the money stock increased.

If the central bank tries to stimulate banks to create liquidity by means of various mechanisms of the monetary policy in order to finance the real sector, there is a number of factors that could stimulate or hinder this process at the level of the banking sector (Selgin G., 1996). Among the main factors that constrain the process of money creation in the Republic of Moldova with the approval of the central bank we should note the following:

- Constraints from the real sector of economy, i.e. the ability of real econom to absorb a greater amount of money. Regardless of the facilities granted by central banks, the process of liquidity injection into the economy at the level of banks by lending money, being strictly regulated in order to reduce risks, can result in minimal effects. Especially considering that the real sector is still suffering the consequences of the global financial crisis and economic agencies do not meet all the requirements necessary to be eligible for a bank loan, being insolvent or having an adverse credit history.

- Prudential constraints, originated from the regulatory system of the banking sector. The modern banking system is highly regulated. Although it is very good for stability and economic sustainability, it can block the propulsion effect of liquidity in the economy (White L.H. 1995). Even if banks take some risks and offer loans, counting on their own experience and knowledge to support the economic growth, they could not do because of the existing regulatory system.

- Cost constraints. To protect banks' exposure to risks arising from lending, losses and possible shock absorption, the NBM stipulates the creation of a special risk fund by every bank in the system. This was an additional prudential requirement to manage credit risks. The increase of loans presupposes extra costs that can not be carried by all banks. And again, there is a regulation effect of the banking activity under which any bank is required to establish a reserve fund for losses on balance sheet assets / conditional commitments subject to credit risks (at least 2% for those classified as standard ones) (Rothbard, M.N. 1990). The establishment of additional reserve funds in its turn requires the availability of a certain amount of equity capital for a period, which cannot be afforded by all banks due to insufficient capital.

The identification of the factors that affect the mechanism of money creation in the banking system of the Republic of Moldova allowed us to conclude that macroeconomic indices have a greater impact on the banks' creation capacity than microeconomic indices in our country, and banks' interest in the money creation process has the smallest contribution to this process. To optimize the process of money creation the BNM should correlate both the monetary policy and the policy at the mezzo-economic level that is related to the influence on banks or the policy may be guaranteed by prudential supervision of the banking activity. Therefore, it is important to bring to the foreground the intercorrelation between the monetary policy and the banking supervision as we can improve the process of money propulsion in the economy by motivating the direct supervision of banks that would like to create money and ease restrictions.

## CONCLUSIONS

To sum up the information mentioned above, we can conclude with certainty that role of banks in the process of money creation is indispensable, having a major impact on the sustainable economic growth and development. Monetary authorities must take this into account and they fulfill their tasks, promoting the monetary policy and controlling the banking activity, and coordinating these two activities through the impact on the banks' money creation. Only by correlating the promoted monetary policy with prudential constraints imposed on banks and their impact on their ability to create money and propel the economy can be achieved not only by fundamental objectives of the monetary policy, but also by random ones, related to the creation of favorable conditions for the sustainable economic development. As the real economic growth can be achieved only if economic agents have permanent access to money and banks can fulfill the function of money creation only if it reaches the final consumer.

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# POTATO BREEDING, MEETING THE CHALLENGES OF CLIMATE CHANGE

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**Abstract**

Potato, the third most important food crop originates from temperate climatic zone characterised by moderate and even precipitation. Current climatic changes in Central European region mean serious challenges to the potato plant, its growers and breeders as well. The average daily temperature in the growing season is generally above the optimum and the required precipitation is less than needed. The risk of spreading pathogens and pest adapted to warmer climates is increasing, while appearance of new strains of common pathogens like Potato Virus Y and *Phytophtora infestans* means new challenges to the potato production in the Region as well. Potato in general is a sensitive crop to biotic and abiotic stresses due to its numerous pathogens, pest and week root system. Stress sensitivity may manifests in yield decrease and quality loss. Breeding and cultivation of stress resistant varieties is needed to maintain profitability of potato production under stressful conditions. The Potato Research Center at Keszthely runs a specific breeding program since 1960 focusing on the release of varieties suitable for Central European agro-ecological conditions due to their resistance against major biotic and abiotic stress factors. The applied breeding strategy is a complex approach using classical and modern biotechnological methods, such as negative and positive selection based on phenotyping, somatic hybridization, DNA marker based selection for certain traits, use of resistant genotypes as parents and application of a complex parental line evaluation system for breeding value estimation of crossing families. As the results of the consistent selection work several new varieties with complex resistance traits were released from the program recently.

**Key words**: potato, resistance breeding, climate change

Potato is the third most important staple food worldwide (FAO, 2008). The plant originates from a temperate climatic zone that is characterised by moderate and even precipitation. Current climatic changes in the Central European region, especially in the Carpathian Basin mean serious challenges to the potato and its growers. At the location of Keszthely where our breeding program runs the climatic conditions for potato production are far from the optimal in general. The day time temperature during the vegetation period is generally above the optimum and the required precipitation is less than needed and rather uneven. The frequency of stress full periods in the growing season was increased during the last decades too.

Potato in general is a sensitive crop both to biotic and abiotic stresses (van Loon, 1981). It has many pathogens and pest and a week root system. Stress sensitivity may manifests in yield decrease (lower tuber number and weight/plant) and quality loss (tuber malformations, internal defects, higher sugar or alkaloid content, etc.), (Vayda, 1994; Levy, Veilleux, 2007). Naturally different potato genotypes may dramatically alter in biotic and abiotic stress sensitivity (Hassanpanah, 2010). Among biotic stresses viruses and potato late blight has the highest influence on yield (Salazar, 1996; Forbs, 1998). Moreover it is well-known that virus infected plants are more sensitive to abiotic stresses like heat and drought. Under environmental conditions where abiotic stress and high virus pressure parallel appear their combined negative impact on potato is even more dramatic. According to the last study in Hungary, the virus pressure is extremely high in the country and more than 90% of potato virus Y (PVY) isolates collected from potato fields belong to the economically most aggressive $PVY^{NTN}$ strain These circumstances provides ideal conditions for simultaneous selection for abiotic stress tolerance and virus resistance under field conditions.

The Potato Research Centre at Keszthely deals with resistance breeding since 1960. One of its major duties is the breeding of varieties suitable for Central European agro-ecological conditions due to their resistance against major pests, pathogens and abiotic stresses. The applied breeding strategy is a complex approach to meet these challenges: negative selection of stress sensitive genotypes under natural stressful condition, use of sexually compatible or non-compatible resistant wild species and hybrids as

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parents, positive selection of genotypes under natural field conditions or after artificial infections with pathogens (Polgar *et al*, 2002; Horvath *et al*, 2002), application of DNA markers linked to resistance genes (Cernak *et al*, 2008, Ahmadvand *et al*, 2013), application of complex parental line evaluation system to predict the breeding value of each cross combinations. Recently Polgar et al (2010) reported the release of three varieties coming out of the program exceeding control varieties both in biotic/abiotic stress tolerance and marketable yield. Here we discuss and evaluate the usefulness of the complex breeding approach and introduce the latest results of the program.

## MATERIAL AND METHOD

The breeding program operates at Keszthely, Hungary since 1960. Meteorological data were collected at site by Metos weather station of Pressl Instruments, Austria. In the program about 15.000 single hills, 500 "A", 60 "B", 40 "C" and 25 "D" breeding clones are evaluated each year under field conditions. Negative selection of stress sensitive genotypes was done based on the recording of visible leaf symptoms during vegetation, for tuber defects and yield at harvest under field conditions. Positive selection for PVY resistance was based on the mechanical infection of genotypes by a local $PVY^{NTN}$ strain according to Cernák et al (2008). DNA markers based selection of positive genotypes for RYsto and Rx1, Rx2 and H1 genes was according to the protocols published by (Cernak at al. 2008, Ahmadvand et al 2013 and Gebhardt et al 1993 respectively). Parental line and crossing family evaluation: characterisation of 100 individuals at single hill stage of each crossing families for average tuber number and average tuber size/plant, general tuber appearance (1 to 3 where 3 is the best), skin colour and the total number of selected genotypes to go for the next generation (clone A) were done at harvest. Collected data were converted into a cumulated file representing the specific combined breeding value of the families of each year.

## RESULTS AND DISCUSSIONS

Selected meteorological data in the vegetation period of the last eight years were collected at the site of the breeding program and compared to the 100 years average. The summarized data proves that potato genotypes taking part in the breeding program are under continuous abiotic stress during their vegetation. *Figure 1* demonstrates that in case of excluding the year of 2010 the average precipitation was 14% less than the average (284 mm).

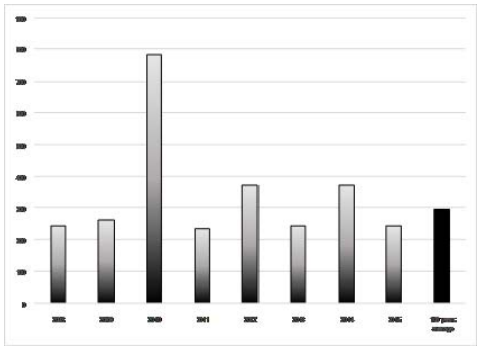

Figure 1 **Average precipitation in May-August (mm)**

The daily average temperatures were above the 100 year average by + 1.4 $^{o}$C, while the daily maximums reached or were above of 35$^{o}$C in each season (*Figure 2*).

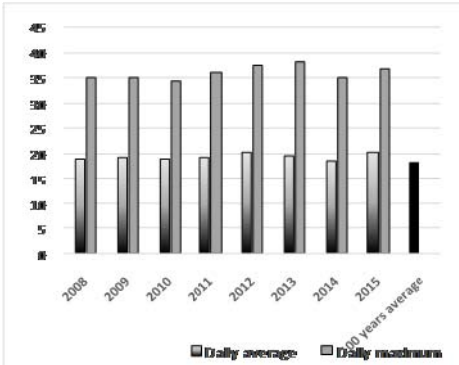


Figure 2 **Daily temperatures in May-August ($^{o}$C)**

Climatic changes of the region manifested in the increasing frequency of days where the daily maximums were above 25 $^{o}$C too. It means in all the evaluated seasons more than 50 % of the days were stressful for potato. From growth chambers experiments of van Dam et al (1996) it is known that haulm growth is fastest between the temperature range of 20˚C - 25˚C while the optimal range of tuberization and tuber development is even lower (15˚C - 20˚C). At a temperature higher than optimal reduction of tuberization and intensified haulm development can take place as recently discussed by Rykaczewska (2013).

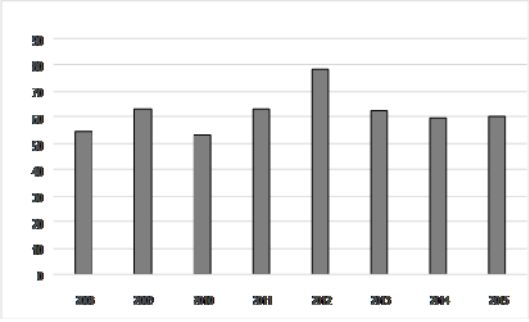

Figure 3 **Percentage of days with + 25$^{o}$C daily maximums (%)**

To meet the combined challenges of abiotic and biotic stress conditions our breeding strategy applies a set of tools built on each other. The first is the use of wild potato species and hybrids to incorporate their resistance genes into the genetic background of new varieties. *Tables 1* summarize the most important species utilized in the program. The second is the application of an intensive back crossing program and consistent selection for desired traits. The next steps of the program work under field conditions. Here the applied complex parental line and crossing family evaluation system makes possible to select the best performing parental combinations, families where we could expect potential new varieties from at the highest chance. By the evaluation system more than 300 cross combinations in total were tested during the last 10 years. Based on the cumulated relative breeding value of the families the best 10 to 15 per year were seeded in the next year with higher numbers, 500-2000 seeds/family (*Figure 4*). For the identification of resistant genotypes molecular markers routinely applied for $Ry^{sto}$, Rx1, Rx2 (own development) and H1 genes from literature adaptation at seedling stage. Genotypes with complex resistance were selected for further steps of the program only.

Table 1

**Main wild species used in the program, those by somatic hybridization marked with ***

| Species | Resistance |
|---|---|
| *S. stoloniferum* | PVY, PVA |
| *S chacoense* | PVY |
| *S. acaule* | PVX |
| *S. tub. ssp. andigenum* | PLRV, Nematodes |
| *S. demissum* | *Phytopthora* |
| *S. hougasii* | PVY, PVS |
| *S. vernei* | Nematodes |
| *S. brevidens** | PLRV, *Erwinia* |
| *S. bulbocastanum** | *Phytophtora* |
| *S. sparsiphyllum* | *Verticillium* |
| *S. tariense** | Pests |
| *S. tarnii** | PVY |
| *S. commersonii** | *Phytophtora* |
| *S. etuberosum** | PVY |

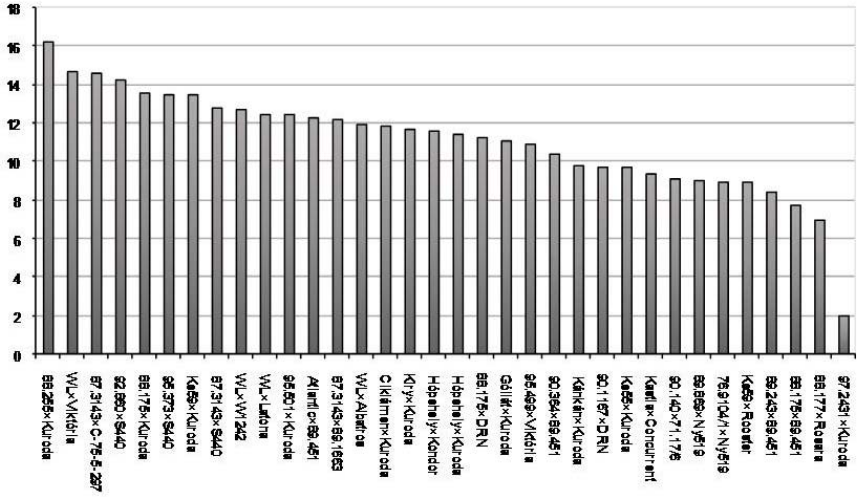


Figure 4 **Sample for comparison of relative cumulated breeding value of tested crossing families**

In these steps at age of clones A, B, C and D commercial evaluation and selection techniques were applied. Here the new variety candidates must reach the yielding potential and culinary quality of standards while must show less problems with tuber malformations and internal defects. *Table 2* summarizes the frequency of tuber disorders of recently released varieties of the program in comparison to standard varieties Desirée and Cleopatra. First year results show that standard varieties are rather sensitive even at virologically healthy status to the ecological conditions being typical for Keszthely location. The frequency of disorders further increased in the second year where seeds were used from the first year harvest for all the tested varieties. However this increase was far less in the case of virus resistant new varieties. The most typical disorders of stress sensitive varieties were tuber malformations and secondary growth reaching 47.5 % for Desiree and 21.1 % for Cleopatra in the second year of the test. Variety Botond showed the least tuber disorders having the highest % 5.5 for malformation and only 1 % for secondary growth.

## CONCLUSIONS

The ecological conditions of the site where the selection process of the breeding program takes place has a significant influence on the efficiency and success of the selection process for biotic and abiotic stresses.

By the combination of common and new molecular breeding tools it is possible to increase the efficiency of the breeding program to combine high level of cultural characters with complex resistance to biotic and abiotic stresses.

Potato varieties having complex biotic resistance may meet the challenge of abiotic stresses caused by the climate change for a certain extent.

Table 2

**Tuber disorders of the newest varieties originating from the complex resistance breeding program**

| Cultivar | Generation | Malformation % | | Secondary growth % | | Tuber cracking % | | Index of glassiness % | | Internal rust spot index % | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | | 1 | **2** | **1** | **2** | **1** | **2** | **1** | **2** | **1** | **2** |
| **Balatoni** | 1 | 8.3 | 15.0 | 2.3 | 13.3 | 0.3 | 10.7 | 0 | 0.2 | 0.1 | 0 |
| | 2 | - | 17.7 | - | 12.0 | - | 5.3 | - | 0.2 | - | 0 |
| **Katica** | 1 | 11.0 | 24.0 | 3.5 | 14.3 | 2.0 | 4.7 | 0.1 | 0.5 | 0 | 0 |
| | 2 | - | 25.0 | - | 11 | - | 4.0 | - | 0.5 | - | 0 |
| **Désirée** | 1 | **27.0** | **31.7** | **8.5** | **20.7** | **1.5** | **6.0** | **0.1** | **0.4** | **0** | **0.1** |
| | **2** | **33.8** | **22.7** | **9.0** | **16.0** | **2.0** | **5.7** | **0** | **0.2** | **0** | **0.1** |
| **Year** | | **1** | **2** | **1** | **2** | **1** | **2** | **1** | **2** | **1** | **2** |
| **Démon** | 1 | 6.0 | 11.0 | 2.0 | 0.4 | 1.3 | 2.2 | 0.1 | 0 | 0.2 | 0 |
| | 2 | - | 15.0 | - | 0.2 | - | 1.6 | - | 0 | - | 0 |
| **Désirée** | **1** | **37.0** | **41.3** | **13.8** | **6.2** | **1.3** | **4.0** | **0.2** | **0.1** | **0** | **0** |
| | **2** | **-** | **47.5** | **-** | **6.2** | **-** | **3.2** | **-** | **0.1** | **-** | **0** |
| **Year** | | **1** | **2** | **1** | **2** | **1** | **2** | **1** | **2** | **1** | 2 |
| **Botond** | 1 | 3.0 | 3.5 | 1.0 | 0.5 | 0.3 | 1.2 | 0.3 | 0.2 | 0 | 0 |
| | 2 | - | 5.5 | - | 0.2 | - | 1.5 | - | 0 | - | 0 |
| **Cleopatra** | **1** | **35.0** | **24.2** | **18.4** | **12.1** | **5.5** | **10.6** | **0.5** | **1.0** | **0.2** | **0** |
| | **2** | **41.2** | **28.7** | **21.1** | **15.6** | **7.8** | **12.2** | **0.7** | **2.3** | **0.2** | **0** |

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# EFFECTS OF $GA_3$ TREATMENTS ON SOME CHEMICAL PROPERTIES OF "AMIGA" AND "FESTIVAL" STRAWBERRY CULTIVARS

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**Abstract**

In the last years, interest in research on polyphenol-rich fruit species has increased due to the potential health benefits of these species, mainly attributed to their high anthocyanin content. This study was conducted to determination of $GA_3$ treatment effects on some chemical properties of "Amiga" and "Festival" Strawberry cultivars. In this research 25, 50 and 75 ppm $GA_3$ were applied. Strawberry fruits were harvested at the same maturity stage during the same growing season and the total phenolic, total anthocyanin and ascorbic acid content were determined. It (25, 50 and 75 ppm $GA_3$ treatments) was compared according to their total phenolic (Folin-Ciocalteu method) and total anthocyanin (pH differential method) and ascorbic acid contents. Total phenolic of "Amiga" strawberry cultivar was varied between 474.97 (mg GAE 100g-1 FW) to 1028.38 (mg GAE 100g-1 FW). Total anthocyanin of "Amiga" strawberry cultivar and ascorbic acid were varied between 105.58 (µg/g) to 219.29 (µg/g) and 17.97 (mg/100 g) to 134.54 (mg/100 g) respectively. Total phenolic of "Festival" strawberry cultivar was varied between 896.85 (mg GAE 100g-1 FW) to 1194.82 (mg GAE 100g-1 FW). And total anthocyanin of "Festival" strawberry cultivar was varied between 37.41 (µg/g) to 113.39. (µg/g). Ascorbic acid contents were determined about 118.88 (mg/100 g) to 172.05 (mg/100 g) in festival strawberry cultivar. Highest value of total anthocyanin and ascorbic acid were obtained from 50 ppm treatment for two varieties. According to results "50 ppm $GA_3$" treatment was suggested.

**Key words**: phenolic, anthocyanin, ascorbic acid, strawberry

Strawberries are an important source of phenolic, anthocyanin and ascorbic acid. Therefore, consumed in abundance by consumers it will be beneficial to health. Some researchers have expressed that rather high antioxidant activity of strawberry (Cordenunsi *et al*, 2002; Wang, Cao, &Prior, 1996, Beatriz *et al,* 2005). However, because the shelf life is short, it has been stated that the fresh consumption is important. (Beatriz *et al,* 2005).

Phenolic, anthocyanin and ascorbic acid that health-promoting compounds are strongly affected by genetic, environmental factors, ripeness at harvest, and storage conditions (Pradas *et al*, 2015). Hence, this study was conducted to see the effects of $GA_3$ application on some chemical properties (Total phenolic, total anthocyanin and ascorbic acid).

## MATERIAL AND METHOD

Amiga and Festival strawberry varieties that we use in our research are widely consumed in the world.

'Amiga', was selected in 1998 from the offspring of a cross between 'Camarosa' and 'selection 3-79' and was tested as 'selection 2-269' over the following years. 'Camarosa', a University of California cultivar (Voth *et al*, 1994; U.S. Plant Patent no. 8708)

'Amiga' is a short-day strawberry cultivar developed by the Spanish public breeding program. 'Amiga' has a very high fruit firmness, high production, long fruit shape, and good appearance. An agronomic and sensory characterization of this new cultivar, in comparison with the well-adapted cultivars Camarosa, Carisma, Marina and Medina, was undertaken during the 2000 and 2001 crop seasons (Voth *et al*, 1994).

'Strawberry Festival' originated from a 1995 cross between 'Rosa Linda' (Chandler *et al,* 1997) and 'Oso Grande' (U.S. plant patent no. 6578).

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'Strawberry Festival' is a short-day cultivar. Festival' has a mean fruit weight similar to that of 'Sweet Charlie' (Chandler *et al,* 1997). Fruit of 'Strawberry Festival' have a very firm texture and excellent flavor. 'Strawberry Festival' is susceptible to anthracnose fruit rot, Colletotrichum crown rot, and angular leaf spot (Chandler *et al,* 1997).

In this research 25, 50 and 75 ppm $GA_3$ were applied. Strawberry fruits were harvested at the same maturity stage during the same growing season and the total phenolic, total anthocyanin and ascorbic acid content were determined. It (25, 50 and 75 ppm $GA_3$ treatments) was compared according to their total phenolic (Folin-Ciocalteu method) and total anthocyanin (pH differential method) and ascorbic acid contents.

Total phenols were determined according to the method of Singleton and Rossi (1965), using the Folin–Ciocalteau reagent. Results were expressed as mg GAE 100g-1 FW.

Total anthocyanin was determined according to the pH differential spectroscopic method (Cheng and Breen 1991).

Ascorbic acid was determined according to the method of spectrophotometrically at 525 nm according to the procedure of Hodges et al (2001).

Statistical analysis was done by using the Minitab 17 software package version (Minitab 17 Statistical Software 2010). Differences between means were first analyzed by ANOVA test and Tukey test was applied ($P < 0.05$).

## RESULTS AND DISCUSSIONS

In this research, the total phenolic, anthocyanin and ascorbic acid contents of "Amiga" and "Festival" strawberry varieties with three different doses treated $GA_3$ were determined (Table 1, Table 2).

The total phenolic content was found to vary from 494.97 to 1028.38 mg/100 g FW according to the treatments for Amiga cultivar. It is ranged from 896.85 to 1194.82 mg/100 g FW in "Festival" cultivar. "Festival" cultivar has a higher total phenolic content from "Amiga" cultivar. If we look at the application, the highest value was determined at the 25 ppm $GA_3$ doses for these cultivars (*table 1, table 2*). In all analyzed phenolic high statistically significant differences between treatments in both cultivars were determined.

The total amounts of phenolic in different varieties of strawberry have reported as 308 to 353 mg/100 g FW by Cordenunsi *et al* (2005) during storage at different temperatures (6, 16 and 25 C°). The results that obtained in our research are higher than the reported value by Cordenunsi *et al* (2005). This was occurred because we have analyzed the fresh sample. However, the values (426.5 to 1014.99 µg GAE/g) that reported by Rekika *et al* (2005) are qualitatively similar with our data.

When we look at the total amount of anthocyanin for "Amiga" cultivar, we see that the highest value was determined at "50 ppm $GA_3$" application (219.29µg/g). Same case has been to the "Festival" cultivar (113.43 µg/g). However, there are not statistically significant differences between "50 ppm $GA_3$" and 75 ppm $GA_3$" treatments. The lowest values were determined in control application for two cultivars.

The data obtained in our research is lower than the values of Tonutare *et al* (2014) that determined by HPLC (27.79-60.05 mg/100g). Also, Rekika *et al* (2005) and Wang and Lin (2000) as reported by the values (190.5-841.26 µg/g and 38.9 mg/100g respectively) is higher than the value we obtained in our research. However, the total anthocyanin in strawberries was reported as 20.07 mg/100g by Zhang *et al* (2007) in fresh fruit. Our findings are consistent with these values. Gill *et al* (1997) reported that when the analyses delayed after the harvest, the total anthocyanin (113.7-153.5 µg/g) was affected. Also, it is reported that the different harvest stages on the total amount of anthocyanin is effective. (Voca *et al* 2014).

Higher ascorbic acid was determined in "Festival" cultivar (171.92 mg/100g) according to "Amiga" cultivar (134.58 mg/100g) in our research. If we look at the application in both varieties, "50 ppm $GA_3$" treatments have higher ascorbic acid content from other treatments. While "50 ppm GA3" treatment (134.58 mg/100g) was followed by "25 ppm $GA_3$" treatment (119.38 mg/100g) in "Amiga" cultivar. "75 ppm $GA_3$" treatment (139.26 mg/100g) was followed in "Festival" cultivar. Amount of ascorbic acid has been reported by Lester *et al* (2012) as 114-182 mg/100g in fresh strawberry fruit. Our findings are consistent with these values.

Various researchers have reported the ascorbic acid amount as 27.1-32.6 mg/100g, 39.9-44.5 mg/100g and 44-60 mg/100g in fresh strawberry fruit. (Asami *et al* (2003), Van de Velde *et al* (2013) and Tonutare *et al* (2009) respectively). Our findings are higher than these values. Although, different growing conditions and genotypes differences are effective we believe that this situation is stemmed from $GA_3$ treatments.

Table 1

**Some chemical characteristics of Amiga**

| Treatments | Total Phenolic (mg/100 g FW) | Total Anthocyanin (µg/g) | Ascorbic Acid (mg/100g) |
|---|---|---|---|
| 25 ppm $GA_3$ | 1028.38 a* | 161.24 c | 119.38 b |
| 50 ppm $GA_3$ | 915.34 c | 219.29 a | 134.58 a |
| 75 ppm $GA_3$ | 997.95 b | 168.80 b | 17.97 d |
| Control | 474.97 d | 105.58 d | 94.10 c |

*The differences between the numbers shown in the same column with different letters are statistically significant (P<0.05)

Table 2

**Some chemical characteristics of Festival**

| Treatments | Total Phenolic (mg/100 g FW) | Total Anthocyanin (µg/g) | Ascorbic Acid (mg/100g) |
|---|---|---|---|
| 25 ppm $GA_3$ | 1194.82 a* | 74.83 b | 131.53 c |
| 50 ppm $GA_3$ | 936.88 c | 113.43 a | 171.92 a |
| 75 ppm $GA_3$ | 1126.26 b | 112.99 a | 139.26 b |
| Control | 896.85 d | 37.41 c | 118.87 d |

*The differences between the numbers shown in the same column with different letters are statistically significant (P<0.05)

## CONCLUSIONS

Strawberries have positive effect on human health. This fruits are delicious and contain rich phenolic substances, anthocyanin and ascorbic acid. In this research which was conducted to increase of these components with some treatments, we determined that $GA_3$ treatments have positive effect according to control plot. "50 ppm $GA_3$" applications have the most effective results for anthocyanin and ascorbic acid. But for highest total phenolic contents most effective results were determined from "25 ppm $GA_3$" treatments. These treatments can be recommended for growers and researchers.

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# RESEARCH ON THE TRANSFER MATERIAL TO OBTAIN MYCELIUM ON GRANULAR SUPPORT AT THE AGARICUS BLAZEI MURRILL MUSHROOMS

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**Abstract**

*Agaricus blazei* mushrooms have nutritional and therapeutic values which differentiates it from other fungi: the highest protein level (46,2 % in comparison to the average 43%), the highest level of non-fibrous carbohydrates (38%), contains more glutamic acid than the other *Agaricus* fungi available on the market. It is used for treating tumors located in various places, low immunity, viral diseases, hypercholesterolemia, atherosclerosis and viral hepatitis. The beta glucan they contain stops the evolution of malignant cells.

Being relatively new introduced crop, the *Agaricus blazei* Murill mycelium production technology is not exactly known. In the study of the transfer material to obtain the granular support mycelium inoculum was intended to achieve the production of mycelium. We have tested many materials to produce mycelium. As granular support, 4 experimental variants were studied: wheat kernels, kernels millet, mustard seed and mixed seeds. Was studied at each experimental variant the effect of amendments on *Agaricus blazei* Murrill mushroom mycelial growth. The best mycelial increase, of 1.85 mm/day was accomplished in mixture of seeds (wheat kernels and kernels of millet), with the calcium sulphate amendment.

**Key words**: mycelia, spawn, mushrooms, transfer material, *Agaricus blazei* Murrill

Using sustainable natural resources is one of the great challenges of our times. This challenge is directly linked to local livelihood and economic viability, without which the use of natural resources (nature conservation) cannot be managed (Heinemann P., 1993).

Along with medicinal plants, fungi had been appreciated for thousands of years for their culinary value and therapeutic properties. The cultivation of the so called "medicinal fungi" has become a large-scale economic activity, being a source of income for producers, tradesmen and manufacturers, while the medical researches of the last decades prove their extraordinary antitumoral properties. (Kawagishi H. *et al,* 1988, 1989; Sorimachi T *et al,* 2001; Kawakami S. *et al*, 2002).

For the successful cultivation of any mushroom on a small scale or commercial scale, one of the most important requirements is the seed of that species or variety. The spawn, a pure culture of the mycelium grown on a special medium, is the mushroom seed, comparable to the vegetative seed in crop plants. The production of spawn is done in the laboratory under controlled conditions of temperature, light and humidity. (Stamets P., 2005).

The success of mushroom cultivation and its yield depend to a large extent on the purity and quality of the spawn used. Mushrooms for spawn production can be grown on sterilized cereal grain (wheat, millet, mustard, rye, sorghum), but usually grain colonized with mycelium (grain-spawn) is used as an inoculum for composts. Grain is preferred as a substrate for mushroom spawn because grain gives a large number of inoculation sites, each with a high inoculum potential derived from the nutrient base the outgrowing fungi can utilize. This helps to ensure that the compost is rapidly permeated, which is important for the exclusion of competitors as well as for the rapid production of fruit bodies. The media used for maintenance, multiplication and preservation of the *Agaricus blazei* Murrill mushroom culture are PDA (potato dextrose agar) and CEA (compost extract agar) medium. (Stamets P., 2010).

## MATERIAL AND METHOD

Materials used in the experience: pure culture of *Agaricus blazei* Murrill, cereal grains

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(wheat, millet, mustard and mix of these cereal grains), bottles, cotton, paper squares 7x7 cm, calcium sulphate (gypsum), calcium carbonate (chalk), glucose bottles/milk bottles, alkathene sheets, autoclave, laminar flow cabinet, incubator/storage room, wire gauge balance, bunsen burner and water.

Method:

1. Substrate preparation:

a. the cereal grains were soaked for one night; 2L of water per 1 kg of grain, the cereal grains were washed and strained to remove all water;

b. the cereal seeds were steamed for 30-45 minutes to soften grains, and the water was drained, and the cereal grains spreaded to cool down and decrease moisture;

c. the three-fourth of the bottle was filled with cereal grains, carefully was prepare cotton plug, and tightly plugged in the mouth of bottle with cotton, and leave out for ventilation.

d. the grain was allowed to surface dry by spreading over alkathene sheets, in shade, for a few hours.

e. the grain was mixed thoroughly with chemicals (calcium sulphate and calcium carbonate at 2% and 0.5%, respectively, on dry weight basis of the grain), to adjust pH of the grain at 7-7.8. the grain must not be coagulated at this stage;

f. the grain-chemical mixture was filled in 500 mL glucose/milk bottles (300-350 g boiled grains/container). However, the first generation spawn (master spawn or transfer material) must be prepared in glass bottles due to their convenience in handling for further subculturing;

g. the bottles/containers were plugged with nonabsorbant cotton; (*figure 1*)

h. the substrate was sterilized by autoclaving at 121ºC (15 psi) for 30 minutes;

i. the process of sterilization was repeated after 24h of first autoclaving

j. the substrate container was allowed to come to room temperature for making the substrate ready for inoculation.

Figure 1 **Bottles filled with grain**

2. Inoculation of substrate:

a. the substrate was inoculated (grain in containers) with the mycelium of the mushroom grown on a specific medium by transferring mycelium in agar on the grain under aseptic (sterile) condition. (*figure 2*)

b. the containers were agitated, after plugging, to distribute the fragments of the mycelium.

Figure 2 **Inoculation of substrate**

3. Incubation:

a. the inoculated containers were stored (incubated) at 25-27ºC in darkness for 3 weeks (*figure 3*).

b. the containers were agitated for an even distribution of mycelium, after a few days of incubation or as soon as mycelium was visible on grain.

Figure 3 **Incubation of substrate**

Mycelial characteristics: Longitudinally striate mycelium (*figure 4*), with radiating rhizomorphs overlaying a cottony mycelial undergrowth. Rhizomorphic mycelia in culture produces hyphal aggregates and pseudo-primordia after one month of incubation on 2% CEA, which fail to enlarge to maturity. Becoming loosely aerial in age, mycelia often exude a yellowish, almond-smelling metabolite.

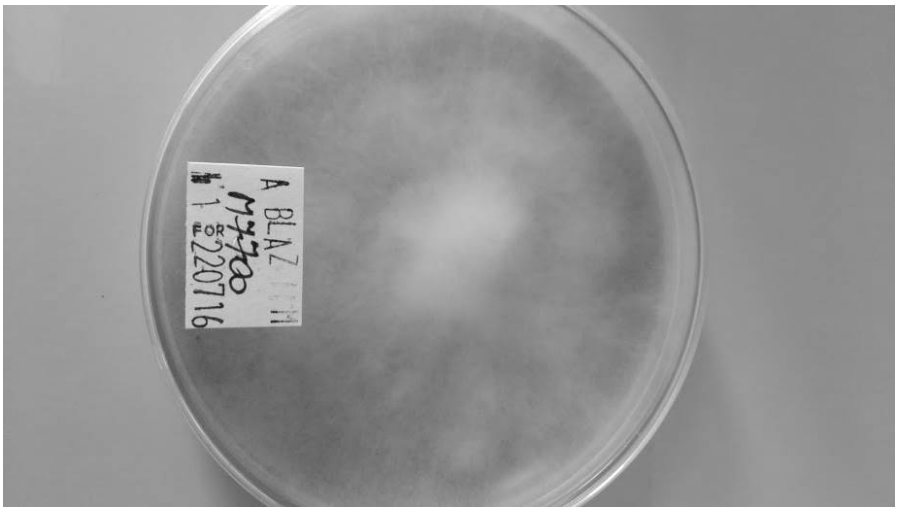

Figure 4 ***Agaricus blazei*** **Murrill mycelial characteristics**

The experimental factors and their graduation are shown below:

A - biological material with the following graduations:

a1 – wheat grains
a2 – millet grains
a3 – mustard grains
a4 – mix of grains (33.3% wheat, 33.3% millet and 33.4% mustard

B – amendments with the following graduations:

b1 – calcium sulphate
b2 – calcium carbonate
b3 – no amendments used

## RESULTS AND DISCUSSIONS

The combination of experimental factors resulted in 12 variants shown in Table no. 1, each version having 3 repetition.The average of repetitions is presented in Table 1 and figure 5.

Table 1

**The combination of experimental factors and the average of mycelial growth**

| Variant | Biological material | Amendments | Mycelial growth mm/day |
|---|---|---|---|
| V1 a1b1 | Wheat grains | calcium sulphate | 1.67 |
| V2 a1b2 | Wheat grains | calcium carbonate | 1.45 |
| V3 a1b3 | Wheat grains | no amendments used | 1.38 |
| V4 a2b1 | Millet grains | calcium sulphate | 1.50 |
| V5 a2b2 | Millet grains | calcium carbonate | 1.28 |
| V6 a2b3 | Millet grains | no amendments used | 1.17 |
| V7 a3b1 | Mustard grains | calcium sulphate | 1.38 |
| V8 a3b2 | Mustard grains | calcium carbonate | 1.25 |
| V9 a3b3 | Mustard grains | no amendments used | 1.07 |
| V10 a4b1 | Mix of grains | calcium sulphate | 1.85 |
| V11 a4b2 | Mix of grains | calcium carbonate | 1.72 |
| V12 a4b3 | Mix of grains | no amendments used | 1.32 |

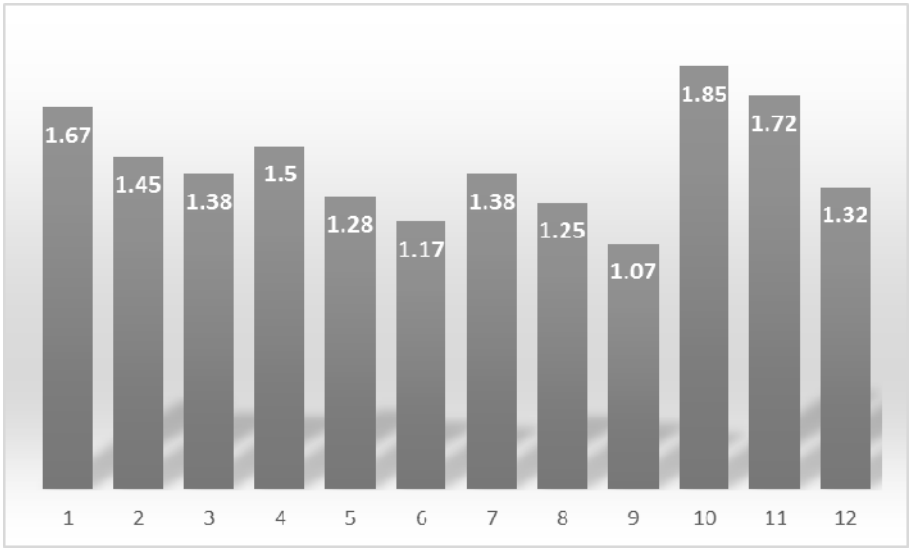


Figure 5 **The average of mycelial growth in mm/day**

Taking into account the unilateral influence of biological material on the *Agarius blazei* Murrill mycelial growth, we can be seen as it recorded a difference of 1.63 mm/day being very significant positive, to the average taken as controls (*table 2*) which registered 1.42 mm/day.

Table 2

**Unilateral biological material influence on mycelial growth *Agaricus blazei* Murrill mushrooms**

| Biological material | Growth mm/day | | Difference ±D mm/day | Significationof difference |
|---|---|---|---|---|
| | Value | % | | |
| | 1.42 | 100 | 0.00 | Mt |
| Wheat grains | 1.50 | 105.6 | 0.08 | * |
| Millet grains | 1.32 | 92.7 | -0.10 | 0 |
| Mustard grains | 1.23 | 86.9 | -0.19 | 00 |
| Mix of grains | 1.63 | 114.8 | 0.21 | *** |
| DL (p 5%) | | | 0.08 | |
| DL (p 1%) | | | 0.12 | |
| DL (p 0.1%) | | | 0.19 | |

Summary comparisons by Duncan test, the influence of biological material on the *Agarius blazei* Murrill mycelial growth, is presented in *Table 3*, the highest value of growth was recorded for seed mix with 1.63 mm / day in last place was located mustard seed with a rise of 1.23 mm / day.

Table 3

**Summary comparisons by Duncan test, the influence of biological material on the *Agarius blazei* Murrill mycelial growth**

| Biological material | Growth mm/day | Significance* |
|---|---|---|
| Mix of grains | 1.63 | A |
| Wheat grains | 1.50 | B |
| Millet grains | 1.32 | C |
| Mustard grains | 1.23 | D |

DS values 0,08-0,08

* Values marked with different letters are significant

Taking into account the unilateral influence of amendments on the *Agarius blazei* Murrill mycelial growth, we can be seen as it recorded a difference of 1.60 mm/day being very significant positive, to the average taken as controls (*table 4*) which registered 1.42 mm/day.

Table 4

**Unilateral amendments influence on mycelial growth *Agaricus blazei* Murrill mushrooms**

| Amendments | Growth mm/day | | Difference ±D mm/day | Signification of difference |
|---|---|---|---|---|
| | Value | % | | |
| | 1.42 | 100.0 | 0.00 | Mt |
| $CaSO_4$ | 1.60 | 112.7 | 0.18 | *** |
| $CaCO_3$ | 1.43 | 100.4 | 0.00 | - |
| No amendments | 1.24 | 87.0 | -0.19 | 000 |
| DL (p 5%) | | | 0.04 | |
| DL (p 1%) | | | 0.05 | |
| DL (p 0.1%) | | | 0.07 | |

In combining experimental factors, amendments and biological material, on mycelial growth we recorded significant values (*table 5*).

The influence of combined factors, amendments and biological material, on the mycelial growth, were recorded the highest values, 1.85 mm/day with $CaSO_4$ amendments, followed by the wheat grain with $CaSO_4$ amendments 1.67 mm/day. On the last place was located the mustard grain with no amendments. It can be concluded that the mycelial growth is more intensive with $CaSO_4$ amendments.

Table 5

**Combining experimental factors, amendments and biological material, on mycelial growth of *Agaricus blazei* Murill mushroom**

| Amendment / Biological material | Mycelium growth | | Difference ±D mm/day | Signification of difference |
|---|---|---|---|---|
| | mm/day | % | | |
| | 1.50 | 100.0 | 0.00 | Mt. |
| $CaSO_4$ / Wheat grain | 1.67 | 111.1 | 0.17 | *** |
| $CaCO_3$ / Wheat grain | 1.45 | 96.7 | -0.05 | - |
| No amendments / Wheat grain | 1.38 | 92.2 | -0.12 | 00 |
| | 1.32 | 100.0 | 0.00 | Mt. |
| $CaSO_4$ / Millet grain | 1.50 | 113.9 | 0.18 | *** |
| $CaCO_3$ / Millet grain | 1.28 | 97.5 | -0.03 | - |
| No amendments / Millet grain | 1.17 | 88.6 | -0.15 | 000 |
| | 1.23 | 100.0 | 0.00 | Mt. |
| $CaSO_4$ / Mustard grain | 1.38 | 112.2 | 0.15 | *** |
| $CaCO_3$ / Mustard grain | 1.25 | 101.4 | 0.02 | - |
| No amendments / Mustard grain | 1.07 | 86.5 | -0.17 | 000 |
| | 1.63 | 100.0 | 0.00 | Mt. |
| $CaSO_4$ / Mix of grain | 1.85 | 113.5 | 0.22 | *** |
| $CaCO_3$ / Mix of grain | 1.72 | 105.3 | 0.09 | * |
| No amendments / Mix of grain | 1.32 | 81.2 | -0.31 | 000 |
| DL (p 5%) | | | 0.08 | |
| DL (p 1%) | | | 0.11 | |
| DL (p 0,1%) | | | 0.15 | |

In combining experimental factors, biological material and amendments, on mycelial growth we recorded significant values (table no. 6).

The influence of combined factors, biological material and amendments, on the mycelial growth, were recorded the highest values, 1.85 mm/day on mix of grain with $CaSO_4$ amendments, followed by the wheat grain with $CaSO_4$ amendments 1.67 mm/day. On the last place was located the mustard grain with no amendments. It can be concluded that the mycelial growth is more intensive on mix of grain with amendments.

Table 6

**Combining experimental factors, biological material and amendments, on mycelial growth of *Agaricus blazei* Murill mushroom**

| Biological material / Amendment | Mycelium growth | | Difference ±D mm/day | Signification of difference |
|---|---|---|---|---|
| | mm/day | % | | |
| | 1.60 | 100.0 | 0.00 | Mt. |
| Wheat grain / $CaSO_4$ | 1.67 | 104.2 | 0.07 | - |
| Millet grain / $CaSO_4$ | 1.50 | 93.8 | -0.10 | - |
| Mustard grain / $CaSO_4$ | 1.38 | 86.5 | -0.22 | 00 |
| Mix of grain / $CaSO_4$ | 1.85 | 115.6 | 0.25 | *** |
| | 1.43 | 100.0 | 0.00 | Mt. |
| Wheat grain / $CaCO_3$ | 1.45 | 101.8 | 0.02 | - |
| Millet grain / $CaCO_3$ | 1.28 | 90.1 | -0.14 | 0 |
| Mustard grain / $CaCO_3$ | 1.25 | 87.7 | -0.18 | 00 |
| Mix of grain / $CaCO_3$ | 1.72 | 120.5 | 0.29 | *** |
| | 1.24 | 100.0 | 0.00 | Mt. |
| Wheat grain / No amendments | 1.38 | 112.0 | 0.15 | ** |
| Millet grain / No amendments | 1.17 | 94.5 | -0.07 | - |
| Mustard grain / No amendments | 1.07 | 86.4 | -0.17 | 00 |
| Mix of grain / No amendments | 1.32 | 107.2 | 0.09 | - |
| DL (p 5%) | | | 0.10 | |
| DL (p 1%) | | | 0.15 | |
| DL (p 0,1%) | | | 0.22 | |

## CONCLUSIONS

All the recipes presented in this paperwork may be used for *Agaricus blazei* Murrill mushroom mycelium production, all of them with result retrieved in foreign scientific literature, with 1.42 mm/day mean value.

The mycelial growth is more intensive on mix of grain with amendments (1.72-1.85 mm/day), followed by wheat grain without amendments (1.38 mm/day).

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# THE INFLUENCE OF CULTURE TECHNOLOGY ON PRODUCTION AND CHEMICAL CONTENT IN *AGARICUS BLAZEI* MURRILL MUSHROOMS

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**Abstract**

Until 40-50 years ago, the medicinal properties of this fungus were known only to inhabitants of villages around the Amazonian forest in Brazil, but after scientific recognition of this mushroom, *Agaricus blazei* Murrill has become one of the most important immunomodulatory and mushrooms defense against tumors.
Attempts to cultivate *Agaricus blazei* Murrill, using biotechnologies have not been satisfactorily until around 2000s. The tropical native environment of *Agaricus blazei* Murrill mushrooms is very difficult to reproduce in the locations of culture. A few years ago, when demand for *Agaricus blazei* Murrill greatly increased, and the price has increased almost exponentially mushrooms in Piedade region in Brazil, mushrooms have disappeared almost completely.
All these considerations have led us to approach this work in biotech crop research on the species *Agaricus blazei* Murrill.
The study was conducted on four types of compost (classical, synthetic, mixed and original) with two different protein supplements, applying semi-intensive and semi-mechanized technology of culture. For each experimental variant were made the following chemical determinations: dry matter; total protein; total fat; ash; carbohydrates; energy value; β-glucan 1-3 D and lovastatin. The results were interpreted in terms of statistics.

**Key words**: *Agaricus blazei* Murrill, β 1-3 D-glucan, lovastatin

Human relationships with mushrooms are ancient and fascinating. The Egyptian believed that they were a gift of god Osiris, while the ancient Romans called them a 'divine food' because they thought that mushrooms resulted from the lightning thrown to early by Jupiter during storms. Mushrooms have been valued as delicious and nutritional foods in many countries. (Atkins F., 2006).

Worldwide specialists looking for new products from various plants and fungi containing vitamins, minerals, enzymes that improve human health. Viewed from this perspective, the mushrooms is a food with a high nutritional value, containing essential amino acids in the protein complex structure, and some species have real therapeutic and medicinal virtues. (Ellertsen L.K., 2005)

Traditionally, the fungi were granted with antitumor and immunological therapeutic virtues, which began to be tested scientifically, especially in the last three decades. The most important medical effects of mushrooms are: immunomodulatory genoprotector, antioxidant, anti-allergic, anti-tumor, liver, diabetes, anti-atherogenic, hipocolesterolic.

Currently, supplements and herbal medicines are provided and many products based on mushroom cultivation and medicinal basidiomycetes. (Halpern G.M., 2007)

Many researchers have scientifically proven that beta-glucan content of these fungi is more beneficial to glucans of other medicinal mushrooms. Beta-glucan of *Agaricus blazei* Murrill main form is 1-6, with a spiral which closely replicate the size and shape of normal DNA. (Kaul N.T., 2002)

Some recently isolated and identified compounds, originating from mushrooms, that block the formation of carcinogens, alter membrane structure suppress DNA synthesis, enhance cell differentiation and compete with estrogen receptors (Stamets P., 2010).

## MATERIAL AND METHOD

Compost is the substrate on which mushrooms grows. The microbial degradation of organic wastes by several microorganism makes the substrate selective for the growth of *Agaricus blazei* Murrill. During composting, distinct changes occur in the physical, chemical and biological

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characteristics of the straw, all of which influence the productivity. The recipes of the compost for each experimental variant of the experience are shown in the *table 1*.

Table 1

**Recipes of the compost used in experience**

| Type of compost | Components | Cantity for 1 tone of compost |
|---|---|---|
| Classical | Horse manure (composed by horse manure and wheat straw bedding 70-75%)<br>Gypsum (calcium sulphate)<br>Superphosphate<br>Ammonium sulfate | 500 kg<br>25 kg<br>7 kg<br>7 kg |
| Synthetic | Wheat straw<br>Poultry litter<br>Gypsum (calcium sulphate)<br>Urea | 350 kg<br>150 kg<br>20 kg<br>7 kg |
| Mixt | Horse manure (composed by horse manure and wheat straw bedding 70-75%)<br>Gunoi de păsări<br>Poultry litter<br>Gypsum (calcium sulphate)<br>Urea<br>Wheat bran 3% | 250 kg<br>100 kg<br>150 kg<br>24 kg<br>2 kg<br>30 kg |
| Original | Shredded cane<br>Horse manure (composed by horse manure and wheat straw bedding 70-75%)<br>Poultry litter<br>Gypsum (calcium sulphate)<br>Urea | 100 kg<br>200 kg<br>150 kg<br>24 kg<br>2 kg |

In order to achieve a directed composting, were made four identical tanks to control, perform and record optimal environmental conditions necessary for composting (*figure 1*)

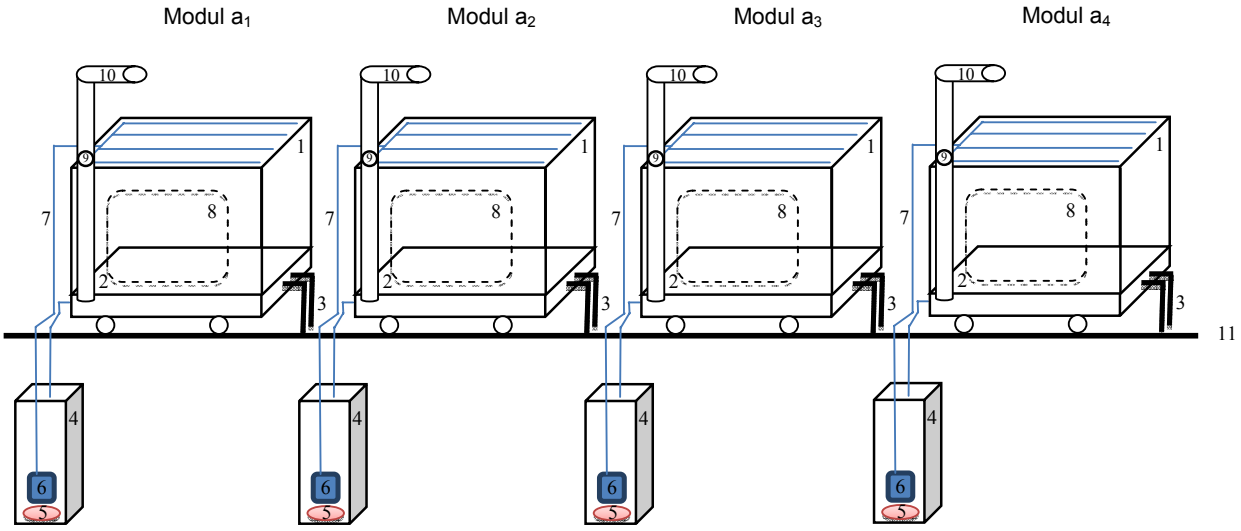


Figure 1 **Sketch for the composting facility - 4 modules**

1 - tank with capacity of 1 $m^3$ for compost components; 2 – rack for compost; 3 - tank heating system for composting; 4 - tank for the collection and recirculation the water excess; 5 - heating elements for wetting water (purine); 6 – water/purine recirculation pump; 7 - recirculation pipes for wetting water/ purine; 8 - compost discharge door; 9 - air flow control valve for aerobic composting; 10 - air inlet pipe to aerobic composting from the compressor; 11 - ground level.

## RESULTS AND DISCUSSIONS

The amounts collected for each experimental variant in part, to the waves 1, 2 and 3 are shown in *table 2*. The results are expressed in kg and are for 1 square meter of cultivated area.

Table 2

**Harvest amounts at 1, 2 and 3 flush**

| Experimental variant | Flush 1 kg/1m$^2$ | Flush 2 kg/1m$^2$ | Flush 3 kg/1m$^2$ | Total kg/1m$^2$ |
|---|---|---|---|---|
| V1($a_1b_1$)* | 15.98 | 12.43 | 7.09 | 35.50 |
| V2 ($a_1b_2$)** | 16.74 | 13.02 | 7.44 | 37.20 |
| V3 ($a_1b_3$)*** | 16.43 | 12.78 | 7.29 | 36.50 |
| V4($a_2b_1$)* | 18.23 | 14.18 | 8.09 | 40.50 |
| V5 ($a_2b_2$)** | 18.90 | 14.70 | 8.40 | 42.00 |
| V6 ($a_2b_3$)*** | 18.63 | 14.49 | 8.28 | 41.40 |
| V7($a_3b_1$)* | 17.55 | 13.65 | 7.80 | 39.00 |
| V8 ($a_3b_2$)** | 18.36 | 14.28 | 8.16 | 40.80 |
| V9 ($a_3b_3$)*** | 17.96 | 13.97 | 7.97 | 39.90 |
| V10 ($a_4b_1$)* | 13.19 | 10.26 | 5.85 | 29.30 |
| V11 ($a_4b_2$)** | 14.09 | 10.96 | 6.25 | 31.30 |
| V12 ($a_4b_3$)*** | 13.82 | 10.75 | 6.13 | 30.70 |

V1, 2, 3 – classical compost, V4, 5, 6 – synthetic compost, V7, 8, 9 – mixt compost, V10, 11, 12 – original compost
* without supplements, **with wheat bran 3%, *** with corn flour 3%

It was analysed the unilaterally influence of compost on *Agaricus blazei* Murrill mushroom production, table 3 show us the obtained values. The mixed and synthetic compost registered very significantly positive differences (4.35 and 3.04) against average and classic and original compost registered very significant negative differences from the average.

Table 3

**Unilateral influence of compost over the production**

| Compost | Obtained harvest | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| | 36.86 | 100.0 | 0.00 | Mt. |
| Classical | 36.22 | 98.3 | -0.64 | 000 |
| Synthetic | 41.21 | 111.8 | 4.35 | *** |
| Mixt | 39.90 | 108.2 | 3.04 | *** |
| Original | 30.11 | 81.7 | -6.75 | 000 |
| DL (p 5%) | | | 0.26 | |
| DL (p 1%) | | | 0.40 | |
| DL (p 0.1%) | | | 0.63 | |

It was analysed the unilateral influence of protein addition in compost on *Agaricus blazei* Murrill mushroom production, *Table 4* shows us the obtained values. The addition of wheat bran 3% registered very significant positive differences (0.87) from the mean, and the addition of corn flour 3% have not experienced a statistically difference from the mean.

Table 4

**Unilateral influence of protein addition over the production**

| Protein addition | Obtained harvest | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| | 36.86 | 100.0 | 0.00 | Mt. |
| Without added protein | 35.91 | 97.4 | -0.95 | 000 |
| Wheat bran 3% | 37.73 | 102.4 | 0.87 | *** |
| Corn flour 3% | 36.94 | 100.2 | 0.08 | - |
| DL (p 5%) | | | 0.23 | |
| DL (p 1%) | | | 0.32 | |
| DL (p 0.1%) | | | 0.44 | |

It was analysed the unilateral influence of compost on the dry matter content, expressed in grams per 100g fresh substance, at the *Agaricus blazei* Murrill mushroom. *Table 5* presents the values obtained. The mixed and synthetic compost registered very significantly positive differences (0.33 and 0.14) against average and the original compost recorded very significant negative differences from the average.

It was analysed the unilateral influence of compost on total protein content, expressed in grams per 100g dry weight, at the *Agaricus blazei* Murrill mushroom. *Table 6* presents the values obtained. The classic, synthetic and mixed composts registered very significant positive differences from the average and the original compost recorded very significant negative differences from the average.

Table 5

**Unilateral influence of compost over the dry matter of *Agaricus blazei* Murrill mushrooms**

| Compost | Dry matter g/100g sp (fm) | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| | 8.44 | 100.0 | 0.00 | Mt. |
| Classical | 8.41 | 99.7 | -0.03 | - |
| Synthetic | 8.77 | 103.9 | 0.33 | *** |
| Mixt | 8.58 | 101.6 | 0.14 | *** |
| Original | 8.00 | 94.8 | -0.44 | 000 |
| DL (p 5%) | | | 0.06 | |
| DL (p 1%) | | | 0.08 | |
| DL (p 0.1%) | | | 0.14 | |

Table 6

**Unilateral influence of compost over the total protein of *Agaricus blazei* Murrill mushrooms**

| Compost | Total protein g/100g su (dm) | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| | 25.16 | 100.0 | 0.00 | Mt. |
| Classical | 26.77 | 106.4 | 1.60 | *** |
| Synthetic | 31.61 | 125.6 | 6.45 | *** |
| Mixt | 28.11 | 111.7 | 2.95 | *** |
| Original | 14.17 | 56.3 | -11.00 | 000 |
| DL (p 5%) | | | 0.34 | |
| DL (p 1%) | | | 0.52 | |
| DL (p 0.1%) | | | 0.83 | |

It was analysed the unilateral influence of compost on total fat content in grams per 100g dry weight, at the *Agaricus blazei* Murrill mushrooms. *Table 7* presents the values obtained. The mixed and classic composts registered very significant positive differences against average and original and synthetic composts registered significant negative differences from the average.

Table 7

**Unilateral influence of compost over the total fat of *Agaricus blazei* Murrill mushrooms**

| Compost | Total fat g/100g dm | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| | 2.20 | 100.0 | 0.00 | Mt. |
| Classical | 2.69 | 122.2 | 0.49 | *** |
| Synthetic | 1.80 | 81.8 | -0.40 | 000 |
| Mixt | 2.76 | 125.3 | 0.56 | *** |
| Original | 1.56 | 70.7 | -0.64 | 000 |
| DL (p 5%) | | | 0.11 | |
| DL (p 1%) | | | 0.17 | |
| DL (p 0.1%) | | | 0.27 | |

It was analysed the unilateral influence of compost on ash content in grams per 100g dry weight, at the *Agaricus blazei* Murrill mushroom. *Table 8* presents the obtained values. The classical and mixt composts registered very significant positive differences against average and the original and synthetic compost registered very significant negative differences from the average.

Table 8

**Unilateral influence of compost over the ash of *Agaricus blazei* Murrill mushrooms**

| Compost | Ash g/100g dm | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| | 8.78 | 100.0 | 0.00 | Mt. |
| Classical | 9.60 | 109.3 | 0.82 | *** |
| Synthetic | 8.44 | 96.2 | -0.34 | 000 |
| Mixt | 9.50 | 108.2 | 0.72 | *** |
| Original | 7.58 | 86.3 | -1.20 | 000 |
| DL (p 5%) | | | 0.11 | |
| DL (p 1%) | | | 0.16 | |
| DL (p 0.1%) | | | 0.26 | |

It was analysed the unilateral influence of compost on carbohydrate content, in grams per 100g dry weight, at the *Agaricus blazei* Murrill mushroom. *Table 9* presents us the values obtained. The original compost registered very significant positive differences from the average and the classic, mixed and synthetic composts registered significant negative differences from the average.

Table 9

**Unilateral influence of compost over the carbohydrates of *Agaricus blazei* Murrill mushrooms**

| Compost | Carbohydrates g/100g dm | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| | 65.49 | 100.0 | 0.00 | Mt. |
| Classical | 64.72 | 98.8 | -0.77 | 000 |
| Synthetic | 60.39 | 92.2 | -5.11 | 000 |
| Mixt | 60.53 | 92.4 | -4.96 | 000 |
| Original | 76.33 | 116.5 | 10.84 | *** |
| DL (p 5%) | | | 0.24 | |
| DL (p 1%) | | | 0.37 | |
| DL (p 0.1%) | | | 0.59 | |

It was analysed the unilateral influence of compost on energy value, expressed in kcal/kg fresh matter, at the *Agaricus blazei* Murrill mushroom. *Table 10* presents the values obtained. Synthetic compost registered very significant positive differences from the average and the classic, original and mixed composts registered very significant negative differences from the average.

Table 10

**Unilateral influence of compost over the energetic value of *Agaricus blazei* Murrill mushrooms**

| Compost | Energetic value Kcal/kg fm | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| | 336.11 | 100.0 | 0.00 | Mt. |
| Classical | 330.56 | 98.3 | -5.56 | 000 |
| Synthetic | 390.11 | 116.1 | 54.00 | *** |
| Mixt | 298.89 | 88.9 | -37.22 | 000 |
| Original | 324.89 | 96.7 | -11.22 | 000 |
| DL (p 5%) | | | 2.22 | |
| DL (p 1%) | | | 3.36 | |
| DL (p 0.1%) | | | 5.40 | |

It was analysed the unilateral influence of compost on the content of β-glucan 1-3 D, expressed in mg per 100 g dry matter, at the *Agaricus blazei* Murrill mushroom. *Table 11* presents the obtained values. The classical and mixed compost registered very significant positive differences against average and the original compost registered very significant negative differences from the average.

Table 11

**Unilateral influence of compost over the β 1-3 D-glucan of *Agaricus blazei* Murrill mushrooms**

| Compost | β 1-3 D-glucan mg/100g dm | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| | 3292.58 | 100.0 | 0.00 | Mt. |
| Classical | 3559.22 | 108.1 | 266.64 | *** |
| Synthetic | 3279.44 | 99.6 | -13.14 | - |
| Mixt | 3360.00 | 102.0 | 67.42 | *** |
| Original | 2971.67 | 90.3 | -320.92 | 000 |
| DL (p 5%) | | | 24.76 | |
| DL (p 1%) | | | 37.50 | |
| DL (p 0.1%) | | | 60.24 | |

It was analysed the influence of compost on unilateral lovastatin content expressed in mg per 100 g dry matter, the *Agaricus blazei* Murrill. *Table 12* presents the obtained values. The classical and mixed composts registered very significant positive differences against average and the synthetic and original compost registered very significant negative differences from the average.

Table 12

**Unilateral influence of compost over the lovastatin of *Agaricus blazei* Murrill mushrooms**

| Compost | Lovastatin mg/100g dm | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| | 15.18 | 100.0 | 0.00 | Mt. |
| Classical | 18.17 | 119.7 | 2.99 | *** |
| Synthetic | 14.28 | 94.1 | -0.90 | 000 |
| Mixt | 16.14 | 106.3 | 0.96 | *** |
| Original | 12.13 | 79.9 | -3.05 | 000 |
| DL (p 5%) | | | 0.11 | |
| DL (p 1%) | | | 0.16 | |
| DL (p 0,1%) | | | 0.26 | |

## CONCLUSIONS

Synthetic compost had the highest yield (41.21 kg/m$^2$), followed by mixed compost (39.90 kg/m$^2$). The lowest production was carried out on the original compost (30.11 kg/m$^2$).

The addition of protein in compost, which ensures higher productivity are wheat bran 3% (37.73 kg/ m$^2$), followed by corn flour 3% (36.94 kg/m$^2$).

Analysing the dry matter content of the mushrooms, it can be concluded that mushrooms harvested from synthetic compost presents the greatest amount of dry matter (8.77g/100g fresh matter).

Analysing the total protein content of mushrooms, it can be concluded that mushrooms harvested from synthetic compost presents the greatest amount of total protein (31.61g /100 g dry matter), followed by mushrooms harvested on mixed compost (28.11 g / dry matter 100g).

Analysing the compost influence on the content of β-glucan 1-3 D, it can be concluded that harvested mushrooms on classical compost presents the highest value of β-glucan 1-3 D (3559.22 mg / 100g dry matter) followed by mushrooms harvested on mixed compost (3360.00 mg / 100g dry matter).

Analysing the compost influence on the content of lovastatin, it can be concluded that harvested mushrooms on classical compost presents the highest value lovastatin (18.17 mg / 100g dry matter), followed by mushrooms harvested on mixed compost (16.14 mg / 100g dry matter).

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# THE INFLUENCE OF pH AND THE SOURCE OF NITROGEN ON THE MYCELIAL GROWTH OF THE PLEUROTUS OSTREATUS MUSHROOMS

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**Abstract**

*Pleurotus ostreatus* mushrooms (popularly called phage trout or oyster mushroom) are edible flora mushrooms under natural conditions, created spontaneous by beech wood waste, from which he also received the popular name of "Trout phage". Cultivation in artificial conditions required a long work of research and selection carried out in different countries around the world to adapt to the growing conditions in artificially climate, with making a substrate of culture optimal to obtain yields bigger per unit area, in terms of profitability.

*Pleurotus ostreatus* mycelium development requires a rich material in polysaccharides and lignin, sufficiently low in essential minerals and without having been previously attacked by bacteria (decomposed). Compared with mineral sources, organic nitrogen sources have a particular influence on mycelial growth. Thus, the addition of barley flour or malt fangs is favorable.

In contrast to the genus *Agaricus* mushroom, at *Pleurotus* species the nutrient medium does not require a fence part (fermentation) of the transformed microorganisms or partially hydrolysed by physico-chemical processes.

*Pleurotus ostreatus* mycelium growth is carried out at pH values between 5 and 6.5 the limits being from 4.2 to 7.5. A highly acidic pH (pH 4) stops the growth of mycelium. Increasing the pH of 4 to 6.5 has a positive influence on the growth of mycelium, unlike higher values, ie pH neutral or slightly alkaline (pH 7-8), when the mycelium growth is again partially inhibited.

With regard to sources of nitrogen, it has been found that the addition of albumin, in the form of soybean meal, reduces the mycelium growth and delay the production of mushrooms.

**Key words**: *Pleurotus ostreatus*, mushrooms, mycelium, pH, nitrogen source

Latin and greek roots: *Pleurotus* comes from the greek “pleuro” which means formed laterally or in a sideways position, referring to the lateral position of the stem relative to the cap. The species ephitet *ostreatus* refers to its oyster shell-like appearance and color.

General description: Cap convex at first, expanding to broadly convex, eventually flat and even upturned in age; 5-20cm (+) in diameter. White to yellow to grayish yellow to tan, rarely with pinkish tones, to lilac gray to gray-brown. Cap margin smooth to undulating like an oyster shell. Color varies according to the strain, lighting and temperature conditions. Stems are typically eccentrically attached to the cap. Flesh generally thin. Some strains form clusters; others forms individuals.

Microscopic features: Spores white to slightly lilac to lilac gray, 7.5-9.5x3-4µ. Clamp connections present. Context monomitic.

Mycelial characteristics: Whitish, longitudinally radial, soon becoming cottony, and in age forming a thick, tenacious mycelial mat. Aged mycelium often secrets yellowish to orangish droplets of a metabolite, a toxin to nematodes. This metabolite deserves greater study.

Fragnance signature: Sweet, rich, pleasant, distinctly anise, and almost almond-like.

## MATERIAL AND METHOD

Isolation of *Pleurotus ostreatus* mycelia.

Materials: Fresh mushrooms, inoculation needle, sterilized agar medium, Petri plates, laminar airflow, Bunsen burner and sterilized PDA slants.

Method: Was taked a fresh mushroom for tissue culture, cleaned the surface with 70% aqueous ethyl alcohol, transferred a small piece with the help of inoculation needle under laminar airflow. Both hands and bottles was cleaned with alcohol and inserted into the laminar air cabinet. The needle was holded with two fingers in an 45º angle and was flamed to disinfect (until the needle turns red). While the needle cools down (15-20

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seconds) using other fingers the mushroom were teared lengthwise . With the needle was cuted a small piece (2 mm x 2 mm) of fleshy tissue from inside the mushroom and was placed in the middle of the PDA surface. The PDA plates was labeled and incubated at 24ºC for 7 days and observed the growth.

For determination the influence of the nitrogen source on the *Pleurotus ostreatus* mushroom mycelium gowth, we used a semisolid agar medium using the following formula/recipes: sterilized PDA medium (diced potato 200g/L, dextrose 20g/L and agar 15g/L) used as control, PDA medium with 15 g/L soybean meal (PDAS) and PDA medium with yeast (PDAY) at different pH values: 4, 4.5, 5, 5.5, 6, 6.5, 7 and 7.5. The results of experiences were recorded during 7 days of mycelium growing in mm/day.

## RESULTS AND DISCUSSIONS

It was analyzed the unilateral influence of agar recipe on the *Pleurotus ostreatus* mycelium growth expressed in mm/day. *Table 1* presents the obtained values. Analyzing the data in the table, it can be said that PDAY recipe, recorded positive differences compared to the experience average, the PDA recipe. At PDAS recipe we recorded negative differences from the average.

Table 1

**Unilateral influence of agar recipe on the *Pleurotus ostreatus* mycelium growth**

| Recipe | Mycelium growth -mm/day- | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| PDA | 4.11 | 100.0 | 0.00 | Mt. |
| PDAS | 3.34 | 81.3 | -0.77 | 0 |
| PDAY | 4.68 | 113.9 | 0.57 | * |
| DL (p 5%) | | | 0.49 | |
| DL (p 1%) | | | 0.80 | |
| DL (p 0.1%) | | | 1.50 | |

It was analyzed the unilateral influence of agar recipe pH on the *Pleurotus ostreatus* mycelium growth expressed in mm/day. Table 2 presents the obtained values. Analyzing the data in the table, it can be said that pH 4, 4.5 and 5, recorded very significant positive differences compared to the experience average. At pH 6 to 7.5 we recorded very significant negative differences from the average.

Table 2

**Unilateral influence of agar recipe pH on the *Pleurotus ostreatus* mycelium growth**

| Recipe pH | Mycelium growth -mm/day- | | Difference ±D | Signification of difference |
|---|---|---|---|---|
| | Obtained values | % | | |
| | 4.04 | 100.0 | 0.00 | Mt. |
| 4 | 4.73 | 117.1 | 0.69 | *** |
| 4.5 | 7.63 | 188.8 | 3.59 | *** |
| 5 | 4.71 | 116.5 | 0.67 | *** |
| 5.5 | 3.88 | 95.9 | -0.17 | - |
| 6 | 3.47 | 85.7 | -0.58 | 000 |
| 6.5 | 3.26 | 80.5 | -0.79 | 000 |
| 7 | 2.88 | 71.2 | -1.17 | 000 |
| 7.5 | 1.79 | 44.2 | -2.25 | 000 |
| DL (p 5%) | | | 0.22 | |
| DL (p 1%) | | | 0.29 | |
| DL (p 0.1%) | | | 0.38 | |

Synthesis using comparisons by Duncan test for the agar recipe pH is presented in table no. 3. We can see that on the first place is located the pH 4.5 recipe with 7.63 mm/day of growth, followed by the pH 4 and 5 recipes. On the last place was located the pH 7.5 recipe with 1.79 mm/day.

Table 3

**Synthesis using comparisons by Duncan test for the agar recipe pH on the *Pleurotus ostreatus* mycelium growth**

| Recipe pH | Mycelium growth mm/day | Significance* |
|---|---|---|
| 4.5 | 7.63 | A |
| 4 | 4.73 | B |
| 5 | 4.71 | B |
| 5.5 | 3.88 | C |
| 6 | 3.47 | D |
| 6.5 | 3.26 | D |
| 7 | 2.88 | E |
| 7.5 | 1.79 | F |

DS 0.22-0.25

* Values marked with different letters are significant

In combining experimental factors, pH value and recipe, on mycelia growth we recorded significant values (table 4).

The influence of combined factors, pH on the growth recipe of mycelium, at pH 4.5 on PDAY recipe was recorded the highest values 8.93 mm/day of growth, followed by pH 4.5 on PDA recipe with 8.17 mm/day of growth. On the last place was located pH 7.5 on PDAS recipe with 1.37 mm/day of growth.

Table 4

**Combining experimental factors, pH and recipe, on mycelia growth of *Pleurotus ostreatus* mushroom**

| pH | Recipe | Mycelia growth –mm/day- | | Difference ±D | Signification of difference |
|---|---|---|---|---|---|
| | | Obtained values | % | | |
| | | 4.11 | 100.0 | 0.00 | Mt. |
| 4 | PDA | 4.73 | 115.2 | 0.63 | ** |
| 4.5 | PDA | 8.17 | 198.8 | 4.06 | *** |
| 5 | PDA | 4.67 | 113.6 | 0.56 | ** |
| 5.5 | PDA | 3.57 | 86.8 | -0.54 | 00 |
| 6 | PDA | 3.53 | 86.0 | -0.58 | 00 |
| 6.5 | PDA | 3.33 | 81.1 | -0.77 | 000 |
| 7 | PDA | 2.93 | 71.4 | -1.18 | 000 |
| 7.5 | PDA | 1.93 | 47.1 | -2.18 | 000 |
| | | 3.34 | 100.0 | 0.00 | Mt. |
| 4 | PDAS | 3.83 | 114.7 | 0.49 | * |
| 4.5 | PDAS | 5.80 | 173.6 | 2.46 | *** |
| 5 | PDAS | 3.97 | 118.7 | 0.63 | ** |
| 5.5 | PDAS | 3.47 | 103.7 | 0.12 | - |
| 6 | PDAS | 3.03 | 90.8 | -0.31 | - |
| 6.5 | PDAS | 2.83 | 84.8 | -0.51 | 00 |
| 7 | PDAS | 2.43 | 72.8 | -0.91 | 000 |
| 7.5 | PDAS | 1.37 | 40.9 | -1.98 | 000 |
| | | 4.68 | 100.0 | 0.00 | Mt. |
| 4 | PDAY | 5.63 | 120.4 | 0.95 | *** |
| 4.5 | PDAY | 8.93 | 190.4 | 4.25 | *** |
| 5 | PDAY | 5.50 | 117.5 | 0.82 | *** |
| 5.5 | PDAY | 4.60 | 98.3 | -0.08 | - |
| 6 | PDAY | 3.83 | 81.9 | -0.85 | 000 |
| 6.5 | PDAY | 3.60 | 76.9 | -1.08 | 000 |
| 7 | PDAY | 3.27 | 69.8 | -1.41 | 000 |
| 7.5 | PDAY | 2.07 | 44.2 | -2.61 | 000 |
| DL (p 5%) | | | | 0.38 | |
| DL (p 1%) | | | | 0.50 | |
| DL (p 0.1%) | | | | 0.66 | |

In combining experimental factors, recipe and pH value, on mycelia growth we recorded significant values (table 5).

The influence of combined factors, the recipe and pH value on mycelium growth, at pH 4.5 on PDAY recipe was recorded the highest values 8.93 mm/day of growth, followed by pH 4.5 on PDA recipe with 8.17 mm/day of growth, taked as control. On the last place was located pH 7.5 on PDAS recipe with 1.37 mm/day of growth.

Table 5

**Combining experimental factors, pH and recipe, on mycelia growth of *Pleurotus ostreatus* mushroom**

| Recipe | pH | Mycelia growth –mm/day- | | Difference ±D | Signification of difference |
|---|---|---|---|---|---|
| | | Obtained values | % | | |
| PDA | 4 | 4.73 | 100.0 | 0.00 | Mt. |
| PDAS | 4 | 3.83 | 81.0 | -0.90 | 0 |
| PDAY | 4 | 5.63 | 119.0 | 0.90 | * |
| PDA | 4.5 | 8.17 | 100.0 | 0.00 | Mt. |
| PDAS | 4.5 | 5.80 | 71.0 | -2.37 | 000 |
| PDAY | 4.5 | 8.93 | 109.4 | 0.77 | * |
| PDA | 5 | 4.67 | 100.0 | 0.00 | Mt. |
| PDAS | 5 | 3.97 | 85.0 | -0.70 | 0 |
| PDAY | 5 | 5.50 | 117.9 | 0.83 | * |
| PDA | 5.5 | 3.57 | 100.0 | 0.00 | Mt. |
| PDAS | 5.5 | 3.47 | 97.2 | -0.10 | - |
| PDAY | 5.5 | 4.60 | 129.0 | 1.03 | ** |
| PDA | 6 | 3.53 | 100.0 | 0.00 | Mt. |
| PDAS | 6 | 3.03 | 85.8 | -0.50 | - |
| PDAY | 6 | 3.83 | 108.5 | 0.30 | - |
| PDA | 6.5 | 3.33 | 100.0 | 0.00 | Mt. |
| PDAS | 6.5 | 2.83 | 85.0 | -0.50 | - |
| PDAY | 6.5 | 3.60 | 108.0 | 0.27 | - |
| PDA | 7 | 2.93 | 100.0 | 0.00 | Mt. |
| PDAS | 7 | 2.43 | 83.0 | -0.50 | - |
| PDAY | 7 | 3.27 | 111.4 | 0.33 | - |
| PDA | 7.5 | 1.93 | 100.0 | 0.00 | Mt. |
| PDAS | 7.5 | 1.37 | 70.7 | -0.57 | - |
| PDAY | 7.5 | 2.07 | 106.9 | 0.13 | - |
| DL (p 5%) | | | | 0.59 | |
| DL (p 1%) | | | | 0.90 | |
| DL (p 0.1%) | | | | 1.50 | |

## CONCLUSIONS

*Pleurotus ostreatus* mycelium growth is carried out at pH values between 5 and 6.5 the limits being from 4.2 to 7.5. A highly acidic pH (pH 4) stops the growth of mycelium. Increasing the pH of 4 to 6.5 has a positive influence on the growth of mycelium, unlike higher values, ie pH neutral or slightly alkaline (pH 7-8), when the mycelium growth is again partially inhibited.

With regard to sources of nitrogen, it has been found that the addition of albumin, in the form of soybean meal, reduces the mycelium growth and delay the production of mushrooms.

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# CONSIDERATION ON THE HAZEL SPECIES CULTIVATION POTENTIAL IN ORDER TO OBTAIN TRUFFLES IN THE MOLDOVA AREA

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**Abstract**

Truffle plantation are traditional crops in countries such as France, Italy and Spain, but also have started to be considered as potential sources of revenue in our country, with the specification that there is a limited dendrological assortment for obtaining the truffles, composed of nut trees, oak, hornbeam, lime and beech species. The survey, conducted at the Livezi County Forest from Bacau, has demonstrated the fact that none of the species listed above can provide the two advantages of the setting up of a hazel culture (*Corylus avellana var. Tonda gentile romana*), namely: earlier production entry, in average with 5-6 years, compared to the tree species and the obtaining of the two main productions (truffles and hazelnuts). Mycorrhized hazel plants have proven that they can produce truffles from the age of 6÷7 years, depending on the edaphic and climatic factors. Hazelnuts production starts in the 4th year when the amount is estimated to be 2÷3 kg/ plant, about 1÷2 tons/ha, but after the plants reach maturity, production of hazelnuts can increase to 10÷15 kg/plant, which means a quantity of approximately 7-10 tonnes of nuts/ha. Truffle production begins in the 8th year and is estimated at an average amount of 50 kg/ha. The investment return can be achieved in the seventh year culture and the cumulative net profit from the exploitation of the hazel truffle plantation, over a period of 13 years, exceeds 920.000 lei.

**Key words**: truffle, the hazel, truffle plantation

The paper presents an experience regarding the technology of cultivation of hazel tree (*Corylus avellana var. Tonda gentile romana*) in order to harvest truffles in the Livezi nursery, from Bacău county, aiming in highlighting the potential of this crop for the Moldova area. Truffle plantations are already a reality in countries with tradition in the cultivation of truffles (France, Italy, Spain, Australia, etc), but have started to become promising in various regions (Dincă, Dincă, 2014). Worldwide, there are approximately 100 species that are part of the *Tuber* family,while in Europe there are about 30 species of truffles, but not all interest gourmet. In our country the only species of truffles that can be successfully cultivated in the present is the *Tuber aestivum/uncinatum* (black truffle or summer truffle), which has an aromatic smell, not too spicy and is harvested from mid May until to late august (Chira *et al*, 2012). For truffle crops there are considered appropriate calcareous, permeable, neutral to weak alkaline, rich in organic substances, permeable and with moderate humidity soils (Cociu, 2006).

## MATERIAL AND METHOD

There have been used 3 schemes of planting in the establishment of the plantation of hazel (*Corylus avellana* var. *Tonda gentile romana*), depending on the culture system (organic or conventional), namely: 5/5 m (400 plants/ha) in conventional system; 5/6 m (333 plants/ha) in ecological system and 6/6 m (277 plants/ha) also in ecological system.

The experiment has proposed to benefit from the advantages of the culture of the hazelnut, namely faster entry in production, with an average of 5-6 years compared to the tree species, and to obtain two products for recouping (truffle and hazelnuts).

Thus, it was found that the michorized plants hazel can produce truffles from the age of 6-7 years, depending on climatic factors and the structure of the soil, when it can begin harvesting truffles quantities of the order of kilograms from the surface of a hectare.

The culture was established in the year 2002 on an initial surface of 4.3 ha, being carried out periodic observations regarding the evolution, productivity and profitability of the truffle-hazel culture.

This crop profitability calculations have been carried out on one ha representative control surface, aiming to both the main output of truffles and the production of secondary fruits (hazelnuts).

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## RESULTS AND DISCUSSION

The truffle plantation on hazel from the Livezi Forest District required a land in reduced slope, mechanised, deep and well drained. The hazelnut tree is cultivated without problems after himself because it is not influenced by the phenomenon of soil fatigue (Botez *et al* ,1984).

Drainage is one of the very important works for the success of the hazel culture. That is why after the basic fertilization (70÷90 t/ha of manure equivalent in the active substance, 300 kg of potassium sulphate and 550 kg superphosphate per hectare) the land has been scarified with special machines at a depth of 35÷45 cm, through two passes perpendicular to each other, with two-three months before planting, achieving the in-depth loosening, aeration and favoring water movement in the soil. It attended tillage with rotary harrow, aiming to break up and to level the surface of the land, being thus prepared for the planting of michorized seedlings.

Before the seedlings planting, the land was picketed with a geodetic GPS, according to the schemes of planting, as outlined above.

The experiment pursued the modalities of the hazel plants conducting, using for truffle culture the following forms of management:single stem, pot, hedge fruit and shrub.

Single stem presents the following advantages: reduces the vigor of the plant, allows the suckers suppression, the stem growth is more balanced, and fruition is earlier. These plants conducted this way are very well lit and give the production more large and constant, also allowing the mechani-zation of the works. As a rule hazelnut form only the skeletal branches of the order I and II and on which are branches of semischelet and rod. Although the young hazel shoots grow quite vigorously (60÷80 cm or more) they do not exhibit anticipated shoots. Moreover, the polarity is poorly expressed, as is the hazel it's not a question of freeing the peaks (Grădinariu, 2002).

The conducting of hazel, in the form of the pot involves the formation of a trunk of approx. 60 cm and a number of 4÷6 trusses, and on each framing 1-2 undertrusses. Due to the large number of roof trusses in the composition of the crown, it is found a reduction of the vigour of the shrub (Sandu, 2008).

The conducting of the hazel in the hedgerow fruit was made quite easy due to the following features: the 2 rows buds placing, thickening and slow lengthening of the skeleton elements, good trusses garnish with branches of semischelet and rod on their entire length, weak polarity, the flexibility of the branches (Grădinariu, 2002).

Leadership in the form of shrub has assumed the maintenance of 6÷8 stems on each plant whose annual extension will be shortened to 70÷80 cm for branching. In the end, the height of the plant reaches 3-3. 5 m. The shape of the shrub at the hazel is not recommended for intensive plantations because it prints a force much greater than the single stem conducting (Sandu, 2008).

The length of the seedlings rows has been oriented on the N-S direction in order to capture a greater amount of light during the day and avoid as much as possible the phenomenon of shading. Planting was carried out in the period March-April, with additions in year 1 in the interval November-December, in the intervals climate devoid of winds.

In the case of spring plantings there were carried out watering periodic as the young plants of the michorized hazel are adversely affected by drought (Cociu, 2006). Maintenance of culture trufiere hazel mainly involved the maintenance of a fair balance of coexistence shrub-fungus, so as to ensure inter-conditionality thereof, on the understanding in the achievement of normal growth of the shrubs and the formation of mycorrhizae well developed, resulting in a rich and constant production of truffles. In the moment in which the truffles start to develop they emit a substance that, when the truffles are mature, produces a destruction of actual vegetation around them, like a halo, like a circle of vegetation around the hazel plant.

Among the maintenance work carried out during the 13 years of the culture it may be mentioned as being important: the mechanized mobilisation of surface soil around the plants, starting at a depth of 12-15 cm, decreasing annually up to 5-6 cm (Delmas, J. 1978); the destruction of weeds around the plant of hazel, mechanized in the first 5 years with tillers, then with trimmers to avoid areas of development of the truffle; deep loosening of the soil between the rows, periodically, for the creation of a good aeration of the soil; irrigation, depending on the culture year rainfall, using water with pH-neutral or slightly alkaline, the most common irrigations being in the first 2÷4 years; starting with the fifth year crop irrigation was aimed at mainly for the hydration of the truffle, which was adapted to the precipitation regime and soil type and in periods of drought stress watering has been carried out from 3 in 3 weeks (Fodor, 2013); maintenance pruning of hazel shrub have consisted in trimming the branches dried and the cuts to create the shape of the canopy desired (pot, shrub or hedge);

conducting in the form of single stem allowed, by trimming the trunk up to the height of 1-1,5 m, a much better insolation, when the managements in the form of a pot, shrub or hedge, with the advantage of better retention of moisture in the soil by shading, the also pose the disadvantage of favoring the installation of pests and diseases; harvesting was performed by collecting manual or by shaking on tilt tarps placed under the plants of the hazel (Dincă, Dincă, 2014).

Calculations on the profitability (cost-benefit ratio) have been carried out to of a representative 1 ha control surface, planted with seedlings of *Corylus avellana var. Tonda Gentile Romana* michorized with the *Tuber aestivum /uncinatum* fungus in a scheme of planting 5/5 m (400 plants/ha) in the conventional system.

In terms of the main truffle production harvesting began in the 6 year of the culture, with a modest value of approx. 50 kg/ha, taking into account the fact that a truffle hazel plantation at maturity can produce 150 kg/ha of truffle.

In subsequent years the production of truffles has increased reaching the amount of 135 kg/ha in the year 13 of the culture.

The price of truffles to the stock market for truffles is rated at 100÷150 euro/kg, depending on their sizes and quality.

In relation to the secondary production of hazelnuts, it could be harvested in the year 4 of culture, with an average amount of 2-3 kg/plant, meaning about 1-2 tonnes/ha, characterized by a exponential growth of the production of hazels during the years of culture, reaching in the year 9 of the culture up to 10÷15 kg/plant, i.e. about 7÷10 tons of hazelnuts per hectare.

The centralization of incomes and expenses for the 13 years of culture (*table 1*) has highlighted the fact that the expenses for the establishment and maintenance of the truffle hazel plantation until reaching maturity are estimated at approx. 115,000 lei, and the revenues accumulated from the exploitation of the plantation over a period of 13 years (first 2 years being unproductive) have been calculated as being approx. 1.117.000 lei for 1 ha.

So, the gross profit cumulated from the exploitation of the plantation over a period of 13 years was approx. 1,002,000 lei and the cumulative net profit from the exploitation of the truffle hazel plantation, over a period of 15 years, exceeds 920,000 lei.

Table 1

**Summary with the expenses and income for the plantation of hazel trufier of 1 ha**

| *Name of indicator/year production* | *Expenses (lei)* | *Incomes (lei)* | *Net Profit (lei)* | *Gross Profit (lei)* |
|---|---|---|---|---|
| Establisment+Year 1 | 93,578 | - | - | - |
| Years 2-3 | 3,485 | - | - | - |
| Year 4 | 1,745 | 15,707 | 13,967 | 11,733.11 |
| Year 5 | 1,745 | 31,415 | 29,675 | 24,927.85 |
| Year 6 | 1,745 | 47,123 | 45,383 | 38,122.57 |
| Year 7 | 1,745 | 62,831 | 61,091 | 51,317.12 |
| Year 8 | 1,745 | 106,590 | 104,850 | 88,077 |
| Year 9 | 1,745 | 127,907 | 126,167 | 105,961.23 |
| Year 10 | 1,745 | 149,225 | 147,485 | 123,868.2 |
| Year 11 | 1,745 | 170,543 | 168,803 | 141,735.4 |
| Year 12 | 1,745 | 191,861 | 190,121 | 159,772.3 |
| Year 13 | 1,745 | 213,180 | 211,440 | 177,649.9 |
| TOTAL | 114,513 | 1,116,883 | 1,098,982 | 923,121.6 |

The results of the financial analysis are presented in *figure 1*, where it is noted that the percentage of 29% net profit for a truffle hazel plantation can justify the opinion that this is a potential success culture for the Moldova area.


Figure 1 **The results of the financial analysis for the truffle hazel plantation**

## CONCLUSIONS

Profitability of the investment was estimated as being approx. 8 %, so a positive value which indicate that a truffle hazel culture in the hilly area of Moldova can be a cost-effective and deserves to be implemented .

The legal provisions in the countries of the E. U. on crops truffle mention the fact that, if after the preparation of the business plan, the profitability of the culture exceeds 2%, the project is considered potentially profitable culture and may receive funding from the grant.

The culture of the truffle hazelnut production taken in the study required in 15 years of culture 115.000 lei expenses for the establishment and maintenance for one hectare of culture.

Revenues accumulated over the 13 years of production (first two years being totally unproductive, from the 3-4 years production being only hazelnuts and from year 8 after truffle can also been harvested) were 1.117.000 lei per ha.

The cumulative net profit of more than 920.000 lei/ha and the fact that the investment can be recoup in the seventh year of culture can lead us to conclusion that the truffle hazel plantation in the hilly area in the center of Moldova can be potentially profitable culture.

We note that the profitability of the truffle hazel culture contributes in a large extent the incomes from the secondary production side of hazelnuts.

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# RESEARCHES ON CONTROLING REED (*Phragmites australis* (Cav.) Trin. ex Steud.) IN FARMLAND

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**Abstract**

In terms of worldwide corn ranked second crop of cultivated areas. In the nearby meadow or shallow ground water control of reeds represents a major problem. To achieve these objectives, in 2016, was established experience monofactorial with 10 variants. The researches were conducted in climatic conditions from farm SC Agroprod Seaca SA, about 15 km east of Turnu Măgurele and 10 km north of the Danube River. It was followed initial weeding base on which occurred experience (spectrum weed, average, participation and constancy), we aimed to also control degree by determining the degree of weed (before post-emergence treatment, at 2 weeks after application and before harvesting), the amount of nitrogen and chlorophyll concentration in leaves of corn and cane with Yara N-Tester respectively Portable Digital LED Tester chlorophyll chlorophyll Testing. The best weed control results, including cane were in order V7, V10, V6, V9. Testing on combating cane from the protective dams by applying Glyphogan 480 SL at a dose of 6 l/ha and 10 l/ha, showed that a control efficiency is achieved at begining of reeds vegetation period (May).

**Key words**: *Phragmites australis*, control, corn field

Worldwide corn crop ranked second in terms of cultivated areas (faostat.fao.org/site/). Weed control is an important component of any crop technology. Weed causes significant losses in maize production, these losses are proportional to the weeding, weeding spectrum, the timing of weed, weed biomass (Silva P.S.L. *et al.*, 2011). Maize plants have a low growth rate in the first part of the growing season, and because they have a low density (5-7 pl/m$^2$), is characterized by a period of sensitivity to weed in the first 6-8 weeks after emergence, and the lack of action to control weeds during this period, depending on the degree of weeds growing, losses can be up to 70% of production potential (Teasdale J.R., 1995), going to compromise culture. Production losses are determined by limiting access to nutrients, but also to water and light. Diego C. *et al.*, in 2012) shows that weeds have a growth rate more stressed and fail to overshadow corn plants, and in the absence of light these plants reduce the intensity of photosynthesis and therefore the amount of biomass synthesized. Clarence S., in 2005, indicates that a soil free of weeds absorbs light of whole spectrum, and in the conditions under which the soil is covered with weeds which will reflect a part of incident light, in particular infrared range, which will be directed towards the underside of the leaves, and under the influence of the lighting corn plants limit their leaves and roots growth.

## MATERIAL AND METHOD

The researches were conducted in climatic conditions from farm SC Agroprod Seaca SA, about 15 km east of Turnu Măgurele and 10 km north of the Danube River, characterized by a soil type aluviosol with a humus content of 2.8%. To achieve these objectives was founded in 2016 with 10 different monofactorial experience ($V_1$ = Untreated control $V_2$ = hoeing check, first hoeing at stage of corn 2-3 leaves, second hoeing at stage of corn 4-6 leaves, third hoeing at stage of corn 8 leaves; $V_3$ = Titus® plus (3.26% 60.87% rimsulfuron + dicamba), in dose of 307 g / ha, in 2-3 leaves stage of maize; $V_4$ = Titus® Plus + 0.1% Trend® 90 (3.26% rimsulfuron + 60.87% dicamba), in dose of 307 g/ha + Glyphogan 480 SL (360 g glyphosate acid/liter), in dose of 2 l/ha, in two treatments, the first in stage of 2-3 corn leaves, applied with nozzle with directed protection, the second stage of 4-6 leaves in corn, applied with touch wicks fed by drip (Wick Rope hand Applicator); $V_5$ = Glyphogan 480 SL (glyphosate acid 360 g/liter), in dose of 2 l/ha, in 2-3 corn leaf stage, applied with nozzle with directed protection;

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$V_6$ = Glyphogan 480 SL (glyphosate acid 360 g/liter), dose in 2 l/ha, in two treatments, in first stage of 2-3 corn leaves, applied with nozzle with directed protection, in the second stage of 4-6 corn leaves, applied with touch wicks fed by drip (Wick Rope hand Applicator); $V_7$ = Glyphogan 480 SL (360 g/l glyphosate) in a dose of 2 l/ha, in three treatments, first in stage of 2-3 corn leaves, applied with nozzle with directed protection, the second in stage of 4-6 corn leaves, applied with touch wicks fed by drip (Wick Rope hand Applicator), third in 8 corn leaf stage, applied with touch wicks fed by drip (Wick Rope hand Applicator); $V_8$ = propane flame, in 2-3 corn leaf stage; $V_9$ = propane flame, in 2-3 leaf stage corn + Glyphogan 480 SL, in dose of 2 l/ha in 4-6 corn leaf stage, applied with touch wicks fed by drip (Wick Rope hand Applicator); $V_{10}$ = propane flame in 2-3 corn leaf stage + Glyphogan 480SL, in dose of 2 l/ha in three treatments, first in stage of 2-3 corn leaves, applied with nozzle with directed protection, the second in 4-6 corn leaf stage, applied with touch wicks fed by drip (Wick Rope hand Applicator), third in 8 corn leaf stage of, applied with touch wicks fed by drip (Wick Rope hand Applicator). Corn was sown on 04.09.2016 by using a drill Amazone 6R. Flame treatment was carried out with the equipment in the image *(figure 1)*.

Figure 1 **Equipment for flame treatment**

Surface plots was about 100 $m^2$ (12 rows x 0.7 m x 12 m interrow distance leng row), 4 repetitions. Spectrum weeding determinations were made in a mesh network of 2x2 m, 0.25 $m^2$ frame (50x50 cm). For each of the 10 experimental variants was calculated average, participation and constancy weed before and after the treatments. Average = S/N, where S is the total number of plants of one species found in all points of determination and N the number of points where determination was done, in other words the average number of weeds in a certain species/$m^2$.

Participation P% = m x 100/ M, where M = $\sum m$ and represent the average number of weeds/$m^2$, the sum of all media of weed species identified. Constancy, K% = n x 100/N, where N is the number of points where a certain species was present.

## RESULTS AND DISCUSSION

Weed spectrum before treatments for weed control was represented by two perennial monocotile weed species *Phragmites australis*, *Sorghum halepense*, 2 species of annual monocotile weed species *Setaria* spp., *Echinochloa crus galli* and 7 annual dicotyledonous weeds species *Amaranthus retroflexus*, *Xanthium strumarium*, *Sinapis arvensis*, *Polygonum convolvulus*, *Chenopodium album*, *Galinsoga parviflora*, *Vicia angustifolia* and 2 species of perennial dicotyledonous weeds species *Convolvulus arvense*, *Cirsium arvense*. Average, participation and constancy of species distribution before treatments data are centralized in *table 1*.

*Table 1*

**Weed spectrum of experimental plots before treatments for weed control**

| | | | |
|---|---|---|---|
| **Species** | **A*** | **P**** | **C***** |
| *Phragmites australis* | 6.4 | 12.9 | 61.2 |
| *Sorgum halepense* | 3.2 | 6.4 | 11.8 |
| **Perennial monocotile** | **9.6** | **19.3** | |
| *Setaria* spp. | 12.8 | 25.7 | 32.4 |
| *Echinochloa cruss galli* | 10.4 | 20.9 | 38.6 |
| **Annual monocotile** | **23.2** | **46.6** | |
| *Amaranthus retroflexus* | 4.8 | 9.6 | 21.3 |
| *Xanthium strumarium* | 2 | 4.0 | 8.4 |
| *Vicia angustifolia* | 2.2 | 4.4 | 10.2 |
| *Solanum nigrum* | 1 | 2.0 | 2.2 |
| *Poligonum convolvulus* | 1.2 | 2.4 | 10.8 |
| *Chenopodium album* | 1 | 2.0 | 20.6 |
| *Sinapis arvensis* | 1.4 | 2.8 | 18.4 |
| *Galinsoga parviflora* | 1.8 | 3.6 | 23.2 |
| **Annual dicotyledonous** | **15.4** | **30.9** | |
| *Convolvulus arvense* | 0.6 | 1.2 | 24.6 |
| *Cirsium arvense* | 1 | 2.0 | 21.4 |
| **Perennial dicotyledonous** | **1.6** | **3.2** | |
| *Total* | **49.8** | **100** | |

*Average; ** Participation; *** Participation

The analysis of data on the average number of weeds is found that the average number of weeds/$m^2$ was 49.8 plants/$m^2$, number of annual dicotyledonous weeds was 15.4 plants/$m^2$, and the number of annual monocotyledonous weeds was 23.2 plants/$m^2$. Regarding participation weed species is found that the largest share had an annual monocotyledonous species with 46.6%, while the lowest participation had dicotyledonous perennial species which did not exceed 1.6%. Constancy of presence of weed species in points of

determination did not exceed 61.2%. Analyzing the data presented we find that before post-emergence treatments, there were no significant differences in weed spectrum, the average number of weeds/m$^2$, participation and constancy. Refferring to weeding maize crop at harvest, *table 2*, contains data on weed (numerical method) on species and groups of weed and control degree. Influence of herbicides treatments on weeds presented in *table 2* shows centralized data on weed species on corn crop, under the influence of applied methods of control.

Table 2

**Results on structure of weeds in maize crop before harvest, depending of weed species**

| Variant | Method of weeds control/ Weed species | *Phragmites australis* | *Sorgum halepense* | *Setaria* sp. | *Echinochloa cruss galli* | *Amaranthus retroflexus* | *Xanthium strumarium* | *Vicia angustifolia* | *Solanum nigrum* | *Poligonum convolvulus* | *Chenopodium album* | *Sinapis arvensis* | *Galinsoga parviflora* | *Convolvulus arvense* | *Cirsium arvense* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_1$ | Untreated check | 15.6 | 7.4 | 8.8 | 16.2 | 5.2 | 4.4 | 1.6 | 0.4 | 2 | 0.2 | 2.2 | 1.2 | 2.6 | 2.8 |
| $V_2$ | Hoeing check | 1.2 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 |
| $V_3$ | Titus® Plus | 12.2 | 1.8 | 3.8 | 1.2 | 0.2 | 0.4 | 0 | 0 | 0.6 | 0 | 0 | 0 | 0.8 | 1 |
| $V_4$ | Titus® Plus + Trend Glyphogan 480 SL | 3.8 | 0.6 | 1.2 | 0.2 | 0.2 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0.6 | 0.6 |
| $V_5$ | Glyphogan 480 SL | 8.2 | 2.2 | 3.4 | 2.6 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.6 | 0.6 |
| $V_6$ | Glyphogan 480 SL Glyphogan 480 SL | 2.2 | 0.8 | 1.2 | 1 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.4 | 0.6 |
| $V_7$ | Glyphogan 480 SL Glyphogan 480 SL Glyphogan 480 SL | 1.6 | 0.4 | 0.2 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 |
| $V_8$ | Propane flame | 6.6 | 2.6 | 1.2 | 1 | 0 | 0.2 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0.2 | 0 |
| $V_9$ | Propane flame Glyphogan 480 SL | 2.8 | 1 | 0.4 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $V_{10}$ | Propane flame Glyphogan 480 SL Glyphogan 480 SL | 1.8 | 0.4 | 0.2 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Analyzing the data results that: applying the methods for combating *Phragmites* reduce the number of plants/m$^2$ from 15.6 at untrated check to 1.2 at hoeing check; implementation of a single method for combating in phenological corn stages BBCH 12-14 caused a reduction to 12.2 plants/m$^2$ *Phragmites* plants with treatment Titus® Plus, treatment with Glyphogan 480 SL to 8.2 plants/m$^2$ and to propane flame treatment 6.6 plants/m$^2$; the application of two or three consecutive methods of weed control was followed by the decrease of *Phragmites* plants to 1.6 plants/m$^2$. For *Sorghum halepense* level of weed presence it was 7.4 plants/m$^2$ at untrated check to 0.2 plants/m$^2$at hoeing check weeding 3 times and reached 0.4 plants/m$^2$ when applying 3 consecutive herbicide treatments. For *Setaria* at untrated check were 8.8 plants/m$^2$ and at hoeing check and variants with two or three control methods reached 0 plants/m$^2$.

Table 3

**Results on weeding maize crop before harvest, depending of category of weeds**

| Var | Method of weeds control/ Category of weed species | Perennial monocotile | Annual monocotile | Annual dicotyledonous | Perennial dicotyledonous | Total |
|---|---|---|---|---|---|---|
| $V_1$ | Untreated check | 23 | 25 | 17.2 | 5.4 | 70.6 |
| $V_2$ | Hoeing check | 1.4 | 0 | 0 | 0.2 | 1.6 |
| $V_3$ | Titus® Plus | 14 | 5 | 1.2 | 1.8 | 22 |
| $V_4$ | Titus® Plus + Trend Glyphogan 480 SL | 4.4 | 1.4 | 0.4 | 1.2 | 7.4 |
| $V_5$ | Glyphogan 480 SL | 10.4 | 6 | 0.2 | 1.2 | 17.8 |
| $V_6$ | Glyphogan 480 SL + Glyphogan 480 SL | 3 | 2.2 | 0.2 | 1 | 6.4 |
| $V_7$ | Glyphogan 480 SL+ Glyphogan 480 SL+Glyphogan 480 SL | 2 | 0.4 | 0 | 0.2 | 2.6 |
| $V_8$ | Propane flame | 9.2 | 2.2 | 0.4 | 0.2 | 12 |
| $V_9$ | Propane flame +Glyphogan 480 SL | 3.8 | 0.6 | 0 | 0 | 4.4 |
| $V_{10}$ | Propane flame Glyphogan 480 SL Glyphogan 480 SL | 2.2 | 0.4 | 0 | 0 | 2.6 |

For *Echinochloa crus galli* year if untreated control were a number of 16.2 plantys/$m^2$ and the hoeing control, and at variants with two or three methods of weed control reached 0 plants/$m^2$. In case of *Amaranthus*, *Xanthium*, *Vicia*, *Solanum*, *Polygonum*, *Chenopodium*, *Sinapis*, species, application of control methods were followed by reducing to 0 the number of plants/$m^2$. For *Convolvulus* the presence of weed was reduced from 2.6 plants/$m^2$ at untreated control to 0.2 plants/$m^2$ in case of hoeing control, to 0 in case of propane flame burning and three treatments (propane burning flame, and two treatments with Glyphogan).

Table 4

**Results regarding efficacity of weeds control for main species of weeds from corn field**

| Variant | Method of weeds control/ Weed species | *Phragmites australis* | *Sorgum halepense* | *Setaria* sp. | *Echinochloa cruss galli* | *Amaranthus retroflexus* | *Xanthium strumarium* | *Vicia angustifolia* | *Solanum nigrum* | *Poligonum convolvulus* | *Chenopodium album* | *Sinapis arvensis* | *Galinsoga parviflora* | *Convolvulus arvense* | *Cirsium arvense* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_1$ | Untreated check | Mt | Mt | Mt | Mt | Mt | Mt | Mt | Mt | Mt | Mt | Mt | Mt | Mt | Mt |
| $V_2$ | Hoeing check | 92.3 | 97.3 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 92.3 | 100 |
| $V_3$ | Titus® Plus | 21.8 | 75.7 | 56.8 | 92.6 | 96.2 | 90.9 | 100 | 100 | 70 | 100 | 100 | 100 | 69.2 | 64.2 |
| $V_4$ | Titus® Plus + Trend Glyphogan 480 SL | 75.6 | 91.9 | 86.4 | 98.8 | 96.2 | 100 | 100 | 100 | 90 | 100 | 100 | 100 | 76.9 | 78.5 |
| $V_5$ | Glyphogan 480 SL | 47.4 | 70.3 | 61.4 | 84.0 | 96.2 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 76.9 | 78.5 |
| $V_6$ | Glyphogan 480 SL Glyphogan 480 SL | 85.9 | 89.2 | 86.4 | 93.8 | 96.2 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 84.6 | 78.5 |
| $V_7$ | Glyphogan 480 SL Glyphogan 480 SL Glyphogan 480 SL | 89.7 | 94.6 | 97.7 | 98.8 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 92.3 | 100 |
| $V_8$ | Propane flame | 57.7 | 64.9 | 86.4 | 93.8 | 100 | 95.5 | 100 | 100 | 90 | 100 | 100 | 100 | 92.3 | 100 |
| $V_9$ | Propane flame Glyphogan 480 SL | 82.1 | 86.5 | 95.5 | 98.8 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| $V_{10}$ | Propane flame Glyphogan 480 SL Glyphogan 480 SL | 88.5 | 94.6 | 97.7 | 98.8 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

*Table 5*

**Results regarding efficacity of weeds control from corn field depending of category of weeds**

| Variant | Method of weeds control/ Weed species | Perennial monocotile | Annual monocotile | Annual dicotyledonous | Perennial dicotyledonous | Total |
|---|---|---|---|---|---|---|
| $V_1$ | Untreated check | Check | Check | Check | Check | Check |
| $V_2$ | Hoeing check | 93.9 | 100.0 | 100.0 | 96.3 | 97.7 |
| $V_3$ | Titus® Plus | 39.1 | 80.0 | 93.0 | 66.7 | 68.8 |
| $V_4$ | Titus® Plus + Trend Glyphogan 480 SL | 80.9 | 94.4 | 97.7 | 77.8 | 89.5 |
| $V_5$ | Glyphogan 480 SL | 54.8 | 76.0 | 98.8 | 77.8 | 74.8 |
| $V_6$ | Glyphogan 480 SL Glyphogan 480 SL | 87.0 | 91.2 | 98.8 | 81.5 | 90.9 |
| $V_7$ | Glyphogan 480 SL Glyphogan 480 SL Glyphogan 480 SL | 91.3 | 98.4 | 100.0 | 96.3 | 96.3 |
| $V_8$ | Propane flame | 60.0 | 91.2 | 97.7 | 96.3 | 83.0 |
| $V_9$ | Propane flame Glyphogan 480 SL | 83.5 | 97.6 | 100.0 | 100.0 | 93.8 |
| $V_{10}$ | Propane flame Glyphogan 480 SL Glyphogan 480 SL | 90.4 | 98.4 | 100.0 | 100.0 | 96.3 |

*Table 3* shows the centralized results of the degree of weeding maize crop under the influence of methods of weed control. Analyzing the data presented shows that perennial monocotile species

decreased from 23 plants/$m^2$ at untreated control to 1.4 plants/$m^2$ at hoeing control and application of methods of fighting was followed by reducing the number of annual monocotile weeds from 25 plants/$m^2$ at untreated control to 0 plants/$m^2$ at hoeing control, and between 0.4 and 5 plants/$m^2$ for other weeds control methods

For perennial dicotyledonous weeds species is found that the number of weed plants was reduced from 5.4 to 0.2 neprăşit witness plants/$m^2$ for hoeing witness, for annual dicotyledonous species their number decreased from 17.2 plants/$m^2$ at untreated control to 0 at hoeing control to witness hoeing. Other experimental variations (less in order $V_3$, $V_5$ and $V_8$), reduces weed spectrum. Considering the effectiveness of different control methods used in the experiment, in tables 4 and 5 show that each variant can cause significant reduction in the number of weeds, both in what concerns a particular species *(table 4)* and the categories of weeds *(table 5)*, the best results are obtained (except for witness weeding 3 times) variants $V_4$ and $V_7$.

Analyzing data on degree of control of weed species under the influence of control methods (Table 4) where there is a degree of Phragmites control varied between 21.8% in variant V3 (treatment with Titus Plus) and 89.7% in variant V7 where three treatments with Glyphogan were applied, while at the control (cultivating 3 times) degree of control was 92.3%. For Sorghum halepense degree of control ranged from 75.7% at variant V3 to 94.6% at V7 and V10 variants. For Setaria spp. degree of control ranged from 56.8% at variant V3 to 97.7% at V7 and V10 variants.

Application of 3 treatments with Glyphogan controled entirely annual dicotyledonous species. At Convolvulus arvense it is found that degree of control was 69.2% after treatment with Titus and 100% plus treatment with propane in the early stages of vegetation filled with Glyphogan. It appears that the greatest degree of weed species control was recorded in the control, weeding 3 times.

Table 5 centralized data on the degree of weed control taking into consideration biological groups of weeds under the influence of weed control methods tested. Analyzing the influence of methods to control the perennial mocotyledonous species are found that this varied between 39.1 after treatment with Titus plus and 90.4% after three times application of Glyphogan treatments. The fact that at annual mocotyledonous lowest level of control was registered in the case of a single treatment with Glyphogan (V5) is explained by the fact that they were countered only weed species that were emerged when applying treatment and then sprang other weeds. The highest degree of control annual mocotyledonous species was recorded in application of 3 treatments with Glyphogan (V7).

For dicotyledonous annual weeds lowest degree of control was when Titus Plus herbicide was applied (V3) and in variants V7, V9 and V10 degree of control was 100%, higest. In case of dicotyledonous perennial species the highest control was recorded after combined treatment with propane and Glyphogan V9 and V10. Analyzing the influence of weed control methods tested it is found that the order of effectiveness was witness hoeing 3 times (V2); treatments with Gllyphogan (V7), Propane + Glyphogan (V10); 2 treatments with Glyphogan (V6); tratment with TitusPlus + Glyphogan (V4); weeds control with propane

Table 6

**Corn yields obtained under the influence of weed control methods**

| Variant | Weed control methods | Productions (kg/ha) | Differences |
|---|---|---|---|
| $V_1$ | Untreated check | 1360.0 | Check |
| $V_2$ | Hoeing check | 5210 | 3850*** |
| $V_3$ | Titus® Plus | 4820 | 3460*** |
| $V_4$ | Titus® Plus + Trend Glyphogan 480SL | 4950.0 | 3590*** |
| $V_5$ | Glyphogan 480SL | 4700.0 | 3340*** |
| $V_6$ | Glyphogan 480SL Glyphogan 480SL | 4830.0 | 3470*** |
| $V_7$ | Glyphogan 480SL Glyphogan 480SL Glyphogan 480SL | 4980 | 3620*** |
| $V_8$ | Propane flame | 3510.0 | 2150*** |
| $V_9$ | Propane flame Glyphogan 480SL | 5100.0 | 3740*** |
| $V_{10}$ | Propane flame Glyphogan 480SL Glyphogan 480SL | 5180 | 3820*** |
| | | DL 5% | 267.7 |
| | | DL 1% | 409.1 |
| | | DL 0,1% | 541.7 |

*Table 6* centralized data obtained regarding maize yields under the influence of weed control methods applied. It found that yields ranged from 1,360 kg/ha to untrated control up to 5,210 kg/ha to witness weeding 3 times, the best results were recorded for the first 3 places $V_{10}$ (5,180 kg/ha), $V_9$ (5,100 kg/ha), $V_7$ (4,980 kg/ha), while the worst results were recorded in $V_7$ (3,510 kg/ha) where production still increased with 2,105 kg/ha.

All weed control methods applied were determined to obtain very significant production increases compared to the untreated control.

## CONCLUSIONS

At the beginning of the research, the highest participation in the weed spectrum was the *Phragmites*.

The application for weed control treatments had reduced the number of each species of weeds compared to untreated control, the reduction was proportional to the number of chemical treatments applied. Yields ranged from 1,360 kg/ha to untrated control up to 5,210 kg/ha to witness weeding 3 times, the best results were recorded for the first $V_{10}$ (5,180 kg/ha).

Corn yields very significant increases were recorded by apllication of suitable methods of weed control.

At the beginning of the research, spectrum weed it was comparable in all experimental variants, the highest participation in the weed spectrum was the *Phragmites*.

The application for weed control treatments had reduced the number of each species of weeds compared to untreated control, the reduction was proportional to the number of chemical treatments applied. Corn yields very significant increases were recorded by aplivcarea methods of weed control.

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# FERTILIZERS WITH HUMIC SUBSTANCES - DEVELOPMENT AND CHARACTERIZATION OF NEW PRODUCTS

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**Abstract**

Fertilizers with humic substances can be used on different types of soil, as well as in technologies for improving degraded or contaminated soils and they proved effective on a wide range of cultures. Due to the variety of sources from which they can be obtained, there are many types of fertilizers containing natural biostimulating substances. This paper presents the development of a rage of complex NPK liquid fertilizers with humic substances, meso and micronutrients. The extraction processes, the humic substances separation, and the organo-mineral fertilizers technology were conducted regarding the physicochemical properties of the humic and fulvic acids in the alkaline/acidic reaction media, as well as their stability in the NPK, meso and micronutrients matrix. Two of the experimental fertilizers are physicochemically characterized and their agrochemical efficiency is shown by the results obtained in the National Fertilizers Testing Network. In the case of soil incorporation of the experimental fertilizers, the average yield increases, as compared to the unfertilized control, were ranging from 37.8% for sunflower crop to 42.3% for sugar beet crop.

**Key words**: humic substances, organic-mineral fertilizers, fertilization.

In the last period the diversification of organo-mineral fertilizers has experienced an explosive growth due to new fertilizing technologies used in agriculture. But when applying these new fertilizing formulas, there must be respected the requirements imposed by the European environmental legislation and also, take into account the needs of a sustainable agriculture.

Worldwide studies conducted on fertilizers with humic substances have shown that there is a positive relation between the content of humic substances in the soil or that applied through fertilization and the yield and quality of crops due to: increasing the efficiency of the conventional fertilizers, stimulating germination of seeds, root development and plant metabolism, increasing the activity of photosynthesis, improving the soil's capacity to retain water, increasing resistance to climatic and technological stress factors (Ali V.K. *et al*, 2009; Chassapis K. *et al*, 2009; Delgado A. *et al*, 2002; Schnitzer M., Khan S.U., 1972; Sirbu C. *et al*, 2009; Sirbu C. *et al*, 2010; Zoja V.L.G. *et al*, 2009).

Fertilizers with humic substances can be used on different types of soil and proved to be effective on a wide range of cultures. The range of fertilizers containing humic substances is so diversified due to the numerous sources from which they can be obtained, different processes of extraction and separation of the active compounds, and also their technology of application (Furukawa K. *et al*, 2008; Gondar D. *et al*, 2006; Plaza C. *et al*, 2005; Sirbu C. *et al*, 2010; Sirbu C. *et al*, 2015; Zaccone C. *et al*, 2009; Zhou P. *et al*, 2005).

## MATERIAL AND METHOD

Elaboration of the technology for extracting humic substances and for humic acid separation was carried out using lignite from Rovinari mining. The coal mass has a content of 60% organic matter and 25% humic substances.

The extraction of humic substances from the mass of lignite was conducted in an alkaline - oxidant media - by the use of nitric acid and the injection of air into the reaction mass.

The yield of the extraction of humic substances depends on many factors among which can be mentioned: concentration of the solution extraction, lignite - extraction solution ratio, temperature and time of extraction (Kim H.T. 2003; Schnitzer M., Khan S.U., 1972; Stevenson F.J.,

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1994; Tipping E., 2002). In order to find the optimum extraction time, were made determinations of the humic acids concentration from the solution at different stages of extraction. Also, there were used extraction solutions with different concentrations of $K_2O$.

Based on the analysis of the experimental data resulted that higher concentrations of humic acids were obtained when using alkaline extraction solutions with a concentration of 0.75% $K_2O$ and 1.0% $K_2O$.

The extraction processes, the humic substances separation, and the organo-mineral fertilizers technology were conducted regarding the physico-chemical properties of the humic and fulvic acids in the alkaline/acidic reaction media, as well as their stability in the NPK, meso and micronutrients matrix (Chassapis K. *et al*, 2009; Chiriac J., Barca T, 2009; Furukawa K. *et al*, 2008; Gondar D. *et al*, 2006; Plaza C. *et al*, 2005; Stevenson F.J., 1994; Zaccone C. *et al*, 2009; Zhou P. *et al*, 2005; Zoja V.L.G. *et al*, 2009).

The new organic-mineral fertilizers have complex synergistic structures of mineral nutrients and bioactive natural compounds (humic and fulvic acids). Using a micro-installation were made numerous experiments for determining the optimum technological process to obtain the lab-scale fertilizer variants.

Following the elaboration and validation of the technology for extracting humic substances and developing new organic-mineral fertilizers there were manufactured two batches of 1,000 liters. The fertilizers were physicochemically characterized and tested in the National Fertilizers Testing Network in order to determine their efficiency and authorise their use in Romanian agriculture.

## RESULTS AND DISCUSSIONS

The physicochemical characteristics of the fertilizers samples obtained during the development and validation of the technology at lab scale are presented as follows ($g/cm^3$):

**HUMIFERT:** Total nitrogen, N - 154; Phosphorus, $P_2O_5$ - 32; Potassium $K_2O$ - 37; Iron, Fe - 0.39; Copper, Cu - 0.16; Zinc, Zn - 0.11; Magnesium, Mg - 0.29; Manganese, Mn - 0.21; Boron, B - 0.31; Sulfur, $SO_3$ - 18.6; Organic substances - 27; Humic substances - 8,8; Density - 1.18.

**HUMIFERT PLUS:** Total nitrogen, N - 172; Phosphorus, $P_2O_5$ - 35; Potassium $K_2O$ - 41; Iron, Fe - 0.44; Copper, Cu - 0.22; Zinc, Zn - 0.21; Magnesium, Mg - 0.31; Manganese, Mn - 0.21; Boron, B - 0.32; Sulfur, $SO_3$ - 25; Organic substances - 32; Humic substances - 13; Density - 1.18

The agrochemical testing of the fertilizers was performed in the National Network for Fertilizers Testing in order to obtain the authorization/license and RO-ÎNGRĂȘĂMÂNT label for agriculture use and distribution in Romania in accordance with 6/22/2004 Order.

The agrochemical experiments carried out using the humic substances ferilizers were conducted as single factorial experiments by soil incorporation application (and compared to a unfertilized control sample), arranged in randomized experimental variants, using four replicates and unfertilized soil.

The experimental investigations conducted in the National Network for Fertilizers Testing were held at the USAMV Didactic and Experimental Station and Ezăreni- Iasi field farm.

The energetic efficiency (Mcal/ha), represents an indicator of the production increase and was calculated by means of the specific methodology (Teşu I., Baghinschi V., 1984).

The main quality and fertility characteristics of the soil (cambic chernozem) are given in Table 1.

The productive and energetic efficiencies of the fertilizers investigated in this study, applied by soil incorporation in dosages of 200 liters/ha are summarized in Tables 2 ÷ 4.

Table 1

**Main physical, chemical and biological properties of the soil resources**

| Property | Depth (cm) | Value |
|---|---|---|
| Soil texture (%coloidal clay) | 0-20 | 35.70- 36.9 |
| Aeration porosity (PA%) | 0-20 | 15 - 20 |
| Soil reaction (pH $_{H2O}$) | 0-20 | 6.83 – 7.22 |
| Humus (%) | 0-20 | 3.37 – 3.58 |
| Total nitrogen content Nt (%) | 0-20 | 0.19 – 0.23 |
| Mobile phosphorus content (ppm) | 0-20 | 63 – 73 |
| Mobile potassium content (ppm) | 0-20 | 223 - 264 |
| Degree of base saturation, V (%) | 0-20 | 87 - 92 |
| Soil respiration (mg $CO_2$) | 0-20 | 28.32 – 40.01 |
| Dehydrogenase (mg TPF) | 0-20 | 18.52 – 20.13 |

Table 2

**Productive and energetic efficiency of soil fertilization to maize crop (DK 4685 Hybrid), applied dosage 200 liters/ha**

Single factor experiment placed in storied blocks and with randomized experimental variants

| **Experimental variants** | Average production (kg/ha) | Productive efficiency | | | **Energetic efficiency -Mcal/ha** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Dif. kg/ha | % | Significance | Output | Input | Balance | Dif. | % | **Significance** |
| ***Control NoPoKo*** | *5023* | *-* | *100* | *-* | *19690* | *6891* | *12798* | *-* | *100* | **-** |
| **HUMIFERT** | 7013 | 1990 | 139,6 | xxx | 27491 | 10996 | 16495 | 3697 | 128,9 | **xxx** |
| **HUMIFERT PLUS** | 7119 | 2096 | 141.7 | xxx | 27906 | 11163 | 16743 | 3945 | 130.8 | **xxx** |

**DL 5%- 654 kg/ha** **DL 5%- 1261 Mcal/ha**
**DL 1%- 817 kg/ha** **DL 1%- 1733 Mcal/ha**
**DL 0.1%- 1265 kg/ha** **DL 0.1%- 2315 Mcal/ha**

Table 3

**Productive and energetic efficiency of soil fertilization to sunflower crop (LG 5412 Hybrid), applied dosage 200 liters/ha**

Single factor experiment placed in storied blocks and with randomized experimental variants

| Experimental variants | Average production (kg/ha) | Productive efficiency | | | Energetic efficiency -Mcal/ha | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Dif. kg/ha | % | Significance | Output | Input | Balance | Dif. | % | Significance |
| *Control NoPoKo* | 2085 | - | 100 | - | 11801 | 4130 | 7671 | - | 100 | - |
| HUMIFERT | 2873 | 788 | 137,8 | xxx | 16261 | 6504 | 9757 | 2086 | 127,2 | xxx |
| HUMIFERT PLUS | 2883 | 798 | 138,3 | xxx | 16317 | 6526 | 9791 | 2120 | 127.6 | xxx |

DL 5%- 301 kg/ha DL 5%- 652 Mcal/ha
DL 1%- 415 kg/ha DL 1%- 987 Mcal/ha
DL 0.1%- 527 kg/ha DL 0.1%- 1318Mcal/ha

Table 4

**Productive and energetic efficiency of soil fertilization to sugar beet crop (Diamant Variety), applied dosage 200 liters/ha**

Single factor experiment placed in storied blocks and with randomized experimental variants

| Experimental variants | Average production (kg/ha) | Productive efficiency | | | Energetic efficiency -Mcal/ha | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Dif. kg/ha | % | Significance | Output | Input | Balance | Dif. | % | Significance |
| *Control NoPoKo* | *22413* | *-* | *100* | *-* | *22413* | *7845* | *14568* | *-* | *100* | - |
| HUMIFERT | 31560 | 9147 | 140,8 | xxx | 31560 | 12624 | 18936 | 4368 | 129,9 | xxx |
| HUMIFERT PLUS | 31898 | 9485 | 142,3 | xxx | 31898 | 12759 | 19139 | 4571 | 131.3 | xxx |

DL 5%- 2718 kg/ha DL 5%- 1328 Mcal/ha
DL 1%- 3851 kg/ha DL 1%- 1956 Mcal/ha
DL 0.1%- 5824 kg/ha DL 0.1%- 2711 Mcal/ha

According to the data listed in Tables 2-4 it can be seen that there are significant differences between the two fertilizers compared to the control sample and these are statistically insured.

## CONCLUSIONS

A method of extracting humic substances from coal and lignite using a potassium alkali was developed. In this study were developed (and physicochemical characterized) two fertilizers applied by soil incorporation or extraradicular. They present a complex composition formed by associating microelements (e.g. Fe, Cu, Zn, Mn, Mg) in a NPK matrix, as well as humic substances (humic and fulvic acids) with chelation and biostimulation role.The use of humic substances fertilizers led to production yields ranging from 39.6 and 41.7% for the corn crop, 37.8 and 38.3%

for the sunflower crop, respectively 40.8 and 42.3% for the sugar beet crop. For all the analyzed crops, the outcome energy indicators (OUTPUT and energy balance) show higher values than those of INPUT, resulting thus significant increases as concerns the energy and the products (crops) as a result of using the humic substances fertilizers.

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# SOME BIOLOGICAL FEATURES AND BIOCHEMICAL COMPOSITION OF CROWN VETCH (*CORONILLA VARIA* L.) IN MOLDOVA

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**Abstract**

Forage legumes are an essential component of agricultural systems in temperate regions of the world, providing high quality animal feed, suitable ground cover, and a valuable source of nitrogen. The crown vetch, *Coronilla varia*, maintained in monoculture, on non irrigated experimental land in the Botanical Garden (I) of the Academy of Sciences of Moldova, served as object of study, the traditional forage legumes: alfalfa, *Medicago sativa* and common sainfoin, *Onobrychis viciifolia* were used as control variants. It has been established that *Coronilla varia* germinates very slowly, in the first year, grows and develops slower than common sainfoin and alfalfa, but in the following years, it starts vegetating 2-3 days earlier. The 3-year-old *Coronilla varia* plants have moderate growth and development rates that allow mowing them at the end of May the green mass yield reaches 3.92 kg/ $m^2$, at the same level as sainfoin and by 25% more than alfalfa, but the forage is characterised by a high content of leaves (63-68%) and a low content of dry matter, in comparison with the traditional crops. The chemical composition of *Coronilla varia* dry matter: 14.72% raw protein, 2.81% raw fat, 35.46% raw cellulose, 39.74% nitrogen-free extractive substances and 7.27% minerals. *Coronilla varia* green mass is characterized by high level of potassium and iron, but lower – of magnesium and sodium. The forage value of 1 kg natural forage accounts 0.20 nutritive units, 2.22 Mj metabolizable energy and digestible protein content – 132.10 g /nutritive unit. The calculated methane yield *Coronilla varia* green mass at the first mowing may reach 2311 $m^3$/ha, exceeding *Medicago sativa.*
The local ecotype of species *Coronilla varia* could be used for restoring degraded, polluted and eroded land, and also for reseeding and increasing economic value of grasslands.

**Key words:** biochemical composition, biological features, *Coronilla varia*, forage value, methane yield

Legumes play a crucial role in natural ecosystems, agriculture, and agroforestry, where their ability to fix N in symbiosis makes them excellent colonizers of low-N environments, and also economic and environmentally friendly crops, pasture and tree species. Over 1500 species of legumes (from about a total of 19 400 *Fabaceae* species worldwide) can be used as feed for livestock, although only about 60 species have been developed and widely used as cultivated forages. Legumes from pastures and meadows contribute N to a complex dynamic recycling system, organic matter containing legume proteins may be mineralized in soil, liberating N as nitrates ($NO_3$) and $NH_4$ that may be used by grass. They are important in livestock feeding systems because they have the potential to extend the grazing season, increase the quantity of grazed forage and hay, and reduce the amount of N fertilizer needed. Legume feed not only improves forage quality but also increases the intake of the ration, hence, gives better performance in terms of livestock production. Many legume forage crops are also excellent honey plants (Frame J., 2005; Luscher A. et al,, 2013; Stoddard F.L., 2013).

The genus *Coronilla* L. contains about 20 species native to Europe and North Africa (Sokoloff D. D. 2003). In the spontaneous flora of the Republic of Moldova, there are 2 species: *Coronilla elegans* Pancic (synonym *C. latifolia* (Hazsl.) Jav.) and *Coronilla varia* L. (synonym *Securigera varia* (L.) Lassen), from these species *Coronilla varia* is the most widespread.

*Coronilla varia* L. commonly known as crown vetch or purple crown vetch is a herbaceous perennial plant, has spreading to diffuse stems that can measure up 0.3 to 1.8 meters long, deeply tap-rooted with numerous lateral roots, spreading via rhizomes which penetrate the soil to 2 m deep. Leaves are deep green, alternate compound pinnate with 9 to 25 oblong to elliptic leaflets. Leaves are 5-10 cm long and leaflets are 1 cm-2 cm long, have smooth margins with small points at the tips. Racemes are umbrella-shaped, 15-20-floral, located on flower stalks exceeding leaves, variegated in color from white and purple. Seed pods are indehiscent, may reach 2-6 cm long, with 3–7 cylindrical segments each containing one ovate-oblong, yellow-orange to reddish-brown rod-shaped seed, 3-3.5 mm in length and

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1-1.5 mm in width. It has a karyotype 2n = 24 and a high proportion of seeds is hard. *Coronilla varia* can grow in soils of low fertility, it is tolerant to low temperatures (down to -33°C) and can withstand periods of drought as well as heavy precipitation (up to 165 cm annual precipitation), but is shade-intolerant. In the United States and Canada, *Coronilla varia* has been extensively planted for erosion control along many roads, highways, and disturbed areas. It has also been widely planted for ground cover, mine reclamation, and as a cover crop as it provides nitrogen to soil through its association with cyanobacteria. Crown vetch is toxic to horses and other non-ruminants because of the presence of nitroglycosides. Recently it has been deemed as good forage when fed as hay to or grazed by ruminant animals such as cattle, goats, sheep, elk and deer. These aliphatic nitro compounds are degraded in ruminant digestion and do not affect the animals. *Coronilla varia* produces little or no bloat hazard in grazing (Acar Z. et al, 2001, Frame J., 2005; Mueller-Harvey I., 2006; Luneva N.N., 2008; Gucker C. L., 2009).

*Coronilla varia* is a source of phytochemicals with cardiac, diuretic, purgative, antibacterial and anticancer activity (Zackova P. et al, 1986; Dehpour A. A., 2016).

This research was aimed at evaluating the biological peculiarities, the biochemical composition of the local ecotype of crown vetch and the possibility to use it as fodder for ruminant animals or as biogas substrate.

## MATERIAL AND METHOD

The local ecotype of crownvetch, *Coronilla varia* maintained in monoculture, served as object of study. The traditional leguminous fodder crops: alfalfa, *Medicago sativa*, and common sainfoin, *Onobrychis viciifolia*, were used as control variants. The experiments were performed on non irrigated experimental land in the Botanical Garden (Institute) of the Academy of Sciences of Moldova (ASM) in spring, when the soil had reached the physical readiness. The experimental design was a randomised complete block design with four replications, and the experimental plots measured 10 $m^2$. The seeds were sown at a depth of 2.0-3.0 cm with soil compaction before and after sowing. The plant growth, development and productivity were assessed according to methodical indications (Novoselov Y. K. et al, 1983). The green mass was harvested in the flowering period (the end of May). The green mass yield was measured by weighing. The dry matter content, or total solids (TS), was detected by drying samples up to constant weight at 105 °C. Crude protein – by Kjeldahl method, crude fat – by Soxhlet method, crude cellulose – by Van Soest method, ash – in muffle furnace at 550 °C. Organic dry matter, or volatile solids (VS), was calculated through differentiation, the crude ash being subtracted from dry matter. Nitrogen-free extractive substance (NFE) was mathematically appreciated, as the difference between organic matter values and analytically assessed organic compounds. The mineral content was investigated by the standard spectrometric methods (Petukhov E.A. et al, 1989).

The carbon content of the substrates was obtained from volatile solids (organic dry matter) data using an empirical equation reported by (Badger C.M. et al,, 1979).

The biogas production potential and specific methane yields were evaluated by the parameter "content of fermentable organic matter", according to (Weissbach F., 2008).

## RESULTS AND DISCUSSIONS

We observed that, after sowing, the emergence of *Coronilla varia* plantlets was uneven and required a 10-17 day longer period as compared with traditional forage crops, probably due to the fact that the seeds of this species were characterized by a denser coat, but water availability and temperature could also influence germination. Over a period of 4-6 weeks, the plants developed fine roots, which grew 15-20 cm long and ensured the necessary water and nutrients for growth and development. We found that during the first month after the emergence of seedlings, the growth and development rate of the aerial part of the plant was very slow, the rosette formed the next month, then the growth rate accelerated and allowed the development of an erect stem, which in August, the flowering season, reached 37-41 cm. In the first year, until the end of the growing season, the plants didn't produce any seeds. Underground, they developed an extensive tap root system and strong fleshy rhizomes, extending down to 70-80 cm. The traditional leguminous forage crops, alfalfa and sainfoin, went through all ontogenetic phases. Alfalfa was harvested twice, common sainfoin and crown vetch – once. The fresh mass yield of crown vetch was 1.59 kg/$m^2$ with high content of leaves (68%), suitable for hay making or grazing.

*Coronilla varia* was characterized by slow germination, seedling emergence and development compared with red clover, birdsfoot trefoil or alfalfa (Peiffer R. A., 1972).

The next year, in spring, when temperatures above 5 °C established, the growing period of the *Coronilla varia* started 2 days later in comparison with *Onobrychis viciifolia*, but 6 days earlier than *Medicago sativa*. Shoots developed from large buds, which were located just above the collar. The plants were tap-rooted and rhizomatous with overwintered rhizomes emerging in spring to initiate new shoots, which would eventually take root and become independent plants. The flowering stage started at the end of May and the seed ripening period after 60-70 days (end of July- first half of August) because of the indeterminate flowering habit of

crown vetch. The seed yield was 19 g/m$^2$ and the average 1000-seed weight – 3.64 g.

Analyzing the results from the 3-year-old, we noted that the *Coronilla varia* plants had resumed vegetation 2-3 days earlier in comparison with *Medicago sativa* and *Onobrychis viciifolia*, and observed that stems had been produced in abundance from rhizomes, being characterized by a faster growth rate than in previous years. Thus, at the end of April, decumbent to ascending shoots of *Coronilla varia* were up to 47.2 cm long, exceeding alfalfa with 8.1 cm and sainfoin with 13.3 cm, this tendency was maintained during the flowering period, when crown vetch plants reached 122.10 cm, while the traditional leguminous forage crops achieved 83.20-85.50 cm *(table1)*.

In other studies, it was mentioned that *Coronilla varia* plants may reach 6 feet or 2 m long (Gucker C. L., 2009).

We observed, in the 3-year-old, budding phase of *Coronilla varia* started at the same time as *Medicago sativa* and 5 days earlier than *Onobrychis viciifolia*. We could also mention that during the next period *Coronilla varia* had a more rapid development rate and was distinguished by a short budding-flowering period (7 days) comparative with *Onobrychis viciifolia* (24 days). *Coronilla varia* produced considerable foliage (63%) and the fresh mass yield at the first mowing reached 3.92 kg/m$^2$, at the same level as sainfoin and by 25% more than alfalfa, but it had a lower content of dry matter in the harvested mass (22.4%).

In some papers it was mentioned that the productivity of *Coronilla varia* under the climatic conditions of Russia reached 65 t/ha green mass (Dronova T.N. et al,, 2009); in South Africa crown vetch yielded 10.6 t/ha of dry matter, but alfalfa - 7.1 t/ha (LeRoux C.J.G. et.al., 1988).

Table 1

**Agro biological peculiarities of the studied species of the family *Fabaceae***

| Indicators | *Medicago sativa* | *Onobrychis viciifolia* | *Coronilla varia* |
|---|---|---|---|
| Resumed vegetation up to: | | | |
| - budding, days | 70 | 75 | 70 |
| - flowering, days | 82 | 99 | 77 |
| - seed ripening, days | 143 | 133 | 141 |
| Plant height, cm | | | |
| - at the end of April | 39.10 | 35.90 | 47.20 |
| - at flowering | 83.20 | 85.50 | 122.10 |
| The yield in the first mowing: | | | |
| - fresh mass, kg/m$^2$ | 3.11 | 3.95 | 3.92 |
| - dry matter, kg/m$^2$ | 0.82 | 1.03 | 0.87 |
| The leaf share of the fodder,% | 44 | 39 | 63 |

Table 2

**Biochemical composition and nutritional value of the studied species of the family *Fabaceae***

| Indicators | *Medicago sativa* | *Onobrychis viciifolia* | *Coronilla varia* |
|---|---|---|---|
| Raw protein,% dry matter | 17.03 | 17.44 | 14.72 |
| Raw fats,% dry matter | 2.30 | 3.39 | 2.81 |
| Raw cellulose,% dry matter | 33.31 | 33.50 | 35.46 |
| Nitrogen free extract,% dry matter | 39.41 | 39.43 | 39.74 |
| Minerals,% dry matter | 8.01 | 6.24 | 7.27 |
| 1 kg of natural fodder contains: | | | |
| nutritive units | 0.21 | 0.23 | 0.20 |
| metabolizable energy, Mj | 2.28 | 2.86 | 2.22 |
| dry matter, g | 263.70 | 274.00 | 224.20 |
| raw protein, g | 46.10 | 47.80 | 33.03 |
| digestible protein, g | 34.50 | 35.87 | 26.42 |
| raw fats, g | 6.20 | 9.30 | 6.34 |
| raw cellulose, g | 80.30 | 86.30 | 79.43 |
| nitrogen free extract, g | 99.30 | 113.50 | 89.10 |
| minerals, g | 21.70 | 17.10 | 16.30 |
| digestible protein, g/ nutritive unit | 164.29 | 156.00 | 132.10 |

Forages are a major source of nutrients for herbivores around the world. Sometimes the balance of nutrients or the presence of some constituent in the forage will have positive or negative effects on animal health and productivity (McDonald P. *et al*, 2010). It was found that dry matter *Coronilla varia* was characterized by optimal protein content (14.42%), which was lower in comparison with traditional forage leguminous crops (17.03-17.44%), about the same nitrogen free extractive substances (39.74%) and high level of raw cellulose (35.46%). In comparison with

traditional forage leguminous crops, the dry matter of *Coronilla varia* was characterised by lower fat content (2.80%) in comparison with *Onobrychis viciifolia,* but advanced – in comparison with *Medicago sativa*; and minerals – inversely proportional (*table 2*).

Some authors mention varied findings about the quality of *Coronilla varia* fodder. Acar Z. et al, 2001 remarked than C*oronilla varia* spp. *varia* in Pakistan contain 14.86% protein and 9.99% ash. According to Dronova T.N. et al,, 2009, the chemical composition of dry matter crown vetch was: 25.2% protein, 3.3% fat, 25.5% cellulose, 34.3% nitrogen-free extractive, but alfalfa – 21.8%, 2.3%, 22.0% and 35.0%, respectively. Reynolds P.J. et al, 1967, reported than crown vetch forage contain 21.7% protein and 22.2% fibre, involving the digestibility in sheep was 65.6% protein and 46.2% fibre, but slightly less than the digestibility of alfalfa forage.

An essential component of protein characteristics is its amino acid composition, which is its main structural characteristic, irrespective of the kind, origin and physiological function. Determining the amino acid composition of green fodder of different species and the proportions of the respective amino acids facilitates the evaluation of its potential nutritional value, especially creating the possibility of not applying synthetic amino acids to enhance the nutritive value of animal feed mixtures.

Analyzing the results on the amino acid content in the fodder *(table 3)*, it was found that the species *Coronilla varia* was distinguished by an optimal content of both essential and nonessential amino acids. Comparing each amino acid separately, we could mention that the content varied in comparison with traditional forage crops.

Table 3

**The content of amino acids (g/100 g dry matter) of the studied species of the family *Fabaceae***

| Amino acids | *Medicago sativa* | *Onobrychis viciifolia* | *Coronilla varia* |
|---|---|---|---|
| asparagine | 1.711 | 1.751 | 1.857 |
| threonine | 0.564 | 0.565 | 0.551 |
| serine | 0.687 | 0.685 | 0.678 |
| glutamine | 1.360 | 1.398 | 1.418 |
| proline | 0.922 | 1.154 | 1.480 |
| glycine | 0.550 | 0.557 | 0.852 |
| alanine | 0.674 | 0.672 | 0.712 |
| valine | 0.559 | 0.654 | 0.459 |
| methionine | 0.139 | 0.091 | 0.101 |
| isoleucine | 0.459 | 0.459 | 0.344 |
| leucine | 0.913 | 0.920 | 0.898 |
| tyrosine | 0.458 | 0.491 | 0.442 |
| phenylalanine | 0.850 | 0.937 | 0.647 |
| histidine | 0.326 | 0.371 | 0.239 |
| lysine | 0.619 | 0.706 | 0.524 |
| arginine | 0.655 | 0.587 | 0.517 |

The role of the first deficient essential amino acid, limiting the nutritive value of protein, was played by methionine. We could mention that the methionine content of the species *Coronilla varia* reached 0.101 mg/100 mg dry matter, thus, it was higher than in *Onobrychis viciifolia*, but lower as compared with *Medicago sativa.* The second limiting amino acid for protein biosynthesis was lysine; the content of this essential amino acid was much lower as compared with *Onobrychis viciifolia* and *Medicago sativa.* We found that *Coronilla varia* fodder was very rich in proline and glycine, rich in asparagine, glutamine, glycine and alanine, but had lower content of phenylalanine, arginine, valine, isoleucine, leucine, histidine and tyrosine in comparison with traditional forage crops.

The presence of minerals in animal nutrition is indispensable for their growth and health, because they are essential components of all tissues and organs that maintain osmotic pressure at a constant level, participate in the regulation of acid-base balance, activate a number of enzymes, moderate the neuromuscular activity, prevent the emergence and development of diseases in animals (McDonald et al,, 2010). The content of mineral elements in fodder is variable, depending on species. It was established that *Coronilla varia* was characterised by a high content of macro elements (*table.4*).

Table 4

**The content of minerals per kg dry matter of the studied species of the family *Fabaceae***

| Minerals | *Medicago sativa* | *Onobrychis viciifolia* | *Coronilla varia* |
|---|---|---|---|
| calcium, g | 16.94 | 11.20 | 12.90 |
| phosphorus, g | 4.42 | 7.53 | 5.67 |
| magnesium, g | 2.71 | 3.28 | 2.31 |
| potassium, g | 15.38 | 15.17 | 21.54 |
| sodium, mg | 349.50 | 366.20 | 52.85 |
| iron, mg | 250.83 | 343.20 | 389.80 |
| manganese, mg | 50.90 | 91.55 | 63.69 |
| zink, mg | 22.37 | 26.15 | 26.96 |
| copper, mg | 7.00 | 6.75 | 5.55 |
| strontium, mg | 49.77 | 34.53 | 35.42 |

Comparing each macro element separately with traditional fodder leguminous crops, we could mention that the content varies from species to species. The species *Coronilla varia* in comparison with *Medicago sativa* is distinguished by low content of calcium (12.90g / kg) and higher content of phosphorus (5.67 g/kg), but inversely proportional in *Onobrychis viciifolia* fodder. *Coronilla varia* fodder is characterized by high level of potassium (21.54 g/kg), but lower – of magnesium (2.31 g/kg) and sodium (52.85 mg/kg). It was determined the content of trace elements in

dry matter of *Coronilla varia*, so, it included: 5.55 mg/kg copper, 26.96 mg/kg zinc, 63.69 mg/kg manganese, 389.80 mg/kg iron, and 35.42 mg/kg strontium. *Coronilla varia* fodder contained large amounts of iron and poor – of copper. In Canada it was determined that *Coronilla varia* fodder contains: 17.9-18.4 g/kg calcium, 2.2-2.8 g/kg phosphorus, 27.2-31.1 g/kg potassium, 1.7-1.6 g/kg magnesium, 0.15-0.16 g/kg sodium, 8.0-9.3 mg/kg copper, 34-40 mg/kg zinc, 36-40 mg/kg manganese, 169-179 mg/kg iron (Gervais P., 2000); in Russia crown vetch forage harvested in budding period contains 40 g/kg calcium, 8 g/kg phosphorus, 0.6 g/kg magnesium, 2.48 mg/kg copper, 14 mg/kg zinc, 49 mg/kg manganese, 105 mg/kg iron (Kshnikatkina A.N. *et al*, 2005); in Pakistan 22.2 g/kg calcium, 22.4 g/kg potassium, 1.88 g/kg magnesium, 14.46 mg/kg copper, 67.35 mg/kg zinc, 40.37 mg/kg manganese, 482.6 mg/kg iron (Acar Z. et al, 2001)

The organic matter content, its biochemical composition and digestibility of the green mass determine the nutritional value and methane yield.

*Coronilla varia* green mass contained: 0.20 nutritive units/ kg, 2.22 Mj/kg metabolizable energy and digestible protein – 132.10 g/nutritive unit. According to the mentioned indices, the natural fodder of *Coronilla varia* had lower nutritional value in comparison with traditional crops, because of the low content of dry matter and raw protein. Thus, if we compare the nutritional value of dry matter, 100 kg of dry matter of *Coronilla varia* contain 89 nutritive units, 990 MJ/kg metabolizable energy and 11.78 kg digestible protein, while *Medicago sativa* contains 80 nutritive units, 865 Mj/kg metabolizable energy and 13.81 kg digestible protein, *Onobrychis viciifolia* – 84 nutritive units, 1050 MJ/kg metabolizable energy and 13.09 kg digestible protein, respectively.

Table 5

**Gas forming potential of the fermentable organic matter from the studied species of the family *Fabaceae***

| Indicators | *Medicago sativa* | *Onobrychis viciifolia* | *Coronilla varia* |
|---|---|---|---|
| Ratio of content of carbon and nitrogen (C/N) | 19 | 19 | 22 |
| Fermentable organic matter, g/kg VS | 642 | 658 | 626 |
| Biogas, liter /kg VS | 514 | 526 | 501 |
| Methane, liter /kg VS | 270 | 276 | 263 |
| Methane productivity, $m^3$/ha | 2214 | 2843 | 2311 |

Grasslands provide a high biomass potential. They are often inefficiently used, so a new utilisation concept based on the biorefining approach can increase the added value from grasslands. Biorefining offers a way for combining feed and bioenergy production. Energy crops are of considerable importance for biogas production. The use of forage legumes as biogas substrate contributing to increase potential for bioenergy and reducing greenhouse gas emissions, through symbiotic nitrogen fixation and compensates inorganic N fertilizer in conventional farms, if the digestate is applied as a fertilizer to the non-legume crops (Stoddard F.L., 2013; Stinner P. W., 2015). The content of organic matter, biochemical composition, biodegradability and ratio of carbon and nitrogen (C/N) of the raw material are essential in the production of biogas. The C/N ratio of the studied species varied from 19 in biomass *Medicago sativa* and *Onobrychis viciifolia* to 22 in biomass *Coronilla varia* (*tab. 5*). The optimal C/N ratio is expected to be in the range 15-25, when the anaerobic digestion process is carried out in a single stage, and for the situation when the process develops in two steps, the optimal C/N ratio will range: for step I: 10-45; for step II: 20-30 (Dobre P. *et al*, 2014).

Fermentable organic matter represents the proportion of organic matter which can be biologically degraded under anaerobic conditions and, thus, can be potentially utilized in biogas facilities (Weissbach F., 2008). The calculated gas forming potential of the fermentable organic matter of *Coronilla varia* reached 501 litre/kg VS, being lower than in the control species (514-526 liter/kg VS), but it had similar content of methane (52.5%).

The methane yield per ha of studied species of the family *Fabaceae* (first mowing) ranged from 2214 to 2843 $m^3$/ha, *Coronilla varia* exceeding *Medicago sativa.*

## CONCLUSIONS

*Coronilla varia* seeds germinate very slowly, need scarification and soil best temperature in comparison with sainfoin and alfalfa.

The 3-year-old *Coronilla varia* plants have moderate growth and development rates that allow mowing them at the end of May the green mass yield reaches 3.92 kg/ $m^2$, at the same level as sainfoin and by 25% more than alfalfa, but low content of dry matter, in comparison with the traditional crops.

The chemical composition of *Coronilla varia* dry matter: 14.72% raw protein, 2.81% raw fat, 35.46% raw cellulose, 39.74% nitrogen-free extractive substances and 7.27% minerals (high level of potassium and iron, but lower – of magnesium and sodium).

The forage value of 1 kg natural forage accounts 0.20 nutritive units, 2.22 Mj metabolizable energy; digestible protein - 132.10 g/nutritive unit.

The gas forming potential of *Coronilla varia* reached 501 litre/kg VS with 52.5% methane.The calculated methane yield *Coronilla varia* green mass at the first mowing may reach 2311 $m^3$/ha, exceeding *Medicago sativa*.

The local ecotype of the species *Coronilla varia* could be used for restoring degraded, polluted and eroded land, and also for reseeding and increasing economic value of grasslands.

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# AGROBIOLOGICAL PECULIARITIES AND PROSPECTS FOR VALORIFICATION OF WOAD, *ISATIS TINCTORIA* L., IN MOLDOVA

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**Abstract**

We studied agro biological peculiarities, chemical composition and nutritional value and evaluated the capacity to produce biogas from aerial biomass of the woad, *Isatis tinctoria* L., family *Brassicaceae* Burnett, which was cultivated on the experimental land of the Botanical Garden (Institute) of Academy of Sciences of Moldova. It was established that the species *Isatis tinctoria*, in the first growing season, was characterised by slow growth and development, produced a basal rosette of leaves and a strong taproot, but in the second growing season, it had an accelerated growth and development rate. This species started flowering 10-15 days earlier than oilseed rape, so, it was valuable for bees as a pollen source. In the flowering period (the second half of April), woad branched stalks reached up to 105-110 cm high, the natural forage yield reached 23.0 t/ha of natural forage with a high degree of foliage (50%), in the seed development period (the end of May) – 35.0 t/ha of natural forage. The chemical composition of solids of green mass of *Isatis tinctoria* in the flowering period is represented as follows: 20.18% raw protein, 4.46% raw fats, 32.40% raw cellulose, 12.25% minerals, 30.76% nitrogen free extracts, but in the seed development period – 12.00%, 3.08%, 38.83%, 8.56% and 37.53%, respectively. The nutritional value in the flowering period was 0.11 nutritive units/kg, 1.14 Mj/kg metabolizable energy and 165.6 g/ nutritive units digestible protein, but, in the seed development period – 0.14 nutritive units /kg, 1.43 Mj/kg and 100 g/ nutritive units gestible protein, respectively. The *Isatis tinctoria* silage prepared from wilted green mass harvested in seed development period, was distinguished by homogeneous dark-brown colour, pleasant smell of pickled cabbage, 0.23 nutritive units./kg and 2.30 Mj/kg metabolizable energy, 110 g/ nutritive units digestible protein, but corn silage – 0.30 nutritive units/kg, 2.64 Mj/kg and 40g/ nutritive units digestible, respectively.
The calculated biogas capacity of woad can reach values of 438-464 l/kg organic substance with 54-56% methane.
Taking into consideration the presented scientific results, the species *Isatis tinctoria* is promising as a crop with multiple utility for founding fodder-melliferous and melliferous-energy plantations, besides; it can be used for green manure.

**Key words**: agro biological peculiarities, biochemical composition, biogas yield, fodder value, *Isatis tinctoria*, woad

The production of great amounts of high quality plant material at low costs is an important factor for the revival of the agriculture and national economy of the Republic of Moldova. It is therefore, necessary to develop modern cultivation techniques for important traditional crops, but taking into account the expansion of degraded soil and the frequency of droughts, it is necessary to identify, mobilize and introduce new species with multiple utility that have gained importance as a new agricultural tool in recent years.

The family *Brassicaceae* Burnett is a monophyletic group of about 338 genera and some 3709 species distributed worldwide. It includes many economically important ornamental and crop species: vegetables or sources of industrial and cooking oils, condiments, forage and energy biomass (biodiesel and biogas). This crop produces large roots which promote soil aeration and water infiltration by diminishing. Certain species from the *Brassicaceae* family produce glucosinolates as secondary metabolites with toxic properties, affecting nematodes, diseases and weeds (Bohinc T. *et al*, 2012.)

The problem of forage with high protein content is still an actual one in livestock farming. One way of strengthening the fodder base is the use more green fodder. Therefore, to get green fodder is necessary promote the system of fodder production that ensures continuous feeding of animals from early spring to late autumn, but early spring green forage were winter rye and triticale. In recent years, good competitors of these crops are brassicas – forage plants known for their rapid growth, great biomass production and nutrient scavenging ability. They provide an excellent source of energy and protein, are a valuable tool

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for meeting the changing feed requirements of livestock, throughout the year. Feed supply and livestock performance can be manipulated through the use of different forage species. Forage rape (*Brassica napus* ssp. *biennis*) is a popular forage crop capable of producing a large bulk of forage in a short period, but not as winter hardy as triticale and kale (*Brassica oleracea* ssp. *acephala*). Therefore, to obtain early spring forage, woad, *Isatis tinctoria*, is of great interest (Kshnikatkina A.N. *et al*, 2005; Pimonov K. I. *et al*, 2010; Milashenko A.V., 2012) *Isatis tinctoria L.* (syn. *Isatis indigotica* Fortune*)*, commonly known as woad, dyer's woad or glastum is a European native, biennial or short-lived perennial herbaceous plant depending on local environmental conditions, with erect stem, hastate leaves and yellow flowers clustered in racemes (Al-Shehbaz I.A. *et al*, 2006). *Isatis tinctoria* combines valuable biological features, such as drought tolerance and winter hardiness, high content of crude protein and the formation of early, suitable for mowing, vegetative mass. In early spring, *Isatis tinctoria* was a good pasture plant, especially for sheep, when ewes with lambs that were grazing woad gained weight by 41% and lambs – 21%. In spring, after the regrowth of woad within 30-35 days, the harvest reached 35-45 t/ha of green mass, with nutritional value that was not lower than in the pea-oat mixture, it was used for feeding cattle and sheep, preparing grass fodder and silage. It is a beautiful honey plant, blooming much earlier than other honey plants. According to the content of protein, *Isatis tinctoria* is superior to corn, rye, triticale and rape (Vavilov P.P., Kondratyev A.A., 1975; Medvedev P.F., Smetannikova A.I., 1981; Pimonov K.I. *et al*, 2010). Among the positive properties of woad, is the possibility of sowing it several times during the growing season, the characteristics that make it an ideal pioneer crop to be grown on hills and marginal lands and the possibility to use it for various purposes (Milashenko A.V., 2012). Since prehistoric times, the leaves have been used as a natural dye. *Isatis tinctoria* is an important medicinal plant: its leaves are used in traditional medicine mainly for the treatment of infections, specifically: encephalitis, upper respiratory infection and gastroenteritis. *Isatis tinctoria* root extract has antibacterial, antiviral, and antiparasitic properties and is also used to treat infections (Galletti S. *et al*, 2013).

This research was aimed at evaluating some biological peculiarities, yield, biochemical composition of the natural fodder and silage of *Isatis tinctoria* and the possibility to use it as fodder in animal husbandry or as biogas substrate under the conditions of Moldova.

## MATERIAL AND METHOD

The local ecotype *Isatis tinctoria* collected from spontaneous flora and cultivated on the experimental land of the Botanical Garden (Institute) served as object of study, the traditional fodder crops: alfalfa, *Medicago sativa* (green mass), and corn, *Zea mays* (silage) – control variants. The plant growth, development and productivity were assessed according to methodical indications (Novoselov Y. K. et al 1983). The green mass was harvested in the flowering period (the second half of April) and in the seed development period (the end of May). The green mass yield was measured by weighing. The *Isatis tinctoria* silage was prepared from wilted green mass in the seed development period (2 days after mowing) and evaluated in accordance with the Moldavian standard SM 108. Dry matter, or total solids (TS) content was detected by drying samples up to constant weight at 105 °C. Crude protein – by Kjeldahl method; crude fat – by Soxhlet method, crude cellulose – by Van Soest method, ash – in muffle furnace at 550 °C. Organic dry matter, or volatile solids (VS), was calculated through differentiation, the crude ash being subtracted from dry matter. Nitrogen-free extract (NFE) was mathematically appreciated, as difference between organic matter values and analytically assessed organic compounds (Petukhov E.A. *et al*, 1989). The biogas and biomethane, litre per kg of volatile solids (l/kg VS), were calculated using the gas forming potential of nutrients (Baserga U., 1998) and digestible index of nutrients (Medvedev P.F, Smetannikova A.I., 1981).

## RESULTS AND DISCUSSIONS

Seeds of woad *Isatis tinctoria* readily germinated at 3 to 25°C. *Isatis tinctoria* plantlets emerged at the soil surface 5-12 days later compared with other brassica forage crops. Over the next 50- 40 days, the growth and development of the aerial part of the plant was very slow, then it accelerated and, until the end of the growing season, produced a basal rosette with long-petioled leaves, 8-15 cm long and 2-4 cm wide. The blue-green leaves had small, soft, fine hairs. The root system was dominated by a strong taproot, which in some plants exceeded 1.0 m in depth, with lateral roots on the upper 18-27 cm that spread laterally about 40 cm.

In the first growing season woad wasn't harvested, but was suitable for grazing.

The species *Isatis tinctoria*, in the second year started vegetating when temperatures were above 3-5ºC, new leaves grew from the crown bud in the rosette, distinguished by an accelerated growth and development rate. 5-7 stems developed

from each rosette, the top of each stem was branched, with many yellow flowers. Wood grows early in the season, often before crops of grain, pasture, or alfalfa emerge. This early growth gives dyer's wood a competitive advantage; it uses early spring moisture and nutrients to grow quickly and produce a large root system. Later, during the growing season, its large taproot draws moisture from deep in the soil to give it an even greater advantage over shallow-rooted species, including many natives. This species started flowering 10-15 days earlier than oilseed rape, so, it was valuable for bees as a pollen source.

Figure 1 *Isatis tinctoria,* flowering period

In the second half of April, during the flowering period (*figure 1*), the branched stalks of *Isatis tinctoria* reached up to 105-110 cm high, the natural forage yield reached 23.0 t/ha of natural forage *(table.1).* The harvested fodder was richer in leaves (50%), but poorer in dry matter (13%). It was found that *Isatis tinctoria*, in the flowering period, was characterized by high content of protein (20.18%), fat (4.46%) and minerals (12.25%), and optimal content of raw cellulose (32.40%) in dry matter, probably due to the report leaves/stems of harvested fodder. It was determined that 100 kg of *Isatis tinctoria* natural fodder contained 11 nutritive units, 114 MJ/kg metabolizable energy, 1.5 kg digestible protein. The harvested green mass of *Isatis tinctoria* can be an excellent supplement, especially to low protein and fat forages such as straw and corn silage.

At the end of May, when the traditional forage crop alfalfa is at the beginning of flowering period and reaches the optimal harvest time, *Isatis tinctoria* is already in the seed development period. The yield of green mass, harvested during this period, reached 35 t/ha and the amount of dry matter and nutrients was considerably higher as compared with the previous period, and was about the same as in alfalfa. Analyzing the data regarding the chemical composition of dry matter in the fodder harvested during this period, a reduction in the content of protein, fat and minerals was found, which was probably related to the ratio leaves/stems. As compared with alfalfa, the dry matter of *Isatis tinctoria* is characterized by higher content of fat and cellulose and lower – of protein and ash. The amount of protein in a nutritive unit meets the zootechnical standards.

Some authors mention similar findings about the quality of *Isatis tinctoria* fodder. So, in 2005, as a result of a research conducted in Penza region, Russia, it was found that the dry matter content of green fodder was 22.3-24.9% raw protein, 3.0-3.6% raw fats, 10.8-12.5% raw cellulose, 13.9-15.4% minerals, 48.5% nitrogen free extracts and the nutritive value reached 0.31 nutritive units/kg green fodder (Kshnikatkina A.N. et .al., 2005); in Western Siberia, Russia - productivity reached 49.2 t/ha green mass, 5.71 t/ha dry matter, 4850 nutritive units and 1256 kg/ha protein (Milashenko A.V., 2012).

The specialized literature states that the fresh mass of *Brassicaceae* plants can be used to prepare silage (Kshnikatkina A.N., et. al, 2005; Pimonov K. I. et al, 2010; Milashenko A.V., 2012), but due to the high moisture content, it is recommended to mow the green mass and let it wilt before ensiling.

Figure 2. Isatis tinctoria silage

Table 1

**Biological peculiarities, productivity, biochemical composition and nutritional value of *Isatis tinctoria***

| Indices | *Isatis tinctoria* flowering period | *Isatis tinctoria* seed development period | *Medicago sativa* flowering period |
|---|---|---|---|
| Plant height, *cm* | 110 | 105 | 83 |
| Yield of natural fodder, *kg/m²* | 2.30 | 3.50 | 2.48 |
| Yield of dry matter, *kg/m²* | 0.30 | 0.58 | 0.60 |
| Content of leaves in the fodder,% | 50 | 32 | 44 |
| Biochemical composition dry matter: | | | |
| - raw protein,% | 20.18 | 12.00 | 16.66 |
| - raw fats,% | 4.46 | 3.08 | 1.88 |
| - raw cellulose,% | 32.40 | 38.83 | 34.24 |
| - nitrogen free extracts,%. | 30.71 | 37.53 | 37.22 |
| - mineral substances,% | 12.25 | 8.56 | 10.00 |
| 1kg of natural fodder contains: | | | |
| - nutritive units | 0.11 | 0.15 | 0.20 |
| - metabolizable energy, Mj/kg | 1.14 | 1.43 | 2.10 |
| - dry matter, g | 130.50 | 166.60 | 243.00 |
| Digestible protein, g/nutritive unit | 165.6 | 100.00 | 154.07 |
| Nutritive units, t/ha | 2.53 | 5.25 | 4.95 |
| Digestible protein, kg/ha | 415 | 529 | 764 |

The investigated *Isatis tinctoria* silage (*figure 2*), prepared from wilted green mass harvested in the seed development period, was distinguished by homogeneous dark-brown colour, pleasant smell specific of pickled cabbage, optimal leaf and low dry matter content compared with *Zea mays*, and no juice leakage was observed during fermentation.

As a result of the performed analysis (*table 2*), it was determined that the pH index of the *Isatis tinctoria* silage was 4.74, but the control variant, corn silage – 4.12. The concentration of total organic acids is higher in the *Isatis tinctoria* silage (4.57%), butyric acid has not been found and lactic acid predominates (3.49%). Lactic and acetic acids are present in silage, being predominantly in fixed state, which is desirable because organic acids in fixed state contribute more to the preservation of nutrients in the silage. The standard requirements for a silage made of traditional plants provide a level of lactic acid of the total organic acids at least 50-55% for the quality class I (Cosman S. *et al*, 1996).

Table 2

**Biochemical composition and nutritional value of the *Isatis tinctoria* silage**

| Indices | *Isatis tinctoria* | *Zea mays* |
|---|---|---|
| Dry matter,% | 25.72 | 29.16 |
| Biochemical composition: | | |
| - raw protein,% | 13.78 | 6.52 |
| - raw fat,% | 3.15 | 3.23 |
| - raw cellulose,% | 35.48 | 20.30 |
| - nitrogen free extracts,% | 36.82 | 65.66 |
| - minerals,% | 10.76 | 4.26 |
| 1 kg of silage contains: | | |
| - nutritive units | 0.23 | 0.30 |
| - metabolizable energy, MJ/kg | 2.30 | 2.64 |
| Digestible protein g/ nut. unit | 110 | 40 |
| pH of the silage | 4.74 | 4.12 |
| Total organic acids,% | 4.57 | 3.38 |
| Acetic acid,% dry matter | 1.08 | 0.62 |
| - free acetic acid,% | 0.38 | 0.27 |
| - fixed acetic acid,% | 0.70 | 0.35 |
| Lactic acid,% dry matter | 3.49 | 2.76 |
| - free lactic acid,% | 0.81 | 1.00 |
| - fixed lactic acid,% | 2.68 | 1.76 |
| Carotene, mg/kg | 10.67 | 9.30 |

Analyzing the data on the chemical composition of the dry matter from the *Isatis tinctoria* silage, we found a low content of nitrogen free extracts (36.82%) and higher content of raw cellulose (35.48%), raw protein (13.78%) and

minerals (10.76%) in comparison with the control, which influenced the nutritive and energy value, so 1 kg of *Isatis tinctoria* silage contained 0.23 nutritive units and 2.30 MJ metabolizable energy, the digestible protein content was 110 g/nutritive unit, but the corn silage (milk-wax stage of ripeness) contained 0.30 nutritive units, 2.64 MJ and 40 g digestible protein/nutritive unit, respectively.

Forage has the potential to play a significant role in the supply of vitamins to ruminants. Carotene is vitamin A precursor, plays a vital role in bone growth, reproduction and immune system health. We could mention that the carotene content in the *Isatis tinctoria* silage is at high level, in comparison with corn silage.

Due to the increasing concern upon the effect of greenhouse gases and crude oil price, biogas has become of major interest as an alternative energy source. The capability of biomass methanization is tightly associated with organic matter content, chemical composition and nutrient digestibility (degrees of conversion) of the feedstock, harvesting time and plant species (Amon T. et al. 2007). Catch crops may form a potential biomass resource for biogas production (Molinuevo-Salces B. *et al*, 2013).

Table 3

**Gas forming potential of the of nutrients *Isatis tinctoria***

| Indicators | Green mass (April) | Green mass (May) | Silage |
|---|---|---|---|
| Organic digestible matter , g/kg | 555 | 569 | 586 |
| Biogas, liter /kg VS | 438 | 450 | 465 |
| Methane, liter /kg VS | 245 | 242 | 251 |
| Methane,% | 56 | 54 | 54 |
| Methane yield, $m^3$/ha | 735 | 1400 | 1431 |

Organic digestible matter (ODM) is an important factor influencing biogas and methane yield. The gas forming potential of organic digestible matter varied from 438 l/kg in biomass harvested in the second half of April, the flowering period, to 450 l/kg VS – in the seed development period (*tab.3*), but the calculated methane content in the biogas decreased from 56 to 54%, reaching from 245 l/kg to 242 l/kg. The substrate from *Isatis tinctoria* silage characterized by high level gas forming potential (450 l/kg VS) and methane production were achieved 1431 $m^3$/ha.

In the Italian context, the anaerobic digestion test showed that in woad herbaceous substrates the net methane production was 153.1 l/kg VS, with 33% estimated degrees of conversion (Carchesio M. et al, 2014).

## CONCLUSIONS

The species *Isatis tinctoria*, in the first growing season, was characterised by slow growth and development, produced a basal rosette of leaves and a strong taproot, but in the second growing season, it had an accelerated growth and development rate. In the flowering period (April) stalks reached up to 105-110 cm high, the natural forage yield reached 23.0 t/ha of natural forage with a high degree of foliage (50%), in the seed development period (the end of May) – 35.0 t/ha of natural forage.

The *Isatis tinctoria* dry matter, in the flowering period, contained 20.18% raw protein, 4.46% raw fats, 32.40% raw cellulose, 12.25% minerals and 30.76% nitrogen free extracts, but in the seed development period – 12.00%, 3.08%, 38.83%, 8.56% and 37.53% respectively.

The nutritional value, in the flowering period, was 0.11 nutritive units /kg, 1.14 Mj/kg metabolizable energy and 165.6 g/nutritive unit digestible protein, but in the seed development period – 0.14 nutritive units /kg, 1.43 Mj/kg and 100 g/ nutritive unit digestible protein, respectively.

The *Isatis tinctoria* silage prepared from wilted green mass harvested in the seed development period, was distinguished by homogeneous dark-brown colour and pleasant smell of pickled cabbage, 0.23 nutritive unit /kg and 2.30 MJ/kg metabolizable energy, 110 g/ nutritive unit digestible protein, but the corn silage – 0.30 nutritive unit /kg, 2.64 MJ/kg and 40 g/ nutritive unit digestible protein, respectively.

The gas forming potential of organic digestible matter varied from 438 l/kg in the green mass harvested in the flowering period to 450 l/kg in the seed development period, but the calculated methane content in the biogas decreased from 56% to 54% (245 l/kg to 242 l/kg VS). The best results of methane production were achieved for *Isatis tinctoria* silage (1431 $m^3$/ha).

Taking into consideration the presented scientific results, the local ecotype of the species *Isatis tinctoria*, is promising as a crop with multiple utility for founding fodder-melliferous and melliferous-energy plantations, as well, it can be used as green manure.

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# EFFECT OF SILVER NANOPARTICLE AND ORGANIC BIOSTIMULATOR NITROZIME OVER MICROPORES AND GERMINATION, GROWTH AND DEVELOPMENT OF SEEDS OF TRITICUM AESTIVUM TO LEVEL OF A BIO ACCUMULATIVE HORIZON TYPE CAMBIC SOIL

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**Abstract**

The present paper monitors the effect of applying different doses of silver nanoparticles (10 ppm, 15 ppm, 20 ppm), and the effect of organic biostimulator Nitrozimes (2ml/l) on the germination, growing and development of the Triticum aestivum species. The changes suffered by the bioaccumulation horizon of the cambic chernozem at micro porous level is also investigated. The silver nanoparticle solution is obtained through electrolysis technique in miliQ water solvent using Nevoton IS-112 device with silver electrodes of 99.99% purity. The determination of the ppm quantity is realized by using TDS-1. The seed germination is tracked in a controlled environment (Petri dishes) in laboratory conditions for 10 days until germination. After, they are transferred in vegetation dishes in the grow house and tracked in a controlled environment of temperature, humidity and soil pH. Data on the micro porosity was taken and analyzed at I.C.A.M. Laboratories in the V. Adamachi resort using micro computed tomography (Brucker Skyscan 1172). The germination evolution, growth and development of the wheat plants was measured weekly throughout the growing season. The results show a reduction in the diameter of the micropores that is inversely proportional to the concentration of silver ions doses applied. From the germination phase until 2-3 leafs stage, the growth is approximately double than the development of the witness plants (untreated wheat grown in bioaccumulative horizon).
**Key words**: silver nanoparticles, biostimulator, soil structure.

Silver nanoparticles (AgNPs) are groups of atoms that have sizes between 1 nm and 100 nm. (Williams G. *et al*, 2008). The prefix nano indicates a billionth of an mm or $10^{-9}$. The more the particle size is reduced the relation between volume and surface increases. Silver nanoparticles are present in natural ecosystems, including the soil which can penetrate through various channels, with major impact for soil microorganisms and plant organisms, it changes the background of complex chemical and biological nature.

Because bio-solids contaminated by AgNPs may be applied to a variety of soils, understanding the factors that influence Ag NP toxicity will be important in determining the risk that Ag NPs pose to soil systems.

To optimize the performance of target applications is the importance of size, shape, surface and state of aggregation of nanoparticles. (Yeo *et al*, 2003, Zhang *et al*, 2006, Chimentao *et al*, 2004).

It is recommended the use of monodisperse nanoparticles that are free of agglomeration (Sudrik *et al*, 2006, Sun *et al*, 2000, Vilchis N. *et al*, 2008). Nano particle characterization is done by transmission electron microscopy (TEM) analysis of particle size by dynamic light scattering, UV visible spectrum analysis, as well as Zeta potential measurements.

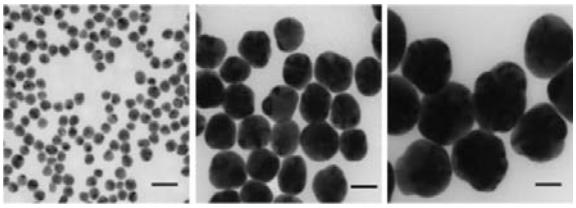

Figure 1 **Transmission electron microscopy (TEM) images of silver nanoparticles with diameters of 20 nm (Aldrich Prod. No. 730793), 60 nm (Aldrich Prod. No. 730815), and 100 nm (Aldrich Prod. No. 730777) respectively. Scale bars are 50 nm.**

Compared to the size of nanoparticles of silver, soil type is a more important factor in accumulating them. (Aaron W. *et al*, 2011).

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At worldwide level, the use of silver as a result of exploitation of this mineral native uncontrolled determine its penetration into the environment, especially in the aquatic systems. Silver nanoparticles are relatively stable in liquid medium, having the opportunity to be present and to accumulate in the soil and in different amounts (ppm). (Korbekandi H. *et al*, 2012).

Systematic application of AgNPs doses at a level horizon bio-accumulative, as do have silver ions to accumulate over time. Extended x-ray absorption fine structure spectroscopy analysis of the horizon indicated that the Ag was approximately 1 to 3% Ag (I), suggesting that Ag ions may be responsible for effects on growth and development caused by exposure to Ag NPs.

The soil due to his state of dispersion, its components, especially those with colloidal character has the ability to adsorb minerals in different forms: molecular and ionic state of dispersion. Humus and clay soil colloids have respective main character electronegative, thus having the ability to adsorb to the surface layer diffuse different cations present in the soil solution (Puiu S., 1980).

On the horizon bioaccumulate, silver nanoparticles (present following an involuntary anthropogenic pollution or as a result of soil formation and evolution of the deposits of silver) form different combinations of ions Cl, $SO_4$, $NO_3$, O, $CO_2$.

$CO_2$ conversion rate per unit area is about 10 times larger silver nanoparticles on the support of 5 nm monolithic than in the case of silver. Increasing the concentration of $AgNO_3$ affect nanoparticle form. (Zhu J. *et al*, 2000).

Silver nanoparticles highlights a broad spectrum biocidal all classes of organisms and microorganisms. The toxic effects of silver nanoparticles has been scientifically demonstrated in different species of plant and animal micro-organisms (Popescu M. *et al*, 2010), invertebrates (Baruwati B. *et al*, 2009), plants (Elghanian R. *et al*, 1997), and if human cells (Hurst S.J. *et al*, 2006, Tran Q.H. et al, 2013), because it the fact that silver nanoparticles possess physico-chemical distinctive properties compared to bulk Ag. *(Naser A. et al, 2013)*.

Unstabilized silver nanoparticles suffers a rapid oxidation and a slight aggregation in solution. (Popa I. *et al*, 2015). In presence of soil moisture and oxygen, a process of oxidative degradation silver ions lose an electron, electron actually intervening in inhibiting the multiplication of bacteria and normal development. (Ramyal M. *et al*, 2012). Antifungal and antibacterial characteristics of silver nanoparticles are still poorly clarified.

Stress caused by applying a treatment with AgNPs indicate a nanoparticle accumulation in the soil, roots, as well as a translocation them to the air. (Gorczyca A. *et al*, 2015).

This study material is trying to approach early, multidisciplinary changes, accumulation, toxicity potential and the cumulative impact on the level of state structural horizon bioaccumulative (Am) soil type chernozem cambic, as well as on the physiology of the species *Triticum aestivum*, following by applying a voluntary human intervention during germination and along the course of vegetation doses of silver nanoparticles and organic bio-stimulator Nitrozime.

## MATERIAL AND METHOD

We choosed a representative location (V.Adamachi farm), with soil profile depth 1.5-2m on which we made the description of the indicators presented in the methodology of writing pedomorfological soil studies. The sample of soil for laboratory analysis (soil texture, morphological type of structure, size of the structural elements, formations of chemical and biological nature, content of organic matter calcium carbonate) was prelevated from each horizon bottom on top to avoid contamination of soil material collected.

The silver nanoparticle solution is obtained through electrolysis technique in miliQ water solvent using Nevoton IS-112 device with silver electrodes of 99.99% purity. The determination of the ppm quantity is realized by using TDS-1. The seed germination is tracked in a controlled environment (Petri vessels) in laboratory conditions for 10 days until germination. After, they are transferred in vegetation vessels in the grow house and tracked in a controlled environment of temperature, humidity and soil pH. Data on the micro porosity was taken and analysed using micro computed tomography (Brucker Skyscan 1172).

## REZULTS AND DISCUSSIONS

The soil contents of humus accumulation horizon (Am), with high thickness (45 cm) followed by Bv color cambic horizon and C horizon with accumulation of calcium carbonate.

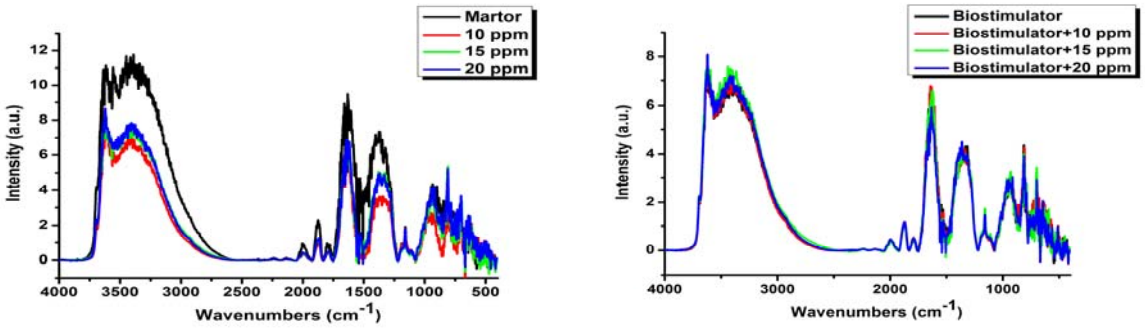
Reserve humus and nutrients is high (3.57g/%) with H/F = 2.4, the maximum content of calcium carbonate is recorded in C horizon. 15.7 g/%, CaCO3 ground presence weak to moderately alkaline reaction (pH – 7.98).

Pedogenetical horizons sequence shown is specific soil type. Edaphic large volume useful and good aero-hydric regime.

Relatively uniform soil matrix color indicates that the soil is not affected by stagnant excess moisture. Angular polyhedral structure and the uneven distribution of roots that are located preferential faces structural elements

Concerning the chemical properties of structural horizon bioaccumulative (Am) soil type chernozem cambic, the FTIR spectra shows the presence of OH group in range of 3000–3700 $cm^{-1}$, C=O group at 1869 and 1790 $cm^{-1}$, C=C at 1624 $cm^{-1}$, C-H, C-N and N-H in range of 1227-1500 $cm^{-1}$ and C-O at 1161 and 953 $cm^{-1}$ (Figure 2 (a) and (b)).

All the identified peaks are presents in martor soil and also in martor plus biostimulator. After the introducing the AgNPs, at different concentrations, for the martor soil, the intensity for all beaks are decreasing, which means the AgNPs create chemical reactions with molecules presented in soil (Figure 2 (a)). For the soil treated also wit Nitrozime biostimulator, the intensity of line are in the same range, which means that the biostimolator molecules are covered the AgNPs, but does not affesct the chemical structure of soil (Figure 2 (b)).




(a) (b)

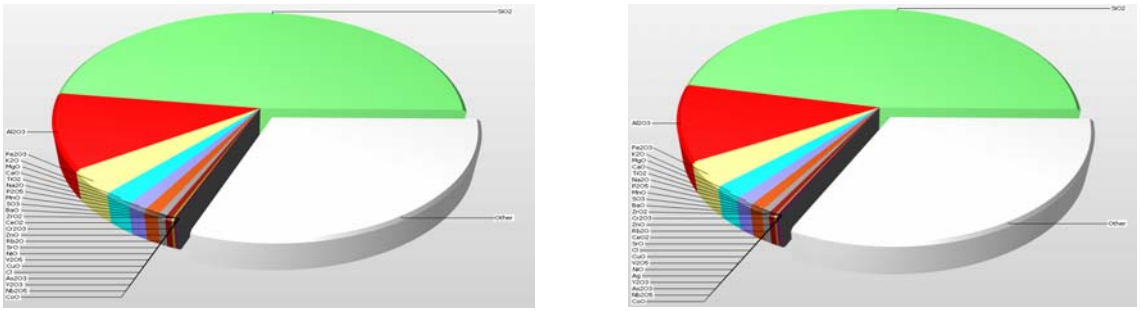
Figure 2 **Typical FTIR spectrum of martor soil and martor soil plus silver nanoparticles (a) martor pus bitstimulator soil and martor soil plus bitstimulator and silver nanoparticles (b)**

Also, this effect was demonstrated with X-ray fluorescence spectroscopy, where the concentrations of minor and major elements remains at the same range (Figure 3 (a) and (b)).

In terms of $Ag^{2+}$ nanoparticles, the concentration are grows and accumulates in soil when the silver solution is added. The maximum concentration of silver is approximatively 50 ppm, for martor soil when added 15 and 20 ppm silver solution and 40 ppm for martor plus Nitrozime biostimulator (2ml/l) soil when added 15 and 20 ppm silver solution every week (Figure 4).

The micro porosity results show a reduction with more than 50% in the diameter of the micropores that is inversely proportional to the concentration of silver ions doses applied (Figure 5 (a) and (b)).

Concerning the total porosity of soil, this are decreasing also when the soil are treated with silver nanoparticles and Nitrozime biostimulator (2ml/l) plus biostimulator. This can be explained by reducing or blocking of the soil pores by the silver nanoparticles and biostimulator aggregates (Figure 6 and Figure 7).



(a) (b)

Figure 3 **XRF results of martor soil and martor soil plus silver nanoparticles (a) martor pus bitstimulator soil and martor soil plus bitstimulator and silver nanoparticles (b)**

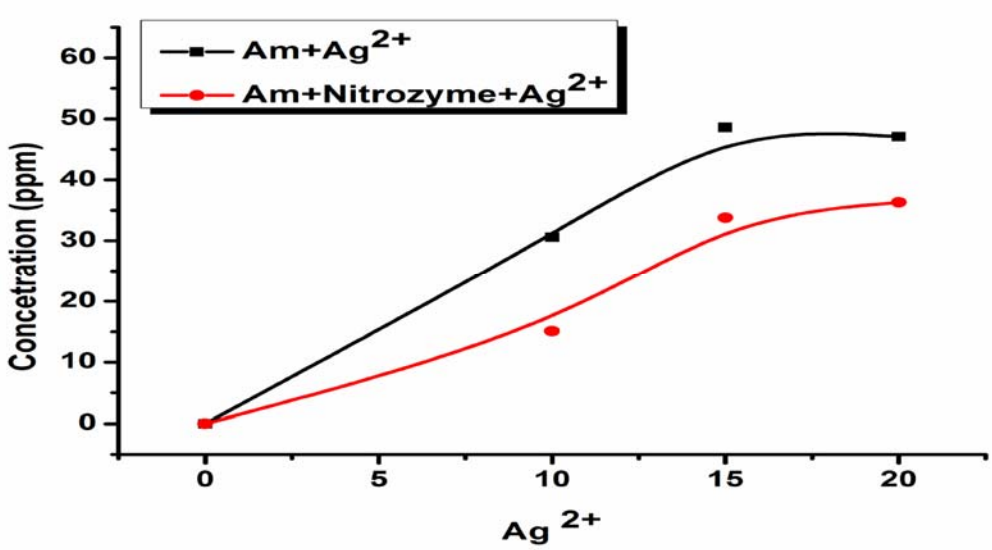
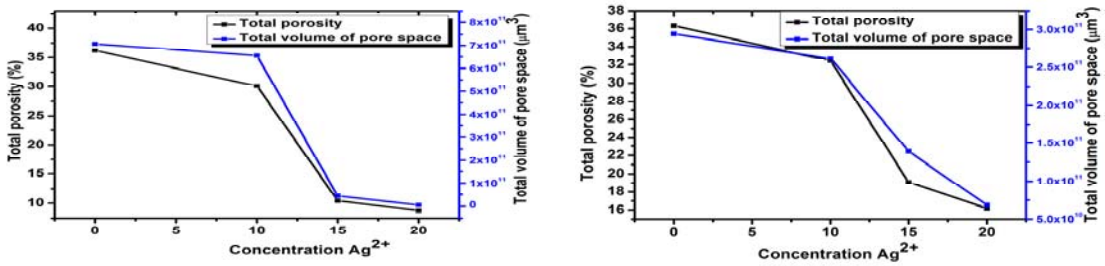



Figure 4 **XRF results of silver nanoparticles concentration martor pus bitstimulator soil and martor soil plus bitstimulator and silver nanoparticles at different concentration (b)**




(a) (b)

Figure 5 **Micro porosity results for martor soil and martor soil plus silver nanoparticles at different concentration (a) martor pus bitstimulator soil and martor soil plus bitstimulator and silver nanoparticles at different concentration (b)**

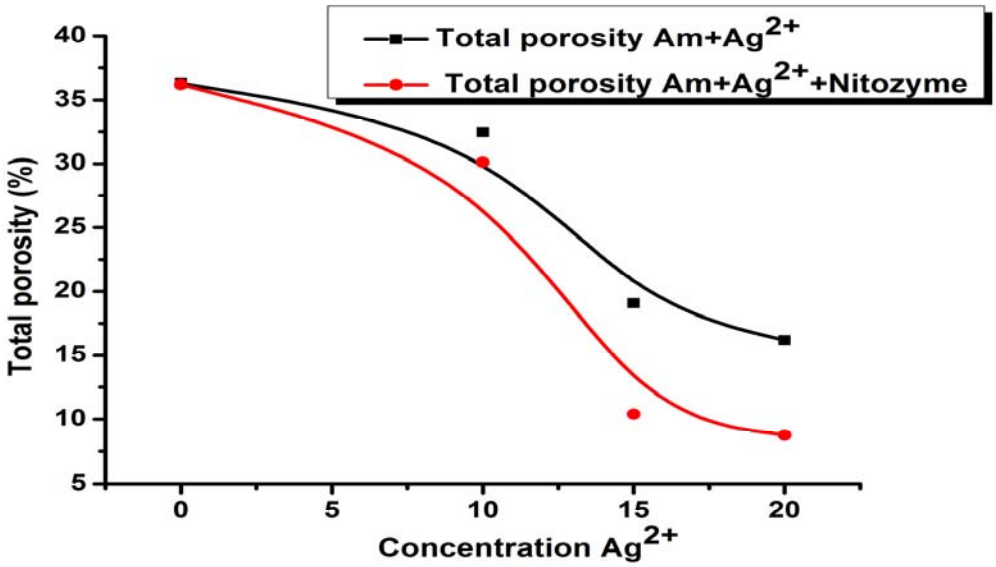
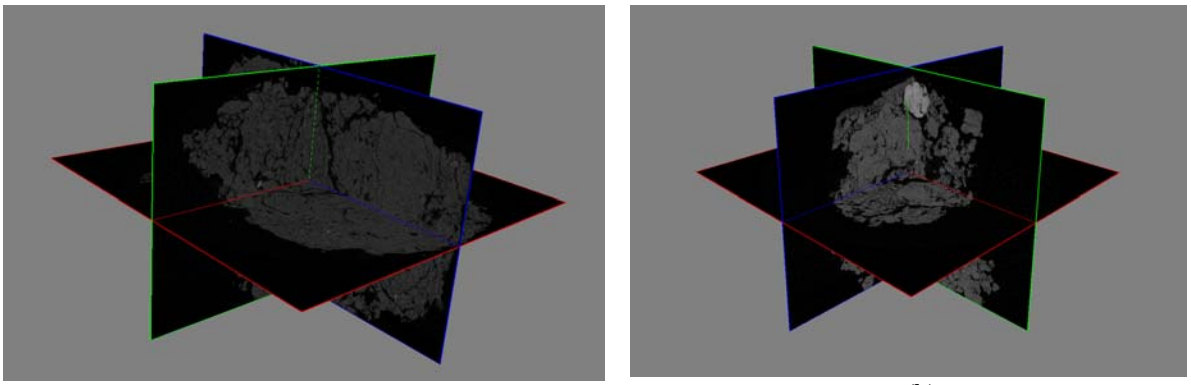



Figure 6 **Micro porosity results for martor soil and martor soil plus silver nanoparticles and bitstimulator at different concentration**



(a) (b)

Figure 7 **Micro CT image for martor soil (a) and martor soil plus silver nanoparticles at concentration 20 ppm (b)**

Figure 8 **Germination process in Petri dishes**

The effect of different doses of AgNPs (ppm) Ag electrodes produced by electrolysis of purity 99.9% with a voltage of 48.5 V with a current intensity of 100 mA continuous, on germination and growth of the species Triticum aestivum was analysed. Germination analysis indicates a value of 90% in the contextual variant, which was not intervened with anthropogenic AgNPs, through a strong saprophyte attack which was approximately 95%. Comparing versions AgNPs, is highlighted keep the germination of 90-95% dose for 15 ppm, with the presence of a small green fungal disease. Germination decreases with about 35% in solution with 20 ppm, while the dose with 10 ppm mentions a germination of 60% with the presence of a small indigo fungal disease. Germinated embryos were transferred into pots vegetation, continues the weekly treatment with AgNPs (*figure 8*).

## CONCLUSIONS

Treatment with nanoparticles produced a major disintegration of cell membranes made of seeds germinated in Petri dishes, an effect emphasized by their low rate of germination. Contextually transfer germinated seeds in vegetation vessel and continued treatment with AgNPs vegetation, affect plant height and a quicker maturity with a decrease in production, reflected in lower thousand grain weight.

The applied of different AgNPS doses, lead to an increase of 47% AgNPs concentration, concentration which decrease to 33% after applying of organic biostimulator Nitrozime.

The stress can be counteract on the mass of microorganisms after applying voluntary AgNPs may be diminished in weakly alkaline conditions of neutral pH and the presence of a calcic mull type humus quality in quantity at least 3-4 g% g soil, a question supply of 160-200 t / ha on a depth of 0 -50 cm.

The stress applying AgNPs treatment indicate an accumulation of nanoparticles in soil, roots, and how their translocation to the airline.

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# AN EXPERIMENTAL SETUP FOR ASSESSING LIGHT AND MINERAL NUTRITION EFFECTS ON *ARABIDOPSIS THALIANA* HEYNH. PHENOTYPE

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**Abstract**

Being able to quantify the phenotype is very important, especially in relationship with the genetic background or the environment. Our research article tested an experimental setup for its ability to analyse the influence of light quality and nitrogen availability on the phenotype. For this purpose, *Arabidopsis thaliana* plants were grown in specially designed hydroponic setups placed in custom made light boxes and were analysed using imaging and image analysis techniques. Parameters for growth (projected rosette area, absolute growth rate, relative growth rate) and parameters for general morphology of the plant (compactness, stockiness) were assessed. Plants grown in red light achieved higher projected rosette area, but were more sensitive to changes in nitrogen concentration, while plants grown in blue light developed a smaller surface area, but were less sensitive to changes in nitrogen concentration. Compactness and stockiness were strongly influenced by light quality, having higher values for plants grown in blue light. Nitrogen concentration did not influenced compactness or stockiness parameters. Overall, the experimental setup and the methodology presented were robust and precise enough to produce good quality data and to allow the identification of both obvious and not so obvious effects of environmental factors on plant phenotype.

**Key words**: light, nitrogen availability, image analysis, phenotype

Sometimes, a big issue for plant scientists is to conceive appropriate experimental setups to help them tackle important research questions or hypothesis which are many times complex and difficult to address. In this background, our article contributes with an example of experimental setup used to assess light and mineral nutrition effects on *Arabidopsis thaliana* phenotype.

Plants differ a lot in appearance, even if we compare plants from the same species or varieties (Pérez-Pérez J.M. *et al*, 2002). This happens because the external aspect of plants is composed from a huge amount of traits, which are the expression of the genome, guided by the environmental conditions. These sums of traits are commonly referred to as phenotypes, and the biological research area that describes and measures the phenotypes is called phenomics. After all the advancement of the last couple of centuries in the field of plant genomics, it became clear that the development of phenomics as a research field should follow, in order to better understand how genes and the environment are shaping the final appearance.

The classical way to assess a phenotype involved using callipers or measuring fresh and dry weights of the plant at the end of the vegetative stage, to receive insight in the plant's aerial biomass. All this methods are either destructive, stressful for the plant or low resolution in terms of assessment over time (Dhondt S. *et al*, 2013). The solution came when non-destructive imaging of the plants started to be employed. Over the past decade, several research groups started to build custom-made plant phenotyping platforms equipped with imaging systems (Granier C. *et al*, 2006; Walter A. *et al*, 2007; Jansen M. *et al*, 2009; Arvidsson S. *et al*, 2011; Skirycz A. *et al*, 2011; Tisné S. *et al*, 2013; Apelt F. *et al*, 2015). Using image analysis methods, growth and other parameters can be quantified in a non-invasive manner.

Image analysis is the process of extracting relevant information from the raw data obtained using sensors. When the objective is to assess morphological traits, the most useful sensor is a camera. There are different examples of setups using cameras, some of them being even able to quantify information in three dimensions (Bours R. *et al*, 2012; Nagel K.A. *et al*, 2012; Apelt F. *et al*, 2015), but the most simple way, especially if the plants analysed have a planar development like

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*Arabidopsis thaliana*, is to take two-dimensional pictures from above using a single camera ( Schmundt D. *et al*, 1998; Leister D. *et al*, 1999; Boyes D.C. *et al*, 2001; Granier C. *et al*, 2006; Arvidsson S. *et al*, 2011; Dhondt S. *et al*, 2014). Specific information is then extracted from the images using specialized image analysis software.

Growth in plants is a complex phenomenon, tightly controlled by developmental programs (Gonzalez N. *et al*, 2012) and strongly affected by environmental factors. From the environmental factors, light and mineral nutrients are probably two of the most important components that facilitate and regulate plant growth and development. Light, besides driving the photosynthesis and being the primary energy source that makes everything possible, acts as well as a signal, controlling gene expression, physiology and developmental programs (Carvalho S.D., Folta K.M., 2014). As a signal, light is perceived by the plants through a series of photoreceptors able to monitor the electromagnetic spectrum from 260 nm (UV-C) to ~730 nm (far-red) (Kami C. *et al*, 2010). Mineral nutrients, on the other hand, are powerful regulators of growth and development too, especially nitrogen which acts both as a nutrient and a signal for plant growth (Crawford N.M., 1995; Scheible W.-R. *et al*, 2004; Rubin G. *et al*, 2009).

In this background, our research was focused on developing a methodology robust enough to help us quantify some effects of light quality and nitrogen availability on mature plant phenotypes and shoot architecture.

## MATERIAL AND METHOD

### Plant material and the experimental setup

*Arabidopsis thaliana* ecotype Landsberg erecta (Ler) seeds, obtained from The Nottingham Arabidopsis Stock Centre (NASC), were used. Seeds were washed very well in an Eppendorf tube and left for 3 days with a drop of bidistilled water at 4°C for imbibition and stratification. Using a toothpick, seeds that looked bigger and most viable were placed on some seedholders (one seed per seedholder). Seedholders were made from Eppendorf tube caps with a 2.5 mm hole drilled on top, and filled with a solidified nutrient solution (1/16 Murashige and Skoog (1962) medium + 0.9 % agar (w/v)) providing support for the seeds and nutrition for the plants in the first few days of development (*figure 1 A*). The seedholders were placed in a hydroponic setup (*figure 1 B*) filled with ~500 ml nutrient solution. There were 4 hydroponic setups in total, representing 4 experimental variants, each variant containing 21 plants.

In the first day seeds were sown, placed in the hydroponic system and covered with cling film to maintain moisture for germination. In the fourth and fifth day after sowing (4 & 5 DAS) all roots of the germinated plants were gently fixed in the agar using the tip of a toothpick. At 6 DAS the cling film was perforated, starting the acclimation of the plants to growth room humidity. At 7 DAS the cling film was removed completely and the nutrient solution was replaced with fresh one in all four setups. At 8 DAS measurements for the phenotype begun and lasted until 15 DAS. At 11 DAS the nutrient solution was refreshed again.

Throughout the entire process the experimental variants were placed in custom made light boxes able to provide specific illumination conditions using light emitting diodes (LEDs) (OSRAM Golden Dragon, Osram Opto-Semiconductors GmbH, Germany). The light boxes were made from extruded polystyrene covered with aluminium foil for uniform illumination.

### Growth conditions and experimental variation of light and nitrogen content

The experiment took place in a growth room at 24°C and 60% humidity. The photoperiod was set at 16 h light with 8 h dark, simulating long day conditions.

After sowing, all four experimental variants were placed under light. Two variants (V1 and V2) were placed under blue light (455 nm) and the other two variants (V3 and V4) were placed under red light (660 nm). The irradiance was set at 130 $\mu moli \cdot m^{-2} \cdot s^{-1}$ for all experimental variants.

Regarding the nutrient solution, all four variants were supplied with ¼ strength Murashige and Skoog (MS) medium until 11 DAS. At 11 DAS two experimental variants (V2 and V4) received ¼ strength MS medium as usual and the other two variants (V1 grown in blue light and V3 grown in red light) received modified ¼ strength MS medium (Nitrogen was decreased from 15 mM to 0.5 mM diluting both $NH_4NO_3$ and $KNO_3$ solutions 30 times; KCl was added to compensate for the lower potassium ions concentration).

### Phenotype analysis

To analyse the phenotype was used a non-invasive technique based on imaging and image analysis. A commercially available imaging and image analysis system (Scanalyzer PL, LemnaTec, Wuerselen, Germany, http://www.lemnatec.com) was employed for data collection. The software setup for the phenotyping system was similar to that previously described by Arvidsson S. *et al* (2011).

The measurements started at 8 DAS and lasted for 8 days. The plants were measured once a day at ~2 hours (+/- 15 minutes) after lights turned on. From 21 plants per experimental variant, only 15 plants were taken into account, the rest being discarded as outliers (due to poor germination or improper growth).

The analysed parameters are grouped in two categories: one category that quantifies aspects of growth (projected rosette area (PRA), absolute growth rate (AGR), and relative growth rate (RGR)) and one category that quantifies aspects of morphology (Compactness and Stockiness). Vanhaeren H. *et al* (2015) offer a detailed description of the parameters and how they are calculated.

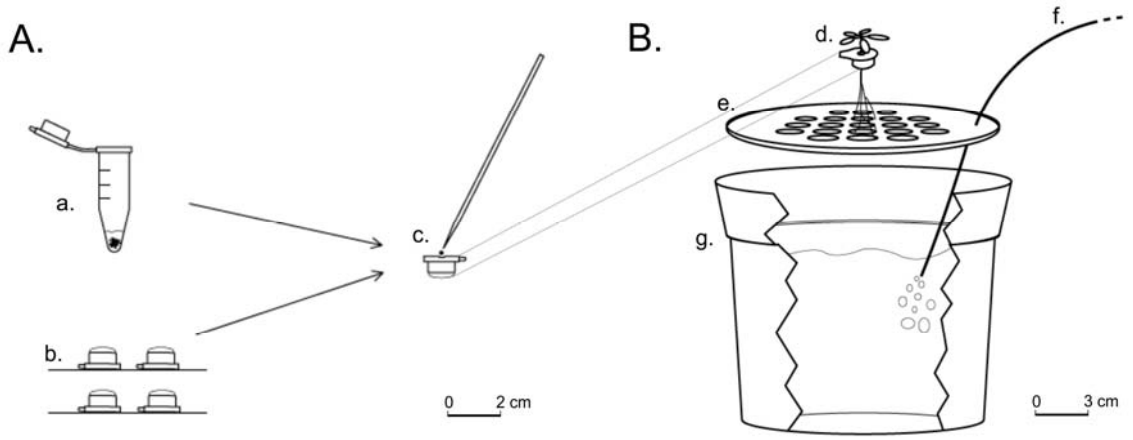


Figure 1 **The graphical representation of sowing Arabidopsis seeds (A) and the hydroponic system in which seedholders are placed (B). The elements present in the figure are: a – Eppendorf tube with seeds, b – perforated Eppendorf caps filled with agar, c – placing the seed using a toothpick, d – perforated Eppendorf cap with plant, e – support for the Eppendorf caps, f – aeration tube, g – container holding the nutrient solution.**

## RESULTS AND DISCUSSIONS

### The experimental setup

The Landsberg erecta ecotype germinated fast (after day one signs of germination could be seen) and uniform. The process of prior stratification and picking the seeds that looked bigger and most viable really helped with uniform germination and even growth.

We found out that placing just one seed per seedholder, instead of placing a couple and trimming them later, is a better choice because avoids tangling of the seedlings and results in less manipulation of the plants in the early stages when they are small and sensitive. However, some gentle manipulation is required at the fourth and fifth day after sowing in order to fix the plants firmly in agar and to give direction to roots that tend to grow on the surface of the agar. The seedholders made from perforated Eppendorf tube caps are an excellent choice because they can hold enough agar to confer plants stability and nutrition in the first stages of development, being as well really easy to move plants around. For example, Conn S.J. *et al* (2013) described a procedure in which seeds were germinated on Eppendorf caps in bulk and then moved to some other hydroponic setup. The seedholders and all the elements that come in contact with the growth medium should be of black or dark colour as stated by Conn S.J. *et al* (2013), in order to limit illumination of the solution and avoid algae growth. Blue light caused algal development where agar or liquid was in contact with it.

Using the 16 h light – 8 h dark photoperiod speeds up the life cycle of Arabidopsis plants (Karlsson B.H. *et al*, 1993; Martinez-Zapater J.M. *et al*, 1994), resulting in shorter and more stable experiments. Plants were analysed until first evidences of bolting started to show up and this happened around 15 DAS. Dhondt S. *et al* (2014) who used the same photoperiod observed bolting appearing around 19 DAS, but they used a different ecotype (Columbia-0) and some growing conditions were as well different (21°C temperature and 60 $\mu moli \cdot m^{-2} \cdot s^{-1}$ irradiance). During the analysed vegetative period, plants developed only six leaves which is very good for top imaging because reduced leaf superposition, giving more accurate results.

Even though other researchers (Dhondt S. *et al*, 2014) reported using a concentration of ½ strength Murashige and Skoog medium, we found it to be too concentrated for normal plant growth and used instead ¼ strength. In order to achieve deprivation, the nitrogen concentration for the modified MS medium was similar with that reported by Martin T. *et al* (2002).

### Light quality and nitrogen availability effects on phenotype

The variants grown in red light resulted in a larger projected rosette area than those grown in blue light for the most part of the experiment

(*figure 2* a). Only in the last two days of the measurements, second experimental variant (V2) increased its projected rosette area becoming the largest at the end of the experiment. The absolute growth rate graph points as well to a difference in growth between experimental variants grown in blue light and those grown in red light (*figure 2 b*). The difference in growth between red and blue started to be visible only after day 8, which is a good indication that 8 DAS is a convenient time to start the measurements.

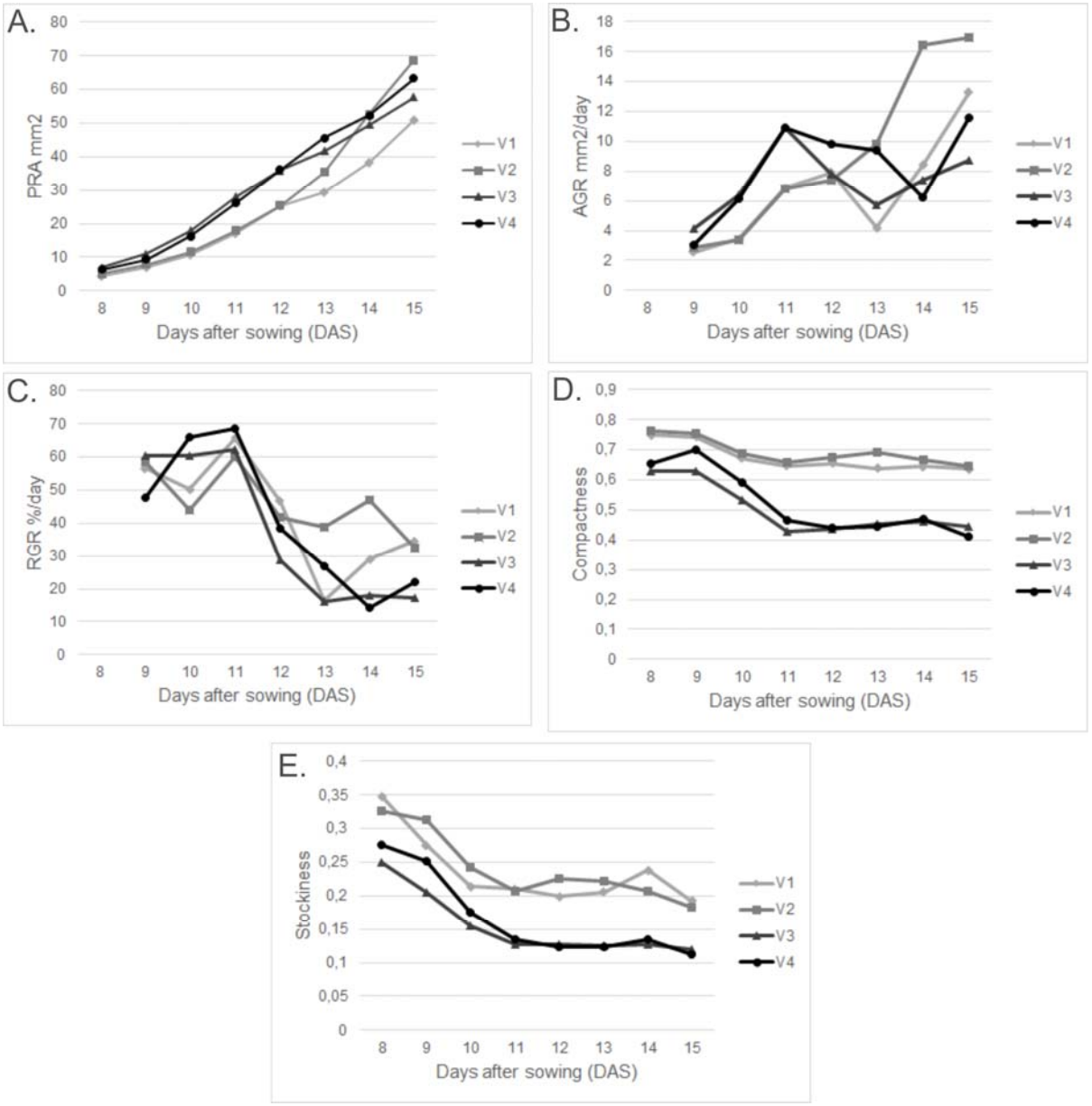


Figure 2 **Graphical representation of phenotype parameters: a – Projected rosette area (PRA), b – Absolute growth rate (AGR), c – Relative growth rate (RGR), d – Compactness, e – Stockiness.**

After day 11 when the nutrient solution is refreshed, growth is slowed down in all experimental variants, this aspect being more visible on relative growth rate graph (*figure 2 c*). The variants which received low nitrogen nutrient solution (V1 and V3), however, exhibited more reduction in growth. An interesting thing is that variants from blue light (V1 and V2) showed less decrease in growth than variants grown in red light (V3 and V4) (*figure 2 b, 2 c*), pointing to the hypothesis that light as a signal can influence how plants react and assimilate mineral nutrients. Plants grown in red light, even though achieve higher projected rosette area, are more sensitive to nitrogen deprivation than plants grown in blue light. Probably this is the explanation to why plant from variant V2 were less affected post 11 DAS

and summed the highest projected rosette area at the end of the experiment.

The morphological parameters (compactness and stockiness) registered a decrease in the first few days of the measurements and became stable afterwards (*figure 2 d, 2 e*). This is normal and it is something encountered by other researchers too (Dhondt S. *et al*, 2014). The difference appears between variants grown in blue light and those grown in red light. Red light promotes larger rosette area but smaller compactness and stockiness than blue light. Interesting to mention is that compactness and stockiness between plants grown in red and blue light, presented already a differentiation at the start of the measurements (8 DAS) (*figure 2 d, 2 e*). This represents another evidence that light starts to influence plant architecture early on. Nitrogen availability does not seem to have an effect on plant compactness or stockiness.

## CONCLUSIONS

The experimental setup is robust and precise enough to produce good quality data and to allow the identification of both obvious and not so obvious effects of environmental factors on plant phenotype. In the growth conditions used for this experiment, eight days after sowing is a good time to start the measurements for the growth parameters, but for the morphological parameters might be better to start earlier.

Plants grown in red light tend to have a larger surface area, but appear to be more sensitive to fluctuations of nutrient concentration than plants grown in blue light. However, this requires further investigations. In contrast with nitrogen availability, light spectrum appears to be the only factor that influences compactness and stockiness. Plants grown in red light have higher values of both compactness and stockiness.

## ACKNOWLEGMENTS

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# INFLUENCE OF ECOLOGICAL FOLIAR FERTILIZERS ON YIELD AND MORPHOMETRIC PARAMETERS IN CULTIVATED MEDICINAL AND AROMATIC PLANTS (BASIL, MARIGOLD, ARTICHOKE)

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**Abstract**

The significance of cultivating aromatic and medicinal plants in ecological settings derives also from the fact that the usage of such species implies direct contact with humans, through consumption or otherwise. Enhanced knowledge of herbs and spices and their ecological cropping is required for a better exploitation of their outstanding properties and which are based on biologically active substances such as alkaloids, phenolic compounds or essential oils.
This paper includes the results of the research conducted within UASVM Iasi, Faculty of Agronomy, focused on the influence of ecological foliar fertilizers (Fylo®, Geolino Plants&Flowers®, Cropmax®, Fitokondi®) on the yield and morphological indices on medicinal and aromatic plants: basil, marigold and artichoke.
Our results showed positive effects of ecological foliar fertilizers on the investigated plant species, especially on the yield of fresh herbs.

**Key words:** *Ocimum basilicum* L., *Calendula officinalis* L., *Cynara scolymus* L., *Phytotherapy*, *Ecological foliar fertilization*

The alimentary role of vegetables has seen constant interest, but the therapeutic uses knew both ascending and descending periods. However, in the last decades, plants are increasingly used as medicinal agents and considered as a safer and friendlier alternative to synthetic products (Farnsworth R.N., Soejarto D.D., 1991). Synthesizing a plethora of bioactive compounds, largely grouped as alkaloids, phenolic and volatile oils (Harborne J.B. *et al*, 1999; Rai M., Chikindas M., 2011), plants are regarded as preventive and curative agents, when used raw or cooked in alimentation, as extracts of various kinds or in purified forms as commercial products. Plants offer stimulation or regulation of various physiological functions, effect anti-inflammatory, antimicrobial, antioxidative activities or bring essential nutrients and elements in the human nutrition (Grusak M.A., Penna D. D., 1999).

Considering the importance held by plants for humans, the constant increases in population numbers has been accompanied by corresponding increases in plant cultivated plant areas. This also led to the use of fertilizers, insecticides, herbicides and fungicides, growth stimulators etc. to sustain production. However, synthetic agents usage in agriculture brought awareness about effects of these substances on the environment and humans, such as eutrophication, resistance, toxicity (Rembiałkowska E., 2007; Brown C.R., Brown T.R., 2014).

As such, alternatives are needed, to allow sustainable and ecological production. Many solutions have been proposed, which range from manual weeding, intercropping, mulching to the use of organic fertilizers or growth stimulators and biocontrol of pests. As a whole, the use of such techniques is intended to reduce the amounts of synthetic products in agricultural practices while providing high yields and quality.

Among cultivated plants, major categories are alimentary species and medicinal ones, with significant overlapping for many cases. Medicinal plants can be found in practically any family, with particular species being adapted to certain climatic conditions. In Romania, medicinal plants cultivation has a long tradition, some species being endemic for the territory. An established place in

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cultivation of such species is held by taxa such as *Calendula*, *Ocimum*, *Cynara*, which are grown for their therapeutic properties as well as for a culinary value (Robu T., Milică C., 2004; Păun E. *et al,* 1988; Honermeier B. et al, 2013).

Similar to global trends, medicinal plants cultivation in our country is expanding, however the agriculture has to meet global standards, which mainly relate to environmental friendly and sustainable practices. Therefore, research is needed to improve cultivation techniques by characterization of effects of organic, natural products which complement or replace synthetic variants which are used for fertilization to achieve higher yield and thus, to optimize terrain usage.

The aim of the current paper is to summarize some published results of research conducted at UASVM Iasi, regarding the influence of foliar ecological fertilizers on the yield and morphological parameters of basil, marigold and artichoke, with comparative approach.

## MATERIAL AND METHOD

Plant material consisted of seeds of studied species which were obtained from different sources: the Botanical Garden – Chisinau, Republic Moldova (*Ocimum basilicum* L. cv ”Cretisor”), the Ecological Farmer BioFarmland, Arad, Romania (*Calendula officinalis* L. cv. Orangefarbige) the collection of medicinal plants of University of Agricultural Sciences and Veterinary Medicine Iaşi, (UASVM) (*Cynara scolymus)*. The experiment was located on the research field of the UASVM and stablished on April 16, 2015 (for *Cynara scolymus* L.), on 8th of May, 2015 (for *Calendula officinalis* L.) and on 12 June, 2015 (for *Ocimum basilicum* L.).

The latin square method was used for the cultivation of plants, in a complete randomized design with 3 replications.

The experimental field is located at 47°15’ N and 27°30’ E with the pedochemical parameters as follows: loamy chernozem, with medium granulation, higroscopicity index between 7.01 and 8.29 and a C/N ratio < 15 in the upper horizon, organic matter 3-4.1%, N 0.17-1.94 %, available P 38 ppm, available K 143-181 ppm, pH 7-7.3.The climatic conditions for 2015 were: 19.2°C mean temperature, 55.8% relative humidity and 180.6 mm precipitations as recorded by the local weather station.

Four different ecological foliar fertilizers were used: Fylo®, Geolino Plants&Flowers®, Cropmax®, Fitokondi®. 1) FYLO is a liquid fertilizer based on biological extracts that is free of pesticides and phyto-hormones. The physico-chemical parameters are: 32.33% N, 1.28% P ($P_2O_5$), 1.04% K, pH 4.37 Geolife (2004). 2) GEOLINO is also made from vegetal extracts. The physico-chemical parameters are: 18.72% N, 0.64% P ($P_2 O_5$), 7.2 K, pH 4.94 Geolife (2004). 3) Crompax is a foliar fertilizer with the following physico-chemical parameters: 0.2% N, 0.4% P, 0.02% K, hollandfarming.ro (2015). 4) Fitokondi is an aqueous solution prepared from medicinal plants, bio-humus, vegetal and essential oils. It has a brown color, specific odor, with a density close to the one of the water. The physico-chemical parameters are: 0.02% N; 0.01% $P_2O_5$, 0.26% $K_2O$, pH 4.5, fitokondi.ro (2015).

The fertilization was performed twice, at the beginning of the vegetative stage and before the bloom (basil, marigold) or 3 times (artichoke), at the beginning of the vegetative stage, during the vegetative stage and at the beginning of blooming.

Plants were harvested in technological maturity between 10.00-15.00 h when the plants have the highest content of the biologic active principals.

The investigated morphological parameters were: plant height, leaf width and length, number of nodes, number of flowers, fresh leaf mass, dry substance and water content (%), fresh and dry yields, loss on drying, for different plants per repetition per treatment.

## RESULTS AND DISSCUSIONS

### *Ocimum basilicum* L.

The ecological fertilizer treatment (Fitokondi) positively influenced the crop of *Ocimum basilicum* L., causing significant increases of the investigated parameters. Plant height, was increased by approximately 11 cm compared to control ones. The number of lateral stems and the fresh mass (106 g) of fertilised plants increased with more than 100% compared to the control plants (48g) (Onofrei *et al*., 2016).

Similar studies support our finding concluding that basil plants that were organically fertilized were more productive than the conventional ones (Berbeć et al., 2003; Succop et al, 2004; Taie et al, 2010). Such bio-fertilizers can be recommended to increase agro productivity of *Ocimum Basilicum* L. and the results from this study recommend further analyses regarding productivity parameters and volatile oil content yield under ecological fertilization of basil.

### *Calendula officinalis* L.

Calendula is an important medicinal plant with antiphlogistic, choleretic, antibacterial, antimicrobial, antidermatitic, antimutagenic and anticancer effects. Therapeutic properties are determined by a diverse range of biologically active substances they contain (carotenoids, triterpenoids, flavonoids, glycosides, volatile oil,

coumarins, mucilages, vitamin C, cholesterol esters.

The highest flower yield was recorder for all treatments, at the end of July and at the end of August. The highest average yield was obtained in Fylo treatment (249.2 kg/ha) followed by Cropmax (227.1 kg/ha), Fitokondi (213.7 kg/ha) and Geolino (200.8 kg/ha) treatments, all fertilizers increasing yield compared to control plants (188.6 kg/ha) (Onofrei *et al*., 2016).

Our results are similar to other research, (Rafie et al. 2013), foliar application of Humiforte 1.5 l/ha caused an increase of flower dry weight with 36.92%. Foliar fertilizers treatments influenced the culture of *Calendula officinalis* L. in the first year of cultivation. These partial results are the starting point for future analysis and experiments regarding quality and yield of marigold. Such foliar fertilizers can be recommended for ecological cultivation of marigold as a medicinal plant with important therapeutic properties.

### *Cynara scolymus* L.

The artichoke is an important medicinal and culinary herb containing many active principles: quinic acid, cryptochlorogenic acid, cynarin, cynaroside, scolymoside, tannins, triterpenoids, sterols, saccharydes, mucilage, pectins (Bruneton, 1993; Schipor, 2001; Robu *et al*, 2004; Neagu, 2009; Stănescu *et al*, 2014).

The morphological traits represented by plant height, leaf width and length, revealed a minor influence of the applied fertilizers on *Cynara scolymus* L. plants comparing to the control plants. Regarding the number of nodes, all plants of artichoke from all fertilization treatments recorded similar values, between 4 and 5 nodes per plant. Regarding the number of inflorescences and the mass of leaves, some treatments recorded higher values, Cropmax (1.6 flowers/plant, 161 g/leaf) and Fitokondi (4.1 flowers/plant and 175 g/leaf) while plants from Fylo and Geolino treatments had similar values compared to control ones, but without a statistical significance. The fresh and dry yields of artichoke were not statistically influenced by the foliar fertilizers. Cropmax, caused a small increase in fresh yield (19962 kg/ha) compared to control (19935 kg/ha). Regarding the dry mass, Fitokondi treated plants had the highest values and the best loss on drying while Geolino treated plants had the highest water content. In our experiment, artichoke plants treated with some foliar fertilizers (Fylo and Fitokondi) recorded higher values for dry matter and loss on drying compared to the control plants. This findings can be important from an economic point of view (Onofrei *et al*, 2016).

Other foliar fertilizers, such as ones based on salicylic acid, when applied on artichoke, lead to an increase in dry substances amounts (Hosseinzadeh et al. 2013) as we found for Fitokondi fertilizer. Foliar fertilization can lead to improvement of yield as found for artichoke (Ierna et al. 2006, Fateh et al. 2009, Ierna et al. 2013).

## CONCLUSIONS

These partial results are the starting point for future analysis and experiments regarding quality and yield of medicinal plants. Such foliar fertilizers can be recommended for ecological cultivation of artichoke, basil and marigold as a medicinal plants, with important therapeutic properties.

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# THE INFLUENCE OF SOME TREATMENTS WITH DIFFERENT PRODUCTS OF PHYTOSANITARY USAGE (FUNGICIDES) ON THE ATTACK OF SOME FUNGI AND ON THE BARLEY PRODUCTION IN THE 2016 PEDOCLIMATIC CONDITIONS OF THE EASTERN BARAGAN

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**Abstract**

The barley is under attacked of many pathogenic agents during the vegetation period. Out of these pathogenic agents, the *Pyrenophora graminea* fungus had been producing barley's leaf stripe disease in the Eastern Baragan area, in 2016 (Velichi E. 2012). An experiment was created in the year 2016, using 4 products of phytosanitary usage, as follows: ACANTO PLUS (picoxistrobin + cyproconazole), MYSTIC 250 EC (tebuconazole); BUMPER 250 EC (propiconazole) and TOPSIN 500 SC (tiophanate-methyl) (Pest – Expert). This experiment consisted in 7 variants (6 variants with phytosanitary treatments in different combinations of products, plus a control sample not treated). The experiment was placed in randomised blocks. The 7 variants were placed in 6 repetitions. Out of the pathogenic agents monitored, the biggest attacks had been produced by *Pyrenphora graminea* fungus which produces leaf stripe at barley. For this, there had been analysed the first two leaves under the spike. The observations had shown that for all 6 variants of treatment, the attack degree (GA %) of the disease (barley's leaf stripe) was more reduced than at the control sample not treated. The productions of the variants treated (V1 … V6) had been higher than the production of the control sample not treated, V7. The productions of some variants of treatment had been significantly higher than the production of the control sample not treated (statistic insurance DL 5%). In what concerns the economic efficiency, the fungicide product MYSTIC 250 EC 0.5l/ha had proven to be the most efficient in what price was concerned.

**Key words**: *Pyrenophora* spp., tebuconazole, phytosanitary, randomised blocks

*Hordeum vulgare* barley is under attack of many pathogenic agents, such as: mildew - *Blumeria graminis* f.sp. *hordei*, leaf stripe - *Pyrenophora graminea*, leaf blotch - *Rhynchosporium secalis*, rust - *Puccinia hordei* (Iacob Viorica, Hatman, M., Ulea, E., Puiu, I. 1998). The first half of the year 2016 was difficult for barley, in what concerns the climatic conditions. Abundant rains and low temperatures had been registered in this period, which had created favourable conditions for the attack of some pathogenic agents. Here we mention especially *Pyrenophora graminea* fungus which produces at barley the disease called leaf stripe. This pathogenic agent attacks the barley crops each year, at high attack intensities. The other pathogenic agents mentioned had proven to be less dangerous for the barley crop.

## MATERIAL AND METHOD

For performing the observations, it was conceived an experiment with 7 study variants. This experiment comprised 6 variants of phytosanitary treatment (fungicide products, their combinations, number of treatments) and a control sample not treated. The variants of the experiment were the following (tab.1):

- V1 - ACANTO PLUS 0.5 L/HA 1 treatment applied at spike's release (25.04.2016),
- V2 - ACANTO PLUS 0.5 L/HA 1 treatment applied at bellows phase (13.04.2016) + 1 treatment applied at the beginning of beans' filling (06.05.2016),
- V3 - MYSTIC 250 EC 0.5 L/HA 1 treatment applied at spike's release (25.04.2016),
- V4 - MYSTIC 250 EC 0.5 L/HA 1 treatment applied at bellows phase (13.04 2016)+1 treatment applied at the beginning of beans' filling (06.05.2016),
- V5 - [BUMPER 250 CE 0.25 L/HA + TOPSIN 500 SC 0.5 L/HA] 1 treatment applied at spike's release (25. 04.2016),
- V6 - BUMPER 250 CE. 0.25 L/HA + TOPSIN 500 SC 0.5 L/HA] 1 treatment applied at bellows phase (13.04 2016) + 1 treatment applied at the beginning of beans' filling (06.05.2016),
- V7 – Control sample not treated.

The experiment was placed in randomised blocks. These 7 variants were placed in 6

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repetitions. Each experimental parcel had an area of 14 $m^2$ (7 x 2m). The total number of experimental parcels was of 42. The area of an experimental variant was of 14 $m^2$ x 6 repetitions = 84 $m^2$. The total area of the experiment was of 84 $m^2$ x 6 = 504 $m^2$. The treatments were executed manually, with a machine of "vermorel" type. "Trend" adjuvant product was added in the irrigation solution, in concentration of 0.03%. Weeds control was done with the help of Mustang herbicide, in a dosage of 0.5 l/ha. The experiment had as purpose establishing the efficiency of the mentioned phytosanitary products, reported to their price, as well as the efficiency and respectively the lucrativeness of applying one or two phytosanitary treatments during the barley's vegetation period.

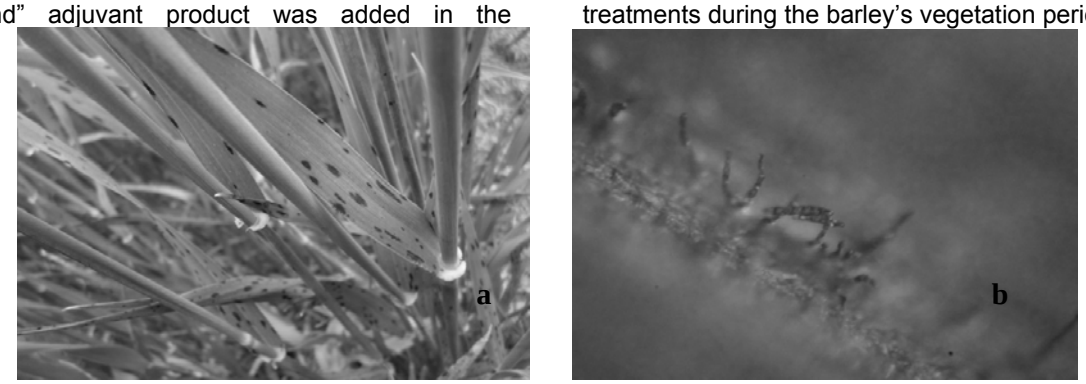


Figure 1 **Barley leaf stripe *Pyrenophora graminea*** **a – attack on leaves, b – conidia (original)**

Figure 2 **Aspects from the experiment field in the blooming phase (original)**

Figure 3: **Aspects from the experiment field in the full maturity phase (original)**

Table 1

**The results of the experiment with fungicide products (6 variants of treatment + control sample not treated) in what concerns the attack (G.A. %) of *Pyrenophora graminea* fungus at barley ("flag" leaf and the next leaf). The observations were performed on the date of May 15th, 2016**

| Variant | "flag" leaf | | | The second flag | | |
|---|---|---|---|---|---|---|
| | G.A% | Dif. against the control sample | Significance | G.A% | Dif. against the control sample | Significance |
| **-V1** - ACANTO PLUS 0.5 L/HA 1 treatment applied at spike's release | 24.06 | 34.27 | *** | 74.5 | 20.91 | *** |
| -**V2** - ACANTO PLUS 0.5 L/HA 1 treatment applied at bellows phase + 1 treatment applied at the beginning of beans' filling | 6.21 | 52.12 | *** | 41.83 | 53.58 | *** |
| - **V3** - MYSTIC 250 EC 0.5 L/HA 1 treatment applied at spike's release | 27.9 | 30.43 | *** | 72.92 | 22.49 | *** |
| -**V4** -MYSTIC 250 EC 0.5 L/HA 1 treatment applied at bellows phase +1 treatment applied at the beginning of beans' filling | 13.93 | 44.40 | *** | 37.03 | 58.38 | *** |
| **-V5** - [BUMPER 250 CE 0.25 L/HA+TOPSIN 500 SC 0.5 L/HA] 1 treatment applied at spike's release | 32.15 | 26.18 | *** | 87.08 | 8.33 | *** |
| **-V6** - BUMPER 250 CE. 0.25 L/HA+TOPSIN 500 SC 0.5 L/HA] 1 treatment applied at bellows phase +1 treatment applied at the beginning of beans' filling | 23.85 | 34.48 | *** | 78.33 | 17.08 | *** |
| **-V7** – Control sample not treated | 58.33 | - | - | 95.41 | - | - |

DL G.A. % for the "flag" leaf
DL 5% = 3.35%
DL 1% = 4.54%
DL 0.1% = 5.98%

DL G.A. % for the second leaf:
DL 5% = 4.08%
DL 1% = 5.54%
DL 0.1% = 7.30%

Table 2

**The results of the experiment with fungicide products (6 variants of treatment + control sample not treated) in what concerns the production (t/ha) obtained at the variants treated as compared to the control sample not treated**

| Variant | Prod. (t/ha) | Difference against the control sample | Significance |
|---|---|---|---|
| V1-ACANTO PLUS 0.5 L/HA 1 treatment applied at spike's release | 5.62 | 1.50 | - |
| V2-ACANTO PLUS 0.5 L/HA 1 treatment applied at bellows phase +1 treatment applied at the beginning of beans' filling | 6.52 | 2.40 | * |
| V3-MYSTIC 250 EC 0.5 L/HA 1 treatment applied at spike's release | 5.80 | 1.68 | - |
| V4-MYSTIC 250 EC 0.5 L/HA 1 treatment applied at bellows phase +1 treatment applied at the beginning of beans' filling | 6.05 | 1.93 | * |
| V5-[BUMPER 250 CE 0.25 L/HA+TOPSIN 500 SC 0,5 L/HA] 1 treatment applied at spike's release | 6.05 | 1.73 | - |
| V6-BUMPER 250 CE. 0.25 L/HA+TOPSIN 500 SC 0,5 L/HA] 1 treatment applied at bellows phase +1 treatment applied at the beginning of beans' filling | 5.85 | 1.93 | * |
| V7 (Mt nt.) - Control sample not treated | 4.12 | - | - |

DL 5% = 1.83 t/ha
DL 1% = 2.50 t/ha
DL 0.1% = 3.41t/ha

The evaluation of the attack's frequency (F%), of the intensity of the attack (I%) and respectively, of the attack degree (G.A.%) was done separately, on each and every experimental parcel, analysing 10 plants/experimental parcel. To them it was assessed the degree of affectation (the

intensity of the attack I %) of the last 2 leaves, especially of the "flag" leaf, which has the biggest contribution to the production of a spike at cereals. The phytosanitary analyses of the plants samples were done with the help of the stereomicroscope and of the optic microscope at Brăila Phytosanitary Office's laboratory – Phytosanitary National Authority. These analyses had revealed the presence of *Pyrenophora graminea* fungus in the samples analysed, which produces the barley's leaf stripe.

In order to assess the production of each variant under study, there had been analysed beans samples from each experimental parcel, 4 samples / parcel, on percentage sampling basis. The demarcation of each sample was performed with a metric frame with the area of 0.25 $m^2$ (0.5/0.5m). The average of the experimental parcel had served for calculating the production of each and every experimental parcel. The statistic interpretation had been done with the help of the limit differences (DL %) (Săulescu N).

The variety used was Nectaria, a French barley variety for beer produced by Secobra Company. The variety is considered very valuable by the producers from this area. The caryopses produce quality malt and have a moderate content of proteins **(***Secobra Recherches* Centre de Bois – Henry, 2002).

Assessing the attack of a damaging agent can be done with the help of values (Prognosis and Warning Methods, 1980):

- Attack frequency (F %);
- Attack intensity (I %);
- Attack degree (G.A %).

- Attack frequency represents the relative value of the number of plants or organs of the plant under attack (n) reported to the number of plants or organs observed (N). The value of the frequency is established through direct observations on a number of plants or organs, according to the case and to the conditions, existing different methods of collecting the samples and of performing the observations. In the case of our observations regarding the foliar diseases, there had been taken into consideration the number of organs of plants attacked from the total of organs of plants observed (leaves), establishing thus the frequency of the attack expressed in percentages %. In case of blights, it had been used the number of spikes attacked, reported to the total number of spikes observed. The frequency was calculated with the help of the formula F%= nx100/N.
- Attack intensity represents the degree or percentage in which a plant or an organ of the plant is attacked and how much from the area of the plant or of the organ analysed (leaf, fruit) is covered by the disease under study.

The assessment of the area attacked had been done with the naked eye or with the magnifying glass, assessing the percentage occupied by spots or burns caused by the pathogenic agent. There can be recorded the damage percentage or grades can be awarded for each plant or organ attacked by the disease or/and by the pest. Grades usage can ease up greatly data summarizing. It can be used a scale with 6 degrees of intensity, as follows:

- Grade 0 no attack
- Grade 1 attack 1 – 3%
- Grade 2 attack 3 – 10%
- Grade 3 attack 11 – 25%
- Grade 4 attack 26 – 50%
- Grade 5 attack 51 – 75%
- Grade 6 attack 76 – 100%

After summarizing the data, the attack intensity had been determined with the following formula:

$$I\% = \frac{\Sigma (i \times f)}{n}$$

Where:

I% - Attack intensity (in %);

i – The intensity according to the grade awarded to the organ or plant attacked;

f – The number of cases (plants, organs) attacked;

n – The number of plants attacked.

In the case of our experiment, grades from 1 to 6 had been awarded, separately, to "flag" leaf and to the next leaf situated below it.

- The attack degree is the expression of the extension of the gravity of the attack on the crop or on the total number of plants for which we are making the observations. The value expression of GA is given by the relation:

$$G.A\ (\%). = \frac{F \times I}{100}$$

In most of the cases, there is a negative correlation between the attack degree of a pathogenic agent or pest and the quantitative and/or qualitative level of the production of a crop.

## RESULTS AND DISCUSSIONS

The agricultural year 2015 – 2016 was a very difficult year for barley crop from the point of view of the attacks of the pathogenic agents specific to barley. It must be underlined the very important fact that the barley (*Hordeum vulgare*) is a species more sensible to the attack of the diseases than wheat. However, it compensates through earliness and implicitly, through a passive resistance to drought, offering productions more certain than in the case of the wheat in the years with deficit from the precipitations point of view.

In what concerns the dynamic of the occurrence of the pathogenic attacks at barley, we mention the following aspects:

- *Rhyncosporium secalis* had not significantly affected the barley in the autumn of 2015 (G.A. < 1%).
- *Blumeria* (*Erysiphe graminis*) had also affected it, but without creating problems (G.A. 1 – 1.5%).
- *Pyrenophora graminea* had affected the barley, being necessary to apply phytosanitary treatments. The attack degree (G.A. %) was of 58.33% at variant V7 - untreated control sample, on the date of May 15th, 2016. It must be underlined the fact that this pathogen had proven to be the most dangerous pathogenic agent of barley's, like in the previous years.
- There had not been observed attacks of the blights specific to barley (*Ustilago nuda* and *Ustilago hordei*).
- Barley's rust (*Puccinia hordei*) had not significantly affected the barley (G.A. < 1.5%).

If we analyse the data from table 1, we observe that the attack degree of the fungus *Pyrenophora graminea* was differentiated as follows:

- V1 - ACANTO PLUS 0.5 L/HA 1 treatment applied at spike's release (25.04.2016) had determined an attack degree of the fungus *Pyrenophora graminis* of 24.06% at flag leaf and 74.5%, so less by 34.27% and respectively by 20.91% as against the control sample not treated (V7).
- V2 - ACANTO PLUS 0.5 L/HA 1 treatment applied at bellows phase + 1 treatment applied at the beginning of filling the beans had determined an attack degree of the fungus *Pyrenophora graminea* of 6.21% at flag leaf and of 41.83%, so less by 52.12% and respectively by 53.58% as against the control sample not treated (V7).
- V3 - MYSTIC 250 EC 0.5 L/HA 1 treatment applied at spike's release had determined an attack degree of the fungus *Pyrenophora graminea* of 27.9% at flag leaf and of 72.92%, so less by 30.43% and respectively by 22.49% as against the control sample not treated (V7).
- V4 - MYSTIC 250 EC 0.5 L/HA 1 treatment applied in bellows phase + 1 treatment applied at the beginning of spike's beans filling had determined an attack degree of the fungus *Pyrenophora graminis* of 13.93 % at flag leaf and of 37.03%, so less by 44.40% and respectively by 58.38% as against the control sample not treated (V7).
- V5 [BUMPER 250 CE 0.25 L/HA + TOPSIN 500 SC 0.5 L/HA] 1 treatment applied at spike's release had determined an attack degree of the fungus *Pyrenophora graminis* of 32.15 % at the flag leaf and of 87.08%, so less by 26.18% and respectively by 8.33% as against the control sample not treated (V7).
- V6 [BUMPER 250 CE. 0.25 L/HA + TOPSIN 500 SC 0.5 L/HA] 1 treatment applied in the bellows phase + 1 treatment applied at the beginning of beans' filling had determined an attack degree of the fungus *Pyrenophora graminis* of 23.85% at the flag leaf and of 78.33%, so less by 34.48% and respectively by 17.08% as against the control sample not treated (V7).
- V7 - Control sample not treated had been affected by *Pyrenophora graminis* at values of the attack degree (G.A. %) of 58.33% at the flag leaf and 95.41% at the second leaf.

From the analysis of Table 2, there can be observed the production differences as compared to the control sample not treated V7, as follows:

- Variant V2 - ACANTO PLUS 0.5 L/HA 1 treatment applied in bellows phase (13.04.2016) + 1 treatment applied at the beginning of beans filling (06.05.2016) had achieved the highest production gain of 2.4 t/ha, as compared to the control sample V7
- Variant V4 - MYSTIC 250 EC 0.5 L/HA 1 treatment applied in the bellows phase (13.04.2016) + 1 treatment applied at the beginning of beans filling (06.05.2016) had achieved a production gain of 1.93 t/ha.
- Variant V6 [BUMPER 250 CE. 0.25 L/HA + TOPSIN 500 SC 0.5 L/HA] 1 treatment applied in the bellows phase (13.04.2016) + 1 treatment applied at the beginning of beans filling (06.05.2016) had also achieved a production gain of 1.93 t/ha.
- The other variants: V1-ACANTO PLUS 0.5 L/HA 1 treatment applied at spike's release (25.04.2016); V3 - MYSTIC 250 EC 0.5 L/HA 1 treatment applied at spike's release (25.04.2016) and V5-[BUMPER 250 CE 0.25 L/HA + TOPSIN 500 SC 0.5 L/HA] 1 treatment applied at spike's release (25.04.2016) had achieved production gains, respectively of 1.5 t/ha, 1.68 t/ha and 1.73 t/ha, but not insured statistically.

## CONCLUSIONS

The observations performed in the spring of the year 2016 on the barley crop, in the pedoclimatic conditions of the Eastern Baragan had lead to the following conditions and recommendations:

1. The most dangerous pathogenic agent of barley had proven to be the *Pyrenophora graminea* fungus which produces the disease under the popular name of leaves "stripe". The

attack of this fungus had determined high production losses (1.93t/ha, 2.4t/ha) as compared to the control sample untreated.

2. There had been observed soft attacks of the fungus which attack the foliage, respectively barley's mildew - *Blumeria graminis* f.sp. *hordei*, leaf stripe - *Pyrenophora graminea*, barley's rust - *Puccinia hordei*, brown leaf blotch - *Rhynchosporium secalis*.
3. For a secure protection against the attack of the pathogenic agents specific to barley, it is recommended the application, in the difficult years (rainy and chilly), of 2 phytosanitary treatments with fungicides homologated products for barley from the triazoles group, such as: Acanto Plus (20% picoxistrobin + 8% cyproconazole) – 0.5 l/ha, Mystic (tebuconazole 250 g/l), Bumper (250 g/l propiconazole), Topsin 500 SC (500 g/l tiophanate-methyl) etc. The first treatment is recommended to be applied in the bellows phase and the second at the beginning of beans filling phase. One can choose also only one treatment in the difficult years, but the production gain is sensibly lower.
4. In the droughty years, unfavourable to the diseases attack, one single treatment can be applied at barley's blooming. In the conditions when in the year 2016 it is foreseen a price of 0.65 lei/kg for barley for beer, the gains of 2.4 t/ha and 1.93 obtained by the variants with two treatments is justified fully from economic point of view. For example, the price of a litre of Acanto Plus is around 350 lei and a litre of Mystic 250 EC is around 135 lei, in the condition when it is applied the treatment with 0.5 l/ha to both products. It seems that Mystic 250 EC product has proven to be more efficient from financial point of view than Acanto Plus, which costs higher than the double of Mystic 250 EC product. Bumper 250 EC product costs 176 – 180 lei/l. It is homologated 0.5 l/ha applied alone. Topsin 500 SC product costs 75 lei/l and is homologated 1.25 l/ha applied alone. The combination used in the experiment, of 0.25 l/ha Bumper 250 EC and 0.5 l/ha Topsin 500 SC, has proven to be quite efficient from economic point of view, but below the level of economic efficiency of Mystic 250 EC product. The latter has proven to be the most efficient from economic point of view.
5. Nectaria beer barley variety has proven to be quite resistant to the diseases specific to barley, achieving in conditions of 0 treatments with fungicides, a production relatively high of 4.12 t/ha, in the conditions the crop succeeded to the autumn rape.

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# ALTERNATIVE MODEL FOR DETERMINING THE STRUCTURE OF INVESTMENTS ACCORDING TO MARKET SITUATION - A CASE STUDY

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**Abstract**

The investment is one of the main vectors of growth economic performance to microeconomic and macroeconomic level. Their effectiveness is to determine the relationship between the economic effects they cause and the efforts required by this. At the same time, the investment opportunity is determined by their ability to be replaced external factors. The research methodology consisted in making a case study in a farm in the county of Vaslui. The results show that some investments in agriculture, although they can be considered effective, may be declared inopportune for the economic conditions.

**Key words**: investment opportunity, external factors, efficiency, agriculture

Strategy on investments resulting from the following factors: investment demand; Interest rate on home loans and the ratio of the rate of profitability; liability and risk taking by firms and financiers; the existence of aggregate supply fluids; Dynamic profits within existing investments and developments in the world economy (Adumitrăcesei I., 1997; Ungureanu G., 2009)

The efficiency of investments on its implications determines a drive companies, a growth and development of their volume of activity, promotion and use of modern technology efficient economic, energy and environmental, increase the supply of goods and services (Cocriş V. *et al*, 1995).

The main approach to economic efficiency implies the several phases: prioritization of investments, determining the volume of investment, establishment of investment financing sources; choosing the optimal investment (I. Stancu, 2004).

The calculations underlying the invetiţiilor, using indicators such as yield per shift; operating ratio probable; work productivity; direct cost savings per unit of product or work; the return on investment, etc. (Donosa D. *et al*, 1999; R. Voicu, 1999).

All these analyzes are based on determining the economic performance of investment at the microeconomic level determined based on their need technically to their effect on the use of other inputs.

On the other hand, economic circumstances in which they operate and economical analysis unit may significantly influence investment opportunities. An investment can be effective in terms of effects and economic efforts on the company's products but ineffective in relation to the possibilities offered by the economic environment (Barreto H., 2012; Manzoni E., 2011).

If the investment firm that brings higher costs to lease the same assets or acquisition of specialized services on the same activities they carry out investment, it proves to be inappropriate. Although the investment firm is efficient, effective would have been better renting the same assets or outsourcing of activities they perform.

This mode of analysis is derived from appreciation of investment opportunity costs that induce the need for valuation variant foregone compared to the version that will be adopted (J. Bouman, 1994; Ignat I. *et al*, 1998; Perloff JM, 2011; S. Rode, 2013).

Accordingly, this paper provides a functional model of assessment depending on volume and structure of investment opportunities offered by the economic environment. This does not exclude the need for other analysis tools but can be viewed as an investment strategies.

## MATERIAL AND METHOD

The analysis model used is based on the opportunity costs, which highlights the effect modification considered due to the change in the

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fixed assets. In other words, the model used fixed assets can be characterized by efficiency indicators determined as the ratio between the effect and effort. The effort takes the form of company ownership and use costs of fixed assets and the effects are expressed as savings to pay for services that would make it not holding company assets.

The model was applied to machines: Combines Claas 150 Domination, Domination combines Claas 96, Combine Class C 116 combines Claas Mega 208, Rippers Rippers Maschio Gaspardo Artiglio model Magnum, cultivator Lemken Karat 9/300 easily.

Case study was chosen the company S.C. Tivico Impex LLC, located in the village Sarateni Murgeni town, Vaslui county, a company organized in two sectors: agriculture and services.

## RESULTS AND DISCUSSIONS

In terms of harvested area under the farm examined, it can be observed *(table 1)* that the most productive combine this view is combine Claas C 116, this yielding one day an area of 47 hectares Pole opposite it is the least productive combine harvester Claas D 150 which only 15 hectares.

Regarding diesel consumption per hectare is the Combines Claas combines an efficient 96 D, with an average consumption of 6.73 l / ha and the highest consumption is achieved which combines Class D 150 per hectare harvested consume average 10.33 liters of fuel.

The lowest consumption is achieved by combining Claas D 150 with an average consumption of 155 l / day followed by combines Claas D 96 with a consumption of 148 l / day, Claas combine M208 with an average consumption of 210 l / day and the highest consumption of diesel per day is achieved by combining Claas C 116 with an average consumption of 325 liters / day, this being influenced by hectares harvested with a certain type of combining a day and fuel consumption per hectare achieved fiecrare combined basis.

Table 1

**Analysis of work rules and diesel consumption**

| Construction type | Surface (ha/ day) | Total (ha) | Diesel fuel consumption (l/ day) | Average consumption (l / ha) |
|---|---|---|---|---|
| **Combine D150** | 15 | 150 | 155 | 10.33 |
| **Combine D96** | 22 | 220 | 148 | 6.73 |
| **Combine C116** | 47 | 330 | 325 | 6.91 |
| **Combine M208** | 31 | 310 | 210 | 6.77 |
| **Scarifier** | 15 | 120 | 178 | 3.85 |
| **Grower** | 63 | 504 | 174 | 4.35 |

On labor efficiency in the equipment used, the research showed that operators who handle these machines are sometimes one for each machine individually with a salary / day of 18.2 euro for operators combine and 15.9 euro for other machines. Also on the table are specified and repair costs and which utialajului price and rental price thereof.

Table 2

**Analysis of wage costs, repairs and agricultural services**

| Construction type | Wages operator (euro / day) | Annual repair costs (euro) | Equipment Acquisition price (euro) | Price rent (euro / ha) |
|---|---|---|---|---|
| **Combine D150** | 18.2 | 380 | 80,000 | 45.5 |
| **Combine D96** | 18.2 | 360 | 15,000 | 45.5 |
| **Combine C116** | 18.2 | 400 | 20,000 | 45.5 |
| **Combine M208** | 18.2 | 425 | 35,000 | 45.5 |
| **Scarifier** | 15.9 | 60 | 7,000 | 25.0 |
| **Grower** | 15.9 | 98 | 2,500 | 13.6 |

Costs of outsourcing the four combine considered are *(table 2):* to combine Claaas D 150 are from 6,818 euro to combine Claas D 96 are 10,000 euro for Claas combine C 115 is 15,000 euro, and combines Claas M 208 are 14,091 euro. In terms of time of use of the equipment it is around 25 years for combines, 8 years and 20 years ripper for the grower.

Machinery depreciation was determined as the ratio between the price of equipment and during its use, so the four combine depreciation is 3,273 euro combine Claaas D 150,614 euro to combine Claas D 96,818 euro to combine Claas C 116 and of 1,432 euro for Claas combine M 208.

Expenses saved because the company has not paid agricultural services are 55,782 euro. These expenses were distributed machines combine D150 - 6,818 euro, combines D96 - Euro 10,000 Combine C116 - EUR 15,000 Combine M208 - 14,091 euro, Rippers - 3,000 euro and easy grower - 6,873 euro.

For this, it was necessary for the work with their own equipment, which is why he spent 1,762 euro material costs, amortization of 7,159 euro, 928 euro wage, 816 euro and 14,551 euro taxes and energy costs.

Table 3

**Cost Analysis (euro)**

| Tip utilaj | Externalisation costs | Material costs | Amortisation | Salaries | Annual taxes | Energy costs |
|---|---|---|---|---|---|---|
| **Combine D150** | 6,818 | 389 | 3,273 | 182 | 409 | 1,585 |
| **Combine D96** | 10,000 | 368 | 614 | 182 | 77 | 1,514 |
| **Combine C116** | 15,000 | 409 | 818 | 128 | 102 | 2,334 |
| **Combine M208** | 14,091 | 435 | 1,432 | 182 | 179 | 2,148 |
| **Scarifier** | 3,000 | 61 | 895 | 127 | 36 | 4,729 |
| **Grower** | 6,873 | 100 | 128 | 127 | 13 | 2,242 |

Analyzing the profitability indicators of the equipment, especially the 4 combine within the unit we can say that these indicators refer to their use project expenditures in the period under review. Thus in these project expenditures included material costs (consumables consisting of annual operation to combine effective remedy) and energy costs (fuel consumption) and annual taxes. Toal their value is 25,215.8 euro *(table 3).*

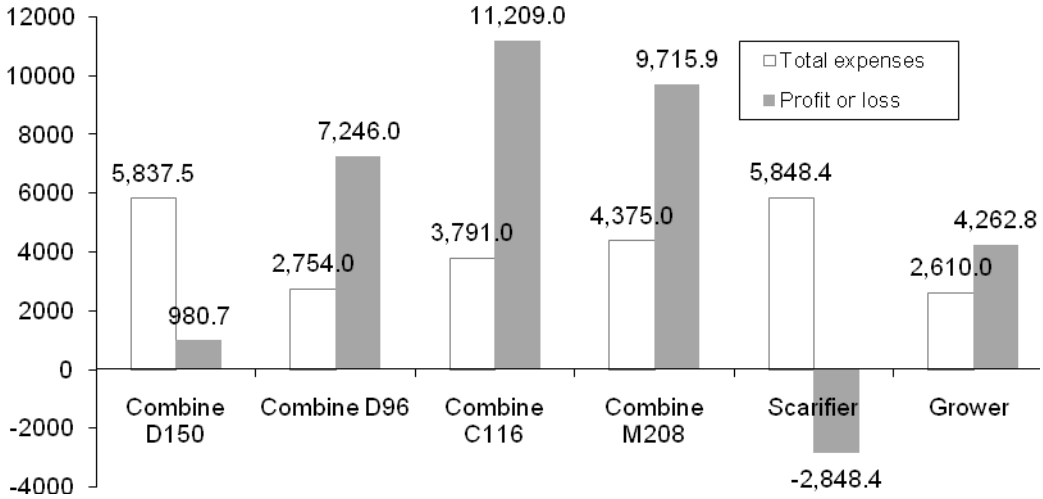


Figure 1 **Total expenses, profit and loss (euro)**

As can be seen the highest expenses are recorded ripper with a value of 5,848 euro and the lowest expenses are recorded grower about 2,610 euro per year *(figure 1).*

The difference between total expenditure and the outsourcing allowed the determination of profits made each year by combining hand. So to combine Claaas D 150 profit is 980.7 euro / year, 7,246 euro / year to combine Claas D 96, from 11,209 euro / year lei for Claas combine C 116 and 9,716 euro / year for Claas combine M 208 . Scarifier a loss of 2,848.4 euro / year, which is the only machine whose acquisition of all machinery proved inopportune analyzed.

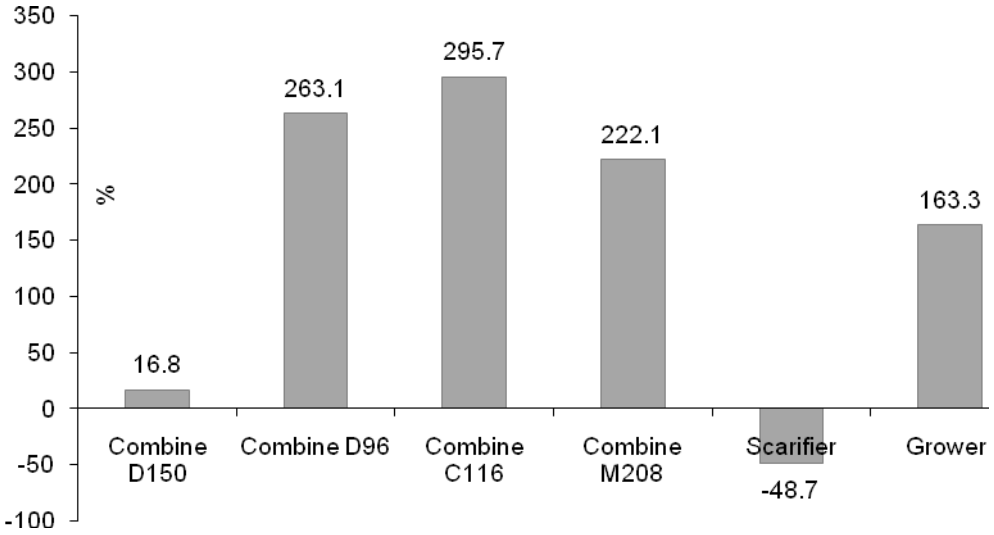


Figure 2 **Economic efficiency specifies the use of fixed assets (%)**

Based on profit and total expenses recorded four combine their profitability rate was achieved *(figure 2)* registered the highest rate of Claas combine C 116 295.7% and the lowest rate recorded for Claas combine D 150 at a rate of 16.8%. Sure scarifier brings a curtain of 48.7 euro for every 100 euro spent. It is recommended to use the services of scarification.

## CONCLUSIONS

Investments in combine and cultivator proved timely because this leads to a profit Additional combine Claaas D 150 profit is 980.7 euro / year, 7,246 euro / year to combine Claas D 96, from 11,209 euro / year lei Claas combine C 116 and 9,716 euro / year for Claas combine M 208. Scarifier a loss of 2,848.4 euro / year, which is the only machine whose acquisition of all machinery proved inopportune analyzed.

The profitability analysis showed that the most cost effective equipment Claas C 116 is combined with the highest rate recorded by 295.7% and the lowest rate recorded by D Claas 150 combine with a percentage of 16.8%. Scarifier brings a curtain of 48.7%.

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# LEASING AS A FINANCING METHOD - A CASE STUDY

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**Abstract**

The leasing begins to occupy an important place in the financial market due to its affordability and tax benefits, economic and financial. The finance leasing is recommended operators wishing to reduce their profit tax and value added tax, those who do not have collateral or a deposit required to obtain a loan. Now research of leasing identify only a drawback would be the lack of ownership of the goods purchased.

**Key words**: financing method, leasing, profit, efficiency

The main sources of financing investment that we make a firm are: availability of previous years, loans and leasing. These are the most used sources of financing for both current and investment activities (Elijah V., 2008; Donosa D. *et al*, 1999; Moraru R.A. *et al* 2003).

Leasing is a contract between two parties (lessor and lessee), where the lessor provides the lessee an asset for a specified period of time in exchange for specific payments (Fletcher M. *et al*, 2005). It has the advantages that: all expenses arising from the contract are tax deductible; financing of investments without recourse to borrowed capital or own; unites the cost of utilization of fixed assets; leases are more flexible to customer needs (Slotty C., 2009; Chemmanur T. Yan A., 2010). Also, a tenant can finance up to 100% of the purchase price of an asset and is not necessary or no guarantee or warranty suplimentarş - guarantee for the transaction is the asset itself.

The main disadvantages of leasing is the relatively higher costs and expenditure are due for a prolonged period without ownership of the asset (Dean M., 2007).

In the current conditions in Romania macroclimate the economic development involves making a large investment is necessary to know the financing alternatives.

This work is justified by the need to know the most efficient sources of finance with special focus on credit and leasing. It is useful to know the costs (actual and opportunity) they involve funding from different sources as they determine the investment opportunity. It is also necessary to know the level of income or savings causing them each to all the others.

## MATERIAL AND METHOD

The purpose of the research presented in this paper is to determine the economic efficiency of specific funding sources. It derives two objectives. determining and quantifying the cost of economic efficiency rates of specific sources. Research methods used were the case study method of comparison and economic simulation. The case study was conducted at SC Proelda Cons SRL Iasi, Romania, a unit specialized in consulting services and managent.

Financing variants analyzed assumed to investment of 11.000 euro for buying a car with a repayment period of the loan and lease for 5 years.

## RESULTS AND DISCUSSIONS

For cost analysis by source of funding was considered a value of financing the leasing of 6,291 euro, the purchase value of the car (11,000euro) of which was low down payments required. Grants for funding was taken into account a value of 5,500 euro, representing 50% of the purchase accounting for share grant. And the debt financing, the bank makes a loan to 85% of the purchase price of the car.

Cumulative interest loan financing have been calculated at an average interest rate of 5.3% per year.

Leasing fee was determined as the sum of monthly interest. Obviously that does not mean self-financing interest and fees.

Cost of services related to finance lease were represented management fee (72 euro/year); the

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commission grants consultancy services (5% of the aid) and the credit risk of the monthly outstanding (3.6% per annum of the loan amount) combined with fee credit file analysis (30 euro).

Opportunity cost is recorded in accrued interest in cash flow because we believe that only the owner of capital can submit this capital to the bank.

Table 1

**Analysis of costs for different sources of investment financing**

| Indicators | Self-financing | Finance lease | Financed by grants | Credit financing |
|---|---|---|---|---|
| Loan value (euro) | - | 6,290.76 | 5,500.00 | 9,350.00 |
| Accrued interest / leasing commission (euro) | | 991.40 | | 2,477.75 |
| Commission related services (euro) | | 360.00 | 275.00 | 1,713.00 |
| Opportunity cost to accrued interest (euro) | 836.00 | - | - | - |
| **Total financing cost (euro)** | 836.00 | 1,351.40 | 275.00 | 4,190.75 |

The total cost of financing the sum of all actual costs and opportunity costs. Accordingly, the cheapest form of financing was that the grants with a level of 275.0 euro *(table 1)* followed by self-financing which cost with 304.0% more than the financing through leasing of 491,4% in May and the more credit by 1,523.2% more than the financing through grants. Note that debt financing was 310.1% more expensive than financing through leasing.

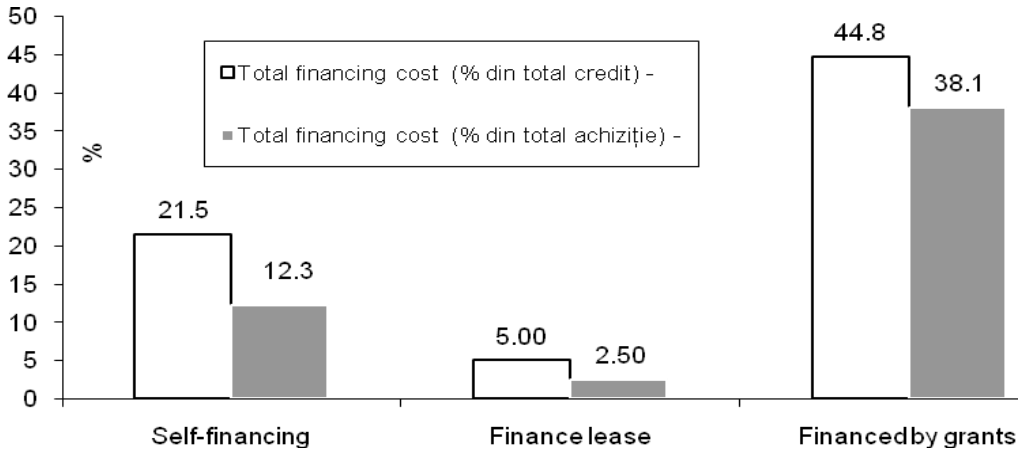


**Figure 1 Relatively funding cost (%)**

Due to the size of the different level of funding it was necessary to determine the total cost of funding relative to total amount of financing and the total cost of financing in relation to the total purchase value of the car. The cost of the total value of the loan was to finance itself invalid because it was not necessary in this case lending *(figure 1).* In contrast to other cases, funding from grants accounted for 5% of the financing, lease financing was more expensive by 16.5% and credit financing was also 39.8 percent more expensive.

The total acquisition cost was reported at lowest for grants at a value of 2.5%; self-financing cost 5.1% more than the grants; finance lease was 9.8% more expensive than financing through loans and grants by 35.6%. We note that financing through leasing was 25.8% cheaper than debt financing.

Table 2

**Cost analysis and savings for different sources of investment financing**

| Indicators | Self-financing | Finance lease | Financed by grants | Credit financing |
|---|---|---|---|---|
| Total financing cost (euro) | 836.0 | 1,351.4 | 275.0 | 4,190.8 |
| VAT recovery (euro) | 1,833.3 | 2,209.0 | 916.7 | 1,833.3 |
| **Gross Profit specific funding (euro)** | 997.3 | 857.6 | 641.7 | - 2,357.4 |

Value Added Tax to be recovered from the investment expressed in this case as a form of income in most economic activities a small proportion of the VAT can be recovered, the largest share of expenditures being held by not carrying VAT costs.

From this point of view, obtain financing through leasing highest value euro 2,209 followed by self-financing and debt financing which recovers 83% of this value *(table 2).* Funding through grants recover VAT obtained 41.5 percent of the lease. Compared to debt financing, leasing financing enables recovery to 375.7 euro more than debt financing.

Gross profit shows the extent to which specific financing costs can be recovered through the value added tax.

Three of the four cases allow cost recovery crediting of VAT, debt financing, in turn, indicates an additional cost of 2,35.4 euro *(table 2).* Financing through grants for this indicator is as favorable showing a gross profit of 641.7 euro specific lease financing exceeded by 33.7% and 55.4% self-financing. Girl leasing and loan financing proves to be more profitable with 3,215 euro.

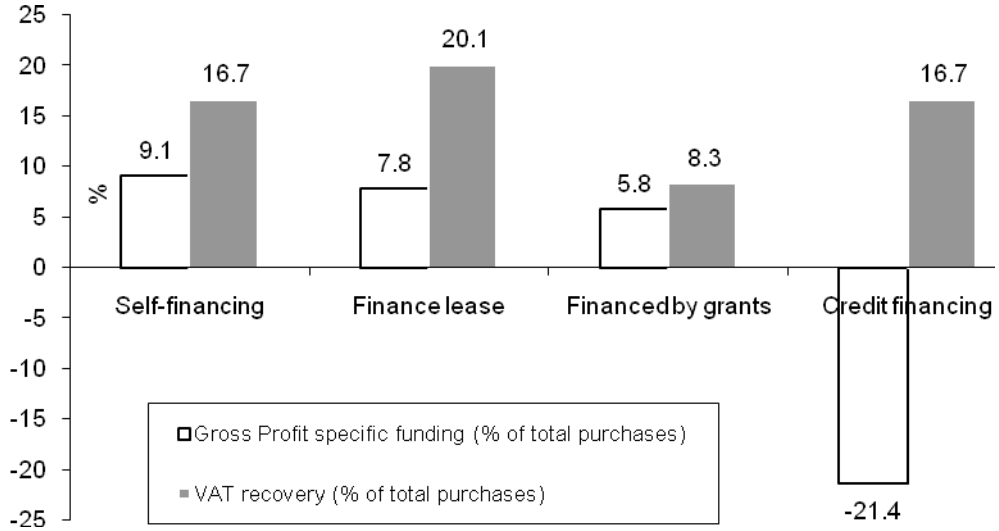


Figure 2 **Profit and savings on the purchase value (%)**

Given the different sizes of the financing, the volume of value added tax has been reported size of the investment. Thus, lease financing afforded 20,102 euro to 100 euro worth getting. Self-financing obtained 16.7 to EUR 100 purchase, ie 83.0% of the lease obtained *(figure 2).* Debt financing of Optina 83.0 percent compared to VAT on leasing and 41.5 percent from grants.

Gross profit funding related to specific purchase amount recorded the highest self-financing by 9.1%. Lease financing obtained 7.8%, 1.3 percent less than the film self-financing, grants a gross profit of 5.8% ie 3.2% less than self-financing. The loan brings a loss of 2.4%. Compared to credit, leasing is by 29.9 percent more profitable.

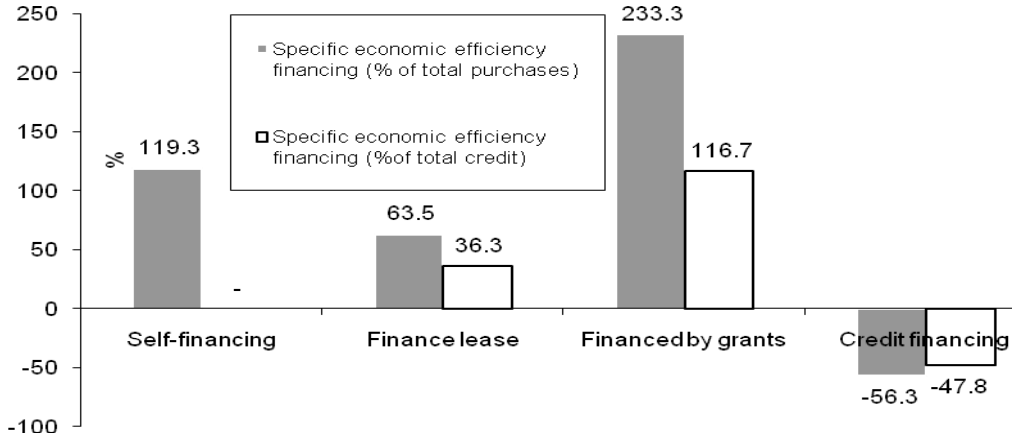


Figure 3 **Specific economic efficiency (%)**

Economic efficiency specific funding has been determined as a ratio between gross profit and specific funding total funding costs. They were assessed according to the value of purchase and depending on the loan amount.

Economic efficiency depending on the purchase amount recorded the highest value in funding from grants to a percentage of 233.3 *(figure 3).* Self-financing was 119.3% less effective than grants followed by finance lease which achieved a value of 63.5%, or 169.9% less than the grants. Efficiency credit financing shows that for every 100 euro spent on financing costs is a loss of 56.3 euro.

Maximum economic efficiency relative to the credit of all the grants was obtained 16.7% followed by 36.3% ie leasing of 80.4% over the first. Loan causes a loss of 47.8% of the costs of lending. Economic efficiency is not representative of specific self-financing because it does not require funding from third parties.

## CONCLUSIONS

The total cost of financing through leasing for a value of 6,290.8 euro 1,351.4 euro and was reported to total lease purchase financing was 9.8% more than the financing through grants. Financing through leasing was 25.8% cheaper than debt financing. Specific economic efficiency financing through leasing had a value of 63.5% based on acquisition value and 36.3% depending on the loan amount. Loan causes a loss of 47.8% of the costs of lending.

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# STUDIES CONCERNING EVALUATION OF LANDS (CASE STUDY)

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**Abstract**

The paper has as motivational support the importance of land value without which you can not do a thorough analysis of its use. Indisputable that in determining the place of the land in national wealth, determining of land value is absolutely necessary. Purpose of the paper is to provide a conceptual framework, methodological needed for an objective estimation of the land value, and the overall objective suppose the estimating the comparative value of land in the village Certesti, Galati county, depending on where they are - in town or outside of town. The paper deals punctualy, methodological, the assessment of lands related Certesti's village,Galati county, on the three types of estimates, in the base of economical parameters, and of the analytical estimations or through income capitalization. Based on economical parameters, the value of a incorporated hectare of land is 13928.57 lei/ha in the village Certesti and 9705.88 lei/ha in the village Cotoroaia, and the value of a unincorporated hectare of land is the 5850 lei/ha respectively 5490 lei/ha. The average price of a incorporated hectare based on estimating through benchmarking method in the base of technical and economical parameters and of the analytical estimations or through income capitalization ranging from 14944.3 lei/ha in Certesti village and 10627.45 lei/ha in Cotoroaia village. The average price of a unincorporated land is 6323.87 lei/ha in Certesti village and 5900.82 lei/ha in Cotoroaia village.

**Key words**: technical parameters, economical parameters, analytical estimations,income capitalization.

The land through its specific nature, is a very valuable natural resource, the most precious economic asset different from other goods. Romania has 14.85 million ha of agricultural land which represents 62.3% of the total area, returning 0.65 ha per capita. Economic evaluation of agricultural land is essential and mandatory for better organization and use of land in order to achieve the main objective of the current land policy which is to achieve effective structures of agricultural holdings in Romania (Bodescu D.,2012).

## MATERIAL AND METHOD

The research methods can be grouped as follows:

- Monographic method;
- Methods used to study structure phenomena divided on components and the interrelationship between them: the method of division of the results;
- Methods used for determining the level of the phenomenon such as the method of comparison;
- Statistical grouping method;
- Case study.

## RESULTS AND DISCUSSIONS

Comparative estimation of land from Certesti, Galati county, depending on where they are - in town or unincorporated was carried out based on economic parameters. Certesti village is situated north of Galati county. Certesti village is made up of three villages: Certesti, Carlomanesti and Cotoroaia. Economic parameters more frequently used are lease norm or rent (Ca), the benefit land (Bf), gross salable production (Pbv), net income (Vn).

Lease norm or rental it is used for land and construction (Bodescu D.,2012). The evaluation process consists of the usual proportion:

$X= (\Sigma V/\Sigma Ca)* xCa$

where :

X – The most probable value of land;

ΣV- the sum of the market prices of similar land;

ΣCa- sum of lease norms related to similar lands;

x CA – economic parameter;

In the case study applying the formula and using data from the Certesti territory village has lead to estimation of the value of land depending on where it is - incorporated or unincorporated.

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In the village Certesti aggregate value for sale-purchase of three land located in urban area of 1 hectare each (Σ V) is 45000 lei, lease norm is 2100 lei that is 700 lei per hectare.

Lease norm of the estimated land it is 650 lei per hectare.

To determine the value of the land apply the following calculation:

$$X = \frac{45000}{2100} \times 650$$

**X= 13928.57 lei/ha**

In the village Certesti aggregate value for sale-purchase of three land located in unincorporated area of 1 hectare each (Σ V) is 19500 lei, lease norm is 1200 lei that is 400 lei per hectare. Lease norm of the estimated land it is 360 lei per hectare.

To determine the value of the land apply the following calculation:

$$X = \frac{19500}{1200} \times 360$$

**X= 5850lei/ha**

In the village Cârlomăneşti aggregate value for sale-purchase of three land located in urban area of 1 hectare each (Σ V) is 39000 lei, lease norm is 1890 lei that is 630 lei per hectare. Lease norm of the estimated land it is 600 lei per hectare.

To determine the value of the land apply the following calculation:

$$X = \frac{39000}{1890} \times 600$$

**X= 12380.5lei/ha**

In the village Cârlomăneşti aggregate value for sale-purchase of three land located in unincorporated area of 1 hectare each (Σ V) is 18900 lei, lease norm is 1000 lei that is 333.3 lei per hectare. Lease norm of the estimated land it is 300 lei per hectare.

To determine the value of the land apply the following calculation:

$$X = \frac{18900}{1000} \times 300$$

**X= 5670lei/ha**

In the village Cotoroaia aggregate value for sale-purchase of three land located in urban area of 1 hectare each (Σ V) is 33000 lei, lease norm is 1700 lei that is 566.6 lei per hectare. Lease norm of the estimated land it is 500 lei per hectare.

To determine the value of the land apply the following calculation:

$$X = \frac{33000}{1700} \times 500$$

**X=9705.88lei/ha**

In the village Cotoroaia aggregate value for sale-purchase of three land located in unincorporated area of 1 hectare each (Σ V) is 18300 lei, lease norm is 900 lei that is 300 lei per hectare. Lease norm of the estimated land it is 270 lei per hectare.

To determine the value of the land apply the following calculation:

$$X = \frac{18300}{900} \times 270$$

**X= 5490 lei/ha**

Analytical estimate identify with economic criterion of capitalization and consists in determination of the probable value of a good through capitalization (Boghiță E., 2011). By this method accumulates at the estimation moment, the future series of constant incomes, averages, normal, on which can provide it the asset.

**Determining the land benefit**

Bf's determination varies depending on management system of enterprise:

For businesses managed in direct economy: Bf = Pbv- Ct, where:

Pbv- saleable gross product;

Ct- total cost;

- for leased enterprises Bf = Ca- Chp, where:

Ca- lease norm;

Chp- owner's cost;

Land benefit which can be obtained from a leased land, can be determined by the relationship:

Bf = Ca – Chp or better Bf = Vbp – Chp

Vbp=owner's gross income;

Saleable gross product which can be obtained for an hectare of arable land located in Certesti village is worth about **600 lei.**

**1. Cerţeşti village**

Land benefit calculated per hectare of arable urban land, will be:

**Bf=600lei - (taxes 100lei + construction executed 300lei +other expenses 40lei)**

**Bf = 600 – 440 = 160lei/ha**

Land benefit calculated per hectare of unincorporated arable land, will be:

**Bf=600lei - (taxes 15lei + construction executed 300lei +other expenses 40lei)**

**Bf = 600 – 355 = 245 lei/ha**

**2. Satul Cârlomăneşti**

Land benefit calculated per hectare of arable urban land, will be:

**Bf=600lei - (taxes 90lei + construction executed 300lei +other expenses 40lei)**

**Bf = 600 – 430 = 170lei/ha**

Land benefit calculated per hectare of unincorporated arable land, will be:

**Bf=600lei - (taxes 12lei + construction executed 300lei +other expenses 40lei)**

**Bf = 600 – 352 = 248 lei/ha**

**3. Satul Cotoroaia**

Land benefit calculated per hectare of arable urban land, will be:

**Bf=600- (taxes 70lei + construction executed 300lei + other expense 40lei)**

**Bf = 600 – 410 = 190 lei/ha**

Land benefit calculated per hectare of unincorporated arable land, will be:

**Bf = 600 - (taxes 10 + construction executed 300lei + other expenses 40lei)**

**Bf = 600 – 350 = 250 lei/ha**

**Estimating the costs of transformation - unincorporated land in urban land**

At the level of village Certesti, estimating transformation costs of unincorporated land in urban land, an area of one hectare, plots of 1000m², is as follows (table 1):

Table 1

**Estimating the costs of transformation - unincorporated land in urban land - village Cerţeşti**

| Costs of transformation | Value -lei- |
|---|---|
| area urbanistic plan | 3300 |
| expenditure on the electricity network | 1150 x 100 m = 115000 |
| expenditure on the electricity network | 2670 x 100m = 267000 |
| expenditure on the construction of asphalt roads | 10235 x 1000m$^2$ = 10235000 |
| gas network costs | 3560 x 100 m = 356000 |
| expenses of running water network | 3115 x 100 m = 311500 |
| **Total** | **11287800** |

In the case of plots with 1000 m² surface,cost per square meter of land transformed into the village Certesti will be:

(11287800 + 14944.3)/10000 = **1130.27 lei**

And the cost for a transformed plot with an area of 1000 m² will be:

1130.27 x 1000 = **1130270 lei**

In the village Carlomanesti cost per square meter of land transformed wiil be:

(11287800 + 12819.14)/10000 = **1130.06 lei**

And the cost for a transformed plot with an area of 1000 m² will be:

1130.06 x 1000 = **1130060 lei**

In the village Carlomanesti cost per square meter of land transformed wiil be:

(11287800 + 10627.45)/10000 = 1129.84 lei

And the cost for a transformed plot with an area of 1000 m² will be:

1129.84 x 1000 = **1129840 lei**

**CONCLUSIONS**

Based on economic parameters estimation, the value of an hectare a urban land 13928.57 lei/ha in village Cerţeşti and 9705.88 lei/ha in village Cotoroaia and the value of an land hectare is 5850 lei/ha respectivly 5490 lei/ha.

Based on the transformation costs results, the cost for a transformed plot with an area of 1000 m² is 1130270 lei in village Cerţeşti, 1130060 lei in village Cârlomăneşti and 1129840 lei in village Cotoroaia.

Regarding the need for land for housing and household annexes, should not be pressures, because the estimated calculations show a reduction in population commune in the near future, on the other hand is expected extension of urban land through superior valorification of land internal resource.

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# STUDY ON THE COOPERATION IN RESEARCH - DEVELOPMENT – INNOVATION ACTIVITIES IN ROMANIAN AGRICULTURE

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**Abstract**

The societal challenges in 2020 horizon are represented by food security, sustainable agriculture and bioeconomy. Romania, as member of European Union, has as objective the competitiveness development in agriculture area, through integration of innovation in business environment. Many research studies proved that the performance of innovation process is directly influenced by the cooperation between business environment, research organizations and other catalytic entities. The paper scope is to highlight the cooperation capacity in the innovation process in Romanian agriculture. The analysis carried out is based on finding answers to the following questions: Which is the level of research - development – innovation (RDI) cooperation in Romanian agriculture? Which are the opportunities for financing the cooperation projects in the 2014 – 2020 period? What is the interest of agricultural entrepreneurs to collaborate with research organizations? The research methodology was based on: documentary analysis, socio – economic investigation and multiple correspondence analysis. The results revealed the existence of a poorly developed network of cooperation between research envirnment and business in Romanian agriculture. The advantages of firms involved in these partnerships consist in access to high quality RDI services (eg. elaboration of soil studies with the latest equipment, by the partner research institutes), transfer of scientific information from the research environment, access to input suppliers networks and customers networks etc. Farmers specialized in different branches of agriculture have common interests in the production area, market and innovation. For example, their interest is to get the higher production in terms of quantity and quality, to charge a price increasingly better and to perform minimal consumption on inputs, with maximum effect in outputs. Cooperation between business and research organisations from agriculture has a very important place at the level of programs and funding measures which are promoted by the European Union. Thus, they stimulate by European funds the partnerships between various categories of economic actors in agriculture and related fields. In the future we believe that there is a high potential for cooperation in this economic field.

**Key words**: cooperation, research and development, innovation, agriculture

The agricultural sector is subject to significant challenges in terms of economic competitiveness and also protecting the environment (Leaver J.D., 2010). Facilitating farmers' access to innovative technologies is vital for the success of companies in the sector on the global market. Innovations in agriculture evolves as a result of interaction between different economic actors, like farms, suppliers of inputs, public organizations, civil society, research organizations etc., defining the innovation systems in agriculture (Klerkx L. *et al*, 2012). At EU level, through the development policies, farmers and other economic actors in agriculture and rural development are encouraged and financially supported to innovate and collaborate with research organizations for integrated research - development activities.

Developing a cooperation network between research environment and business environment in Romanian agriculture is a key element of increasing competitiveness in Romania's agricultural sector. Due to the increasing complexity of the processes that generates innovation and technical progress, companies are becoming increasingly dependent on external sources of research - development - innovation (eg. the technical expertise of researchers, the equipment and research equipment of research organizations) (Bougrain F. and Haudeville B., 2002). Various empirical studies have confirmed the positive impact of cooperation on innovation performance growth, which is measured by the share of innovative products and processes released on the market (Maurasse D.J., 2013; Lööf H. and Heshmati A., 2002; Belderbos R. *et al*, 2004). Nevertheless, at the Romanian economy

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level, the relations between business environment and research organizations are still very poor. As outlined in the National Strategy for Research, Development and Innovation 2014 - 2020, the Romanian public research sector has a research offer poorly adjusted to the real economy, respectively a low capacity of attracting private clients.

Based on the results of aforementioned studies, this paper aims to find answers to the following questions:

- Which is the level of RDI cooperation in Romanian agriculture?

- Which are the opportunities for financing the cooperation projects in the 2014 – 2020 period?

- What is the interest of agricultural entrepreneurs to collaborate with research organizations?

## MATERIAL AND METHOD

To answer the research problem, the paper used the following methods for data analysis: documentary analysis, socio – economic investigation and multiple correspondence analysis.

Documentary analysis was performed on the following types of documents:

- Official documents (eg. National Strategy for Research, Development and Innovation 2014 - 2020, National Rural Development Programme 2014-2020, etc.);
- Statistical documents (eg. Statistical Yearbook of Romania, Eurostat Reports etc.).

The socio - economic investigation is an indirect method of data collection. It was based on the statistical questionnaire as a tool for data collection. Our demarche during the field research focused on conducting an exploratory study on the level of interest of agricultural companies for colaborating with the University of Agricultural Sciences and Veterinary Medicine "*Ion Ionescu de la Brad*" (UASVM) of Iasi, în RDI activities within the Research Institute for Agriculture and Environment (ICAM) Iasi. The empirical study was conducted during June to August 2015, at the agricultural business level from North - East and South – East Development Regions. In this ares were applied 150 questionnaires to managers of companies in the field. The respondent must meet the following criteria: to be manager of an agricultural business and to conduct business in the vegetable sector. The response rate was 80% and we have received 120 completed questionnaires. The questionnaire consisted of six questions and a section with information about the respondent (residence, age and sex).

The multiple correspondence analysis was used to describe qualitative variables in the statistical questionnaire. It has observations on *N* qualitative variables $X^q$ (q = 1 ÷ N, N > 2), with *n* response modalities. In the analysis were included nine qualitative variables with 2 to 4 response modalities which are mutually exclusive.

The variables were simultaneously observed on a sample of 120 individuals. In the analysis it was calculated *The Cronbach's alpha coefficient* (α). Cronbach's alpha coefficient (internal consistency of scales) shows a test measurement accuracy and the fidelity of psychological instruments used.

$$\alpha = \frac{N x \, r_n}{1 + (N - 1) x \, r_n}$$

where,

N – number of variables

$r_n$ – the average of correlation coefficients between variables

*Cronbach's alpha* coefficient can have values between 0 and 1, and 0.7 is the minimum threshold accepted by scholars, so that the scale to be considered consistent and relevant.

## RESULTS AND DISCUSSION

The analysis of cooperation in innovation process between research environment and business environment in Romanian agriculture is based on a study which includes the following parts:

I. Analysis of the current degree of cooperation in research - development – innovation (RDI) field;

II. Analysis of financing opportunities of cooperation in RDI, as part of projects financed in the programming period 2014 – 2020 (COP, NRDP);

III. Carrying out the field research through a socio – economic investigation based on questionnaire.

*Analysis of the current degree of cooperation in RDI field*

The research activity of public research organizations and private innovative companies, was supported in the period 2007 - 2013, especially through the Sectoral Operational Programme Increase of Economic Competitiveness (SOP IEC), Priority Axis 2 - Research, Technological Development and Innovation. According to the lists of grants beneficiaries under the SOP IEC 2007 - 2013, published on the website of NASRI, in this period were contracted in total 675 projects with a total value of over 1,14 billion euro *(table 1).*

We noted from Table 1 that only 39 contracted projects (5.78% of total projects) were in the agriculture field (including agro-food industry) with a total grant of 85 million euro (7.45 % of the total). These projects were contracted in six operations of the eight available under the

program. The most important operation for financing projects in agriculture field was represented by OP 221 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres), through which were financed 11 projects amounting to 61.37 million euro.

Table 1

**Situation of of the research projects contracted through SOP IEC 2007 - 2013, Axis 2**

| Operations | No. of projects | | Overall grant - euro | |
|---|---|---|---|---|
| | Total, of which: | in agriculture | Total, of which: | in agriculture |
| OP. 211 | 59 | 5 | 19.091.503 | 1.828.319 |
| OP. 212 | 43 | 4 | 44.681.516 | 16.896.787 |
| OP. 221 | 111 | 11 | 790.234.808 | 61.377.618 |
| OP. 223 | 11 | - | 4.732.000 | - |
| OP. 224 | 77 | 10 | 24.977.974 | 808.809 |
| OP. 231 | 147 | 5 | 24.126.627 | 870.449 |
| OP. 232 | 89 | 4 | 125.898.640 | 3.632.629 |
| OP. 233 | 138 | - | 112.010.692 | - |
| **TOTAL** | **675** | **39** | **1.145.753.760** | **85.414.611** |
| **Pondere** | **100%** | **5.78%** | **100%** | **7.45%** |

*Source: National Authority for Scientific Research and Innovation - NASRI - The beneficiaries of grants under the SOP 2007 - 2013, own calculations*

Through these projects have been upgraded or created major research infrastructures in universities and other research organizations, representing the necessary technical basis for the partnerships with the business environment. Also, through the projects developed under OP 211 - Joint R&D projects between universities/research institutes and enterprises and OP 212 – Complex research projects fostering the participation of high-level international experts, it was strengthened the ability to cooperate both with the private sector and international research organizations, by attracting foreign researchers. The grants have facilitated investments in last generation research equipment, in performant laboratory which can compete with those from countries called leaders of innovation (Norway, Sweden, etc.). Moreover, partner enterprises had benefited from the access to knowledge, to research facilities of public entities and to researchers expertise.

Along with the research projects supported by SOP IEC, a great importance for developing the innovation and cooperation potential in agriculture, is given to the innovation clusters. A leading proponent of the cluster concept is M. Porter (2000) which defines it as "*geographic concentration of interconnected companies and institutions, in a particular field*".

The cluster is a social community specializing in the creation and transfer of knowledge, respectively is a network of independent economic actors sharing the same geographical location and market segment to achieve common strategic objectives, including innovation (Boschma, R.A. and Martin, R., 2010; Mudambi, R. and Swift, T., 2012). Partnerships formed by clusters include four types of organizations, following the "*four-leaf clover*" model, respectively: companies in the industry - research organizations - public authorities - catalysts (Cosnita D. and Guth M., 2010). In Romania, in the agriculture field (including agro-food industry) are currently six clusters shown in Table 2.

Table 2

**Romanian clusters in the agriculture field**

| Cluster | No. of partners | | | |
|---|---|---|---|---|
| | PE | RO | P | C |
| AgroFood Crisana Banat | 3 | 5 | 3 | 6 |
| AGROPRO Oltenia Cluster | 16 | 3 | 4 | 1 |
| Agro-Food Regional Cluster | 25 | 5 | 6 | 15 |
| Agro Transilvania Cluster | 22 | 2 | 1 | 3 |
| Ind Agro Competitiveness Pole | 14 | 16 | 2 | 8 |
| IND AGRO VEST | 12 | 4 | 0 | 0 |
| **TOTAL** | **92** | **35** | **16** | **33** |

*Source: Romanian Cluster Association*

*PE – private enterprises; RO– research organizations; P – public authorities; C – catalysts*

According to Romanian Cluster Association, in the six clusters from agriculture field are engaged 176 partners, of which over 50% are private enterprises, and 20% research organizations.

We see a very small number of companies that were involved in cluster partnerships, which indicates a reduced capacity for cooperation and change from Romanian companies, and also an insufficient promotion of these entities. In other words, many companies do not have the necessary information on cluster joining opportunities and benefits of such a partnership.

Companies adhere to cluster desiring to improve the economic performance, to change and innovate, with an attitude of openness and cooperation (Rubach S. *et al*, 2014). The advantages of firms involved in these partnerships consist in access to high quality RDI services (eg.

elaboration of soil studies with the latest equipment, by the partner research institutes), transfer of scientific information from the research environment, access to input suppliers networks and customers networks etc. Farmers specialized in different branches of agriculture have common interests in the production area, market and innovation. For example, their interest is to get the higher production in terms of quantity and quality, to charge a price increasingly better and to perform minimal consumption on inputs, with maximum effect in outputs.

*Analysis of financing opportunities of cooperation in RDI*

The literature confirms that lack of resources is one of the main factors that inhibit the activity of innovative companies (Fakhri S. and Bahoussa A., 2014; Božić, Ljiljana, 2011; Tiwari, A.K. *et al*, 2007).

As innovation is a priority of EU development policy in 2020 horizon, the economic actors in various fields can benefit from grants for RDI activities. Analyzing the strategic programming documents for the 2014 – 2020 period, of EU and Romania, we extracted the main opportunities for financing the RDI projects in the agricultural sector *(table 3).*

*The 16 Measure - Cooperation* is dedicated exclusively to projects in agriculture filed, while the priority axes of the *Regional Operational Programme (ROP) 2014-2020* and *Competitiveness Operational Programme (POC) 2014-2020* supports projects included in health area and in the areas of smart specialization: bio-economy (agriculture); information and communication technology, space and security; energy, environment and climate change; eco-nano-technologies and advanced materials.

Table 3

**Main european funding sources for RDI projects for 2014 – 2020 period**

| Program/ Measure – Axis | Total budget (euro) | Main result indicators |
|---|---|---|
| NRDP 2014 – 2020/ M16 - Cooperation | 31.134.556 | - 24 operational groups<br>- 187 other cooperation operations |
| ROP 2014 – 2020/ PA 1 - Technology transfer | 175.531.915 | - 60 technology transfer units<br>- 600 SMEs benefiting from technology transfer services |
| COP 2014 – 2020/ PA 1 - Research, Technological Development and Innovation (RDI) | 797.872.340 | - 18 scientific public-private co-publications / 1 mil. loc.<br>- 270 mil. euro contribution from Horizon 2020 attracted by Romanian entities<br>- 420 enterprises supported<br>- 437 new researchers in enterprises supported |
| **TOTAL** | **1.004.538.811** | |

*Source: NRDP 2014 – 2020, ROP 2014 – 2020, COP 2014 – 2020*

Given our research problems, we will analyze the capacity of cooperation in agriculture through the National Rural Development Programme 2014 - 2020, M16 - Cooperation through operational groups (OG) and other types of partnerships.

The operational group is a partnership between farmers, research organizations, universities, consultants and other relevant economic actors in the agricultural sector (eg. banks, suppliers of agricultural inputs etc.). Its aim is to develop the innovation degree in the agricultural sector and to increase the competitiveness at European level.

Specifically, through this measure will be developed pilot projects, new products and processes, will be stimulated the transfer of ideas and best practices, will be facilitated the farmers's access to agricultural inputs, to finance sources and to markets. In these projects, it will play an important role the public research organizations from Romania, in agriculture field, which will provide technical resources (laboratories, equipment, installations etc.), human resources (academics, researchers) and information (databases, know-how etc.), required by RDI activities. There will also be stimulated and projects carried out by partnerships for horizontal and vertical cooperation between actors in the supply chain, for example, farmers, processors, food traders etc.

Accessing European funds to develop innovative capacity of the agricultural sector will reduce costs of production factors, will increase the economic returns (by optimizing the use of resources, implementation of new agricultural technologies, etc.) and will add value to obtained production (quality, diversity and larger quantities). Promoting the agricultural products and the local brands is a key element in increasing economic importance of agriculture in Romania. The formation of operational groups and other partnerships is a prerequisite for the future development of new clusters of innovation, through which Romanian agriculture may increase its international competitiveness.

*Assessing the potential for private sector involvement in RDI partnerships*

To answer the question „*To what extent the private agricultural businesses is interested in setting up partnerships for RDI?*", an empirical research was carried out based on a statistical questionnaire. The questionnaire included six questions related to: farm size (measured in hectares); crop specialization (cereals, industrial crops or vegetables); experience in agriculture (measured in years); level of education in agriculture (with or without specialized studies); allocation of inputs as a result of specialized studies (yes or no); interest for cooperation with UASVM Iasi for conducting specialized studies (yes or no). We present below the main results of the research.

Table 4

**Model Summary Multiple correspondence analysis**

| Dimension | Cronbach's Alpha | Variance Accounted For | | |
|---|---|---|---|---|
| | | Total | Inertia | % of Variance |
| 1 | ,783 | 3,293 | ,366 | 36.584 |
| 2 | ,426 | 1,611 | ,179 | 17.895 |
| Total | | 4,903 | 545 | |
| Mean | ,666[a] | 2,452 | ,272 | 27.240 |

*Cronbach's alpha* coefficient has a value of 0.783 for the first dimension, which demonstrates the consistency and relevance of the chosen scale. The two factorial axes explains 54.479% of the total variance, and the first factorial axis explains 36.584% of the variance, resulting that the biggest differences are identified through the analysis of this axis.

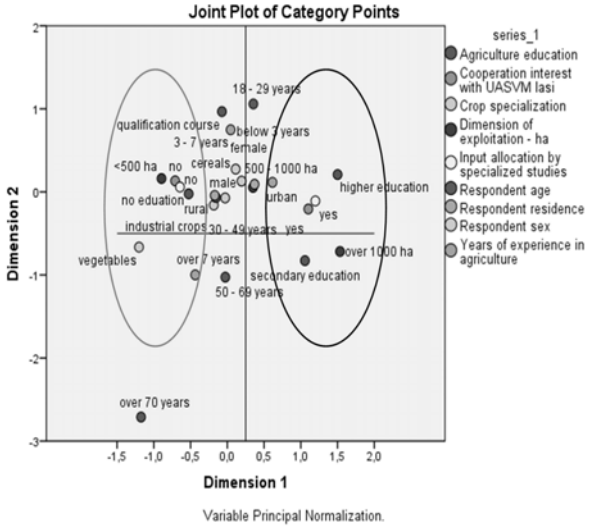


Figure 1 **Graphical representation of the factorial correspondences on two axes**

As shown in *figure 1*, the first dimension is related to farm size, manager typology and the interest in cooperation with the research organization. This dimension reflects a greater discriminatory power of the variables, compared to dimension 2, where are no significant differences and the categories of variables are close.

Analyzing the first factorial axis we note that there is a difference in terms of interest in cooperation with UASVM for RDI activities among managers with secondary and higher education in agriculture, allocating inputs given by specialized studies, on the one hand, and managers without education in agriculture, which relies on experience and not on scientific reasons, on the other hand. The first category is interested in collaborating for activities in the partnership, while the second category managers have a reticent attitude in the face of change and collaboration.

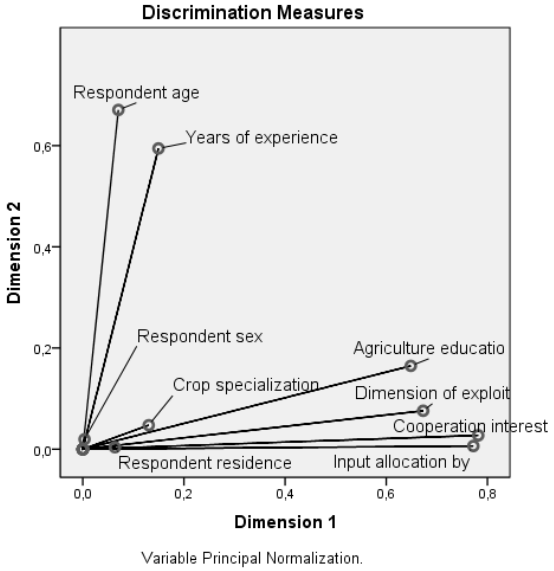


Figure 2 **Discrimination measurses of variables**

We note the influence of the level of training in the field and, implicitly, of the integration of scientific elements in economic activity, on the possibility of cooperation with the research organization.

Large firms which exploits over 1,000 hectares of agricultural land shows high interest in cooperation, as a result of the financial capacity to co-finance the costs required by RDI services.

Analyzing the extent of discrimination for the categories in the dimension 2, we see that the indicators expressing respondent's age, years of experience, production specialization and sex of respondents does not influence the manager's requirements regarding the establishment of partnerships with the research environment.

## CONCLUSIONS

The specialized studies demonstrates the priority role of the cooperation between research environment and business environment, in the area of economic growth and development.

Cooperative relationship between research environment and business environment is the accelerator of economic growth and development through knowledge transfer. In this regard, enterprises are increasingly dependent on external sources of research - innovation.

The access to knowledge is achieved through partnerships. The analysis of the ability to achieve partnerships in the agricultural sector of Romania used the information relating to the existing partnerships, the research environment offer and the requirements of private economic environment.

In the field of agriculture there are six partnerships as clusters, mainly geographically located in West and Central Development Regions of Romania. This number is very low compared to the existing potential

The requirements of private economic environment, to access knowledge are a function of size and type of manager. Thus, companies with a holding of less than 500 hectares, whose manager has no specific studies are not willing to cooperate with research organizations. In contrast, large firms led by managers with agriculturalm education, present a high interest for partnerships.

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# CONCEPTUAL APPROACHES REGARDING THE IMPACT OF INNOVATION ON THE ENTERPRISE PERFORMANCE

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**Abstract**

The purpose of this paper is to identify the main approaches in the literature that describe the company's performance evaluation indicators and the influence that innovation activities have on performance growth. The impact of innovation on company performance extends from effects on turnover and market share to changes of productivity and efficiency. Research carried out falls into the theoretical research category, whose methodology is based on meta-analysis. Object of meta-analysis is the analysis of a number of ten relevant empirical studies which approach the relationship of innovation - performance at the enterprise level. Results of the studies analyzed show that, in general, innovation has significant positive effect on firm performance increase. The increase of this influence is favored of the managers involvement in innovation activities, of market orientation of the company and improving the relationship of internal and external communication. Key indicators for assessing the impact of innovation on overall performance which are used in empirical studies of researchers are represented by financial - accountants indicators: ROA, ROE, revenue growth, return on sales, productivity growth of factors and net profit growth.

**Key words**: innovation, performance, enterprise

Innovation is, for the present society, the most important way of economic growth and improve the overall performance of the business, especially long-term (Ionescu, 2015). Innovation must provide both an improvement in the economic-financial performance indicators calculated on the basis of accounting information (for example, turnover, total revenues, profits, return) and compliance to sustainable development principles. In other words, existing businesses are no longer evaluated solely by indicators of economic performance and product quality, but also by the ability to improve community life and protect the environment.

Some studies on the relationship between innovation and economic performance of firms use the approach of the production function, according to which firm performance is explained by several independent variables, such as physical capital, human capital, research - development expenditure and other innovations relating to investments (Hatzikian, 2013; Patton, 2014).

Innovation process can improve productivity and income, whereas technical progress reduces operating costs and lead times or can improve quality of invested capital, internal skills and long-term competitiveness of the company (Pianta, 2005; Artz *et al*, 2010). Driven by increased competition in global markets, companies have begun to understand the importance of innovation because rapid changes in these markets and severe global competition quickly erodes the added value of existing products and services (Patton, 2014).

Based on results of studied research, was formulated the main objective of the research, respectively to find the answer to the question: How can be evaluated the relationship between innovation - performance at the enterprise level?

## MATERIAL AND METHOD

Object of meta-analysis is the analysis of a number of ten relevant empirical studies addressing the relationship relationship between innovation - performance at the enterprise level. The studies selected for analysis were conducted during the period 2011 - 2015 and is based on empirical research of the impact of innovation on the overall performance of the company.

## RESULTS AND DISCUSSIONS

*Literature review*

Overall performance of the company expresses the aggregation of economic, social and

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environmental performance (Baret, 2006). Performance is relevant in strategic management research. Despite its relevance, it is difficult to reach a consensus on the definition, measurement and dimensionality to that limit progress in research and understanding of this concept (Santos and Brito, 2012).

When defining performance is important to consider two main elements: the time and point of reference. We can distinguish between past and future performance and performance between short, medium or long term. Some scholars believe that another important element in analyzing performance is reference to which we refer, eg industry sector average, results or performance of the main competitors in the past (Silvert, 2011).

Comparisons to the past objectives and performances indicates effectiveness and the company's evolution. However, they are not suitable to compare companies of different sizes and industries, which is why the comparisons are economic analyzes of the mean value of the industry and its main competitors in the market (Santos Brito, 2012). Such assessments indicate the competitive position of companies and could be useful for strategic analysis and determining future policy development. The company's performance is a multidimensional indicator (Glick *et al*, 2005), and researchers must choosethe most relevant dimensions to their research, according to their purpose (Richard *et al*, 2009). In other words, it applies the saying "what you measure is what you get" (Merchant and Van der sted, 2007). The relationships created between company performance indicators determining economic concepts defined in terms of profitability, efficiency, productivity and competitiveness (Ștefan, 2012). The most used methods of performance evaluation are those based on objective indicators, respectively the accounting valuation by specific indicators, such as profit rate, return on asssets, return on capital etc. (Danielson and Press, 2003) and the stock market indicators evaluation. Although the accounting valuation is sometimes seen as reality distorted, because of interpretable accounting policies, of human errors and fraud (Richard *et al*, 2009), it still remains the most accessible method for performance evaluation.

The effects of innovation on the company's performance is expressed by competitive advantage obtained by the innovative enterprise in relation to its competitors. The competitive advantage is held by one who succeeds dominate the market forces (Coca, 2014) and takes two forms: cost advantage and price advantage.

The cost advantage is obtained mainly through economies of scale in mature markets and is an effect of experience and process innovation, while the price advantage is obtained through differentiation and product innovation. Economic experience has shown that on consumer goods market, with consumption very elastic to price, companies compete by reducing costs and hence of sales prices (Brem *et al*, 2015). Regarding the luxury goods market, consumers are attracted by the goods with high quality and differentiation, while practicing a high price determines the increase of market demand. The research of Mansury and Love showed that innovation service has positive effects on increasing revenues, but has no effect on productivity, which is why growth due to innovation can be attributed to external links taken into innovation process (2008), which favored the transfer of knowledge. Although many studies have highlighted the positive impact of innovation and technical progress on labor productivity, some authors have found a negative relationship between them. Thus, the negative impact on performance is given by the lack of skills to properly use new technologies, high costs in the process of adapting to change, learning costs (Ahn, 1999) or the technological and organizational rigidities which may arise (Benner and Tushman, 2002).

*The main results of meta-analysis*

Innovation allows companies to gain a competitive advantage that can only be maintained through a continuous process of innovation. To identify how innovation influence growth of enterprise performance, we conducted an analysis of ten relevant scientific papers in the field *(table 1)*, identifying indicators for assessing the of the relationship innovation - performance.

Table 1

**Selective studies regarding the impact of innovation on the performance**

| Study code | Authors | Year of publication |
|---|---|---|
| 01 | Gunday, G., Ulusoy, G., Kilic, K. and Alpkan, L. | 2011 |
| 02 | Kostopoulos, K., Papalexandris, A., Papachroni, M. and Ioannou,G. | 2011 |
| 03 | Postruznik, N., Moretti, M. and Gospodarstvo, N. | 2012 |
| 04 | Güven, A., Muzaffer, B., Cengiz, Y and Pinar, B. | 2012 |
| 05 | Fernandes, C. I., Ferreira, J. J. M. and Raposo, M. L. | 2013 |
| 06 | Moghaddam, A.G., Imani, Y.A., Erteza, N. and Setayeshi, L. | 2013 |
| 07 | Javier, A.C. | 2013 |
| 08 | Prorokowski, L. | 2014 |
| 09 | Waleed, O. | 2015 |
| 10 | Fujii, H., Edamura, K., Sumikura, K., Furusawa, Y. Fukuzawa, N. and Managi, S. | 2015 |

Table 2

**Meta-analysis of relevant studies regarding the impact of innovation on the performance**

| Study code | Research Methodology | Performance evaluation variables | Innovation evaluation variables | Main results |
|---|---|---|---|---|
| 01 | - analysis on a sample of 184 companies in Turkey with RDI activities;<br>- applying questionnaires and interviews with company managers. | - return on total assets (ROA);<br>- general profitability of the company;<br>- return on sales;<br>- market share;<br>- customers satisfaction;<br>- duration of the production cycle. | - quality of new services and products;<br>-number of research projects for products and services;<br>- organizational innovation;<br>- marketing innovation. | -the performance of the company is directly and positively affected by organizational , product and marketing innovations;<br>- marketing innovation is considered the most powerful determinant of performance;<br>- innovative production and performance indirectly have a positive impact on financial performance through marketing performance. |
| 02 | -analysis on a sample of 461 enterprises in Greece;<br>- applying statistical questionnaire. | - return on sales (ROS);<br>- return on total assets (ROA). | - external diversity and quality of information retrieved;<br>- R & D expenditure share in total revenues;<br>- the share of employees in total employees RDI activities;<br>-the value of investments in scientific and technical training. | - absorption capacity of innovation positively affects the financial performance;<br>- the relationship innovative performance - financial performance is positive and significant;<br>- involvement of firms in collaboration innovation positively affects performance. |
| 03 | - the application of semi-structured interviews to managers of 11 companies in Slovenia. | - return on total assets (ROA);<br>- return on equity (ROE);<br>- internal communication;<br>- culture of marketing. | - the importance degree of innovation to managers by investing in research - development. | - enterprises that have allocated more importance to innovation and deployment of innovative communication methods had a higher financial performance;<br>- between ROA and the level of importance for innovation there is a higher correlation than between ROE and innovation. |
| 04 | - sample that included 112 companies from Turkey;<br>- applying questionnaires and interviews with company managers. | - ROI;<br>- market share;<br>- total sales growth;<br>- the share of foreign capital | - product innovation;<br>- process innovation;<br>- organizational innovation;<br>- market efficiency (product quality, new product development). | - company's performance has a direct relationship with strong product innovation and process;<br>- market efficiency is positively influenced by all kinds of innovation;<br>- the share of foreign capital is positively influenced by organizational innovation;<br>- firm performance and innovative capacity are better at the experienced enterprises compared to start-ups. |
| 05 | - analysis on a sample of 61 companies that took innovative activities in the two neighboring countries (Portugal and Spain);<br>-applying statistical questionnaire. | - turnover;<br>- overall competitiveness. | - product innovation. | - at the Portuguese companies level there is no significant association between the importance attributed to different factors of innovation and growth of turnover;<br>- regarding the Spanish companies the level of importance attributed to product innovation is significantly associated with turnover;<br>- the relationship between innovation and financial performance has been validated statistically for Spanish companies who confirmed that the introduction of a greater number of innovative products has led to a higher total turnovers. |

| Study code | Research Methodology | Performance evaluation variables | Innovation evaluation variables | Main results |
|---|---|---|---|---|
| 06 | - sample that included 169 small businesses in industrial parks;<br>- applying the questionnaires to managers. | - increasing profits;<br>- increasing market share;<br>- increasing the rate of profitability compared to competitors; | - introduction of new products and services;<br>- accumulation of new knowledge in the organization;<br>- consideration of the innovation like a good highest value;<br>- orientation the company to market. | - market orientation positively influence the company's financial performance;<br>- firm orientation towards innovation is positively correlated with performance and increases the company's ability to cope with environmental changes;<br>- combining innovation with market orientation determines obtaining a higher performance. |
| 07 | - multiannual analysis on a sample of 88 firms with at least an investment for environmental protection in 14 countries;<br>- application a statstic questionnaire. | - return on total assets (ROA). | - environment patent. | - ecological innovations represent 4% of all patents companies;<br>- green innovation affect significantly and positive the financial performance at the firm level;<br>- with greater rigor environmental rules, the lower is the likelihood that eco-innovation leading to increased financial performance;<br>- firms with a high level of eco-innovation intensity are able to increase their financial performance. |
| 08 | - sample that included 2,000 innovative companies in Poland, listed on the Warsaw Stock Exchange;<br>- analysis based on financial statements and applying statistical questionnaire (42 questionnaires). | - return on equity (ROE);<br>- return on asset (ROA);<br>- total revenue growth. | - R & D expenditure share in total revenues;<br>- the share of employees in total employees RDI activities;<br>- innovative business strategies;<br>- product innovation. | - improved financial performance depends on monitoring production costs and maintaining market networks;<br>- the increase ROE and ROA was higher in companies with higher innovative performance;<br>- volatility in sales was lower in innovative enterprises;<br>- market capitalization had an influence on investors wishing to invest in innovative companies;<br>- the percentage of employees CDI has positively influenced the overall performance. |
| 09 | - Sample that included 162 SMEs in Tunisia;<br>- applying the questionnaires to managers. | - financial performance: Return on total assets (ROA), financial liquidity, net profits;<br>- non-financial performance: customer satisfaction, increasing the market share. | - innovative behavior of managers;<br>- participation in innovation activities in the past 3 years;<br>- favorable perception of market dynamism. | - financial and non-financial performance is positively affected by the company's innovative capacity;<br>- enterprises in which managers had a great involvement in innovation activities have better performance;<br>- the innovative capacity is directly influenced by the quality of the relationship chief - employee;<br>- the results of innovation are correlated with increased sales. |
| 10 | - sample that included 1,067 firms in the manufacturing industry in Japan, rated at Stock exchange;<br>- analysis conducted on the basis of financial statements and applying statistical questionnaire (145 questionnaires) | - sales / employee;<br>- profit / employee;<br>- the cost of labor;<br>- the overall productivity of factors. | - intellectual property rights (patents);<br>- technical progress overall. | - enterprises that were based on innovation, technical progress and the accumulation of knowledge have greatly increased the overall productivity of factors;<br>- the production quality management determined the increase of technical progress;<br>- intellectual property rights positively affects overall productivity and performance. |

Analyzing the selected studies, we can say that they are based on empirical research conducted on representative samples from several European and non-European countries. Data collection was done mostly by combining information from financial statements with applying of statistical questionnaires and taking interviews to managers of sampled firms. The

company's financial performance was evaluated mainly by financial indicators - such as accountants ROA, ROE, revenue growth, return on sales, productivity growth factors and net increase profits. Non-financial performance was assessed in particular by increasing market share and customer satisfaction.

Innovation activities was assessed by qualitative indicators: the importance of innovation for managers gain new knowledge in the organization, looking innovation as a good highest value and quantitative indicators: product innovation (new products / services), innovation process (progress technical), number of patents, the share of research - development expenditure in total revenues and the share of revenues from the sale of innovative products in total revenues.

Analyzing the selected studies, it resulted the following main effects of innovation on the enterprise performance: i) the technological and market innovation has a positive influence on financial performance; ii) the collaboration in innovation process has a positive influence on performance; iii) the innovation determines the growth of return on assets; iv) the market effectiveness is positive influenced by all types of innovation; v) there is a positive correlation between product innovation and the growth of turnover; vi) a very rigid environment policy has a bad influence on the adoption of ecological innovations and financial performance; vii) the productivity of production factors is positively influenced by innovation and knowledge acumulation.

We believe the results are relevant to our research question and they will be the starting point in choosing future empirical research variables.

## CONCLUSIONS

Process innovation at the enterprise level has as effects: a) it reduces the production costs; b) it reduces the time required to execute the products; c) it increases the rotation of invested capital; d) it increases the potential of company in the market game; e) it increases the competitiveness on medium and long-term; it increases the performance; it increases the effective involvement of labor in production; it improves the communication relations inside and outside the enterprise; it develops creativity and skills to use the information.

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# DEVELOPMENT OF DRY ONION PRODUCTION AND FOREIGN TRADE IN TURKEY AND IN THE WORLD

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**Abstract**

Onion is one of the rare vegetables that are used in the kitchens of both the rich and poor families in the world regardless of the income level. In addition to containing many vitamin and mineral substances that are important for human nutrition, it is also a medical plant the use of which is known since the beginning of human history. Turkey holds an important spot in the world with regard to onion production and production area. The objective of this study was to examine dry onion production and foreign trade in Turkey and in the world during the 1996-2013 period. Whereas world dry onion production was 44. 8 million tons during the 1996-2000 period, it increased by 1.9 times thus reaching 84.8 million tons. India showed the greatest development during the same period with an increase of 4.3 times, whereas a decrease of 13% took place in the production of dry onion in Turkey. China is ranked first in the world with regard to dry onion production with a share of 26.35%, whereas India is ranked second with a share of 22.76% and Turkey is ranked number six with a share of 2.25%. When dry onion yield is examined, it can be seen that the world average is 21.07 ton/ha, that Ireland is ranked first with an average of 68.75 tons/ha, that South Korea is ranked second with 64.58 tons/ha and that Turkey is ranked number 11 with a share of 29.86 tons/ha. Whereas world dry onion export was 3.4 million tons during 1996-2000 period, it increased by two times thus reaching 7 million tons in 2013. India is ranked first in the world in dry onion export with a share of about 21.06%, the Netherlands is ranked second with a share of 17.43% and China is ranked third with a share of 10.64%. Whereas Turkey is ranked number 10 in the world with a dry onion export share of about 2.25%. About 52% of Turkish dry onion export is made to Iraq. When world dry onion import is examined, it can be observed that the top five countries are Malaysia (6.71%), the USA (6.38%), England (6.34%), Bangladesh (5.26%) and Japan (4.41%). Main problems in the dry onion sector of Turkey are that the manufacturers are not organized sufficiently and that there is no production plan.

**Key words**: dry onion, development, production, foreign trade, Turkey

Onion (*Allium cepa L.*), whose green leaves and tubers are used, is a pungent herbaceous plant from liliaceous family. It is one of the rare vegetables used in the kitchens of all rich and poor families in the world regardless of the income level. In addition to containing many vitamins and mineral substances that are important for human nutrition, it is a medical plant whose usage is known since the beginning of human history (DPT, 2001). It is one of the oldest products cultivated and its origin is West Asia, but it is produced in a large area in the world. *Allicin* and *Alliin* in the onion whet the appetite, facilitate digestion and serve as a regulatory impact on intestines. It has gained importance in modern medicine due to containing a variety of substances. It is also used in making almost every kind of meals and sauces. Its consumption and production are substantially made due to all these features (Pala, M., Saygı, B., 1991).

Dry onion has an important place in human nutrition and trade of agricultural products in Turkey. Although the dry onion cultivation is made in almost every region of Turkey, it is seen that the cultivation is concentrated on Marmara, North Central and East Anatolian Regions. The objective of this study is to examine the dry onion production and foreign trade in Turkey and in the world. For this purpose, the study compared some indicators about dry onion such as production, production area, yield, export, import, price and consumption per capita for the major onion producer countries in the world and Turkey. Finally, the serious issues faced by the sector were identified and the solutions for them were proposed.

## MATERIAL AND METHOD

The main material of the study consisted of data and reports from the institutions such as Food

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and Agriculture Organization of the United Nations (FAO), Istanbul Chamber of Commerce (ITO), and State Planning Organization (DPT). It was also utilized from the formerly performed similar studies on the subject. In the light of the data and information, the developments in dry onion production areas, yields, productions, consumptions, exports, imports and world prices were investigated for Turkey and the important countries in the world in terms of dry onion production and trade between the years 1996-2013. As calculating the index and rates, the data were interpreted as charts and graphs.

## RESULTS AND DISCUSSIONS

Dry onion production is spread over a wide area in the world due to adapting to different climate conditions and widespread use. The developments in production areas for major dry onion producer countries in the world are given in Table 1. While the world dry onion production area was 2.6 million hectares in average in the 1996-2000 period, it rose to 4.4 million hectares in 2013 as showing a 1.7-fold increase. It is seen that the largest increase is in Nigeria when the dry onion production area is examined for the major producing countries in the world. In the analyzed period, the dry onion production area in Nigeria has increased by about 4.2 times. Following Nigeria, the countries where the largest increase occurs are Bangladesh (4-fold), India (2.8-fold), Uganda (2.3-fold) and Myanmar (1.9-fold), respectively. In the same period, Turkish dry onion production area has decreased to 64 thousand tons from 104 thousand tons as showing a decline by around 39%. According to 2013 data, India has the largest share in the world dry onion production

Table 1

**Development of dry onion production area in the world (ha)**

| Countries | 1996-2000 | 2001-2005 | 2006-2010 | 2011 | 2012 | 2013 | Share (%) (2013) | Index* |
|---|---|---|---|---|---|---|---|---|
| India | 434 080 | 558 340 | 848 640 | 1 087 230 | 1 052 000 | 1 217 000 | 27.75 | 280 |
| China | 540 004 | 808 746 | 962 636 | 1 015 239 | 1 021 242 | 1 026 250 | 23.40 | 190 |
| Nigeria | 45 062 | 63 362 | 187 000 | 373 450 | 386 300 | 190 000 | 4.33 | 422 |
| Bangladesh | 34 014 | 49 379 | 118 989 | 127 940 | 135 721 | 134 354 | 3.06 | 395 |
| Pakistan | 87 064 | 110 831 | 137 500 | 147 600 | 129 700 | 125 900 | 2.87 | 145 |
| Indonesia | 89 931 | 84 473 | 97 661 | 93 667 | 99 519 | 94 898 | 2.16 | 106 |
| Vietnam | 63 672 | 78 719 | 88 945 | 88 598 | 90 000 | 92 000 | 2.10 | 144 |
| Russia | 100 800 | 118 294 | 95 250 | 95 500 | 92 100 | 85 740 | 1.96 | 85 |
| Myanmar | 36 751 | 58 868 | 70 115 | 71 980 | 69 800 | 70 600 | 1.61 | 192 |
| Iran | 47 035 | 47 272 | 54 251 | 61 519 | 71 000 | 70 125 | 1.60 | 149 |
| Uganda | 28 646 | 45 623 | 63 029 | 61 000 | 62 000 | 66 521 | 1.52 | 232 |
| Turkey | 104 200 | 85 356 | 66 606 | 74 000 | 63 000 | 63 796 | 1.45 | 61 |
| World | 2 623 171 | 3 165 940 | 3 918 706 | 4 541 216 | 4 442 772 | 4 385 306 | 100.00 | 167 |

FAO, 2016. * Index: 1996-2000= 100

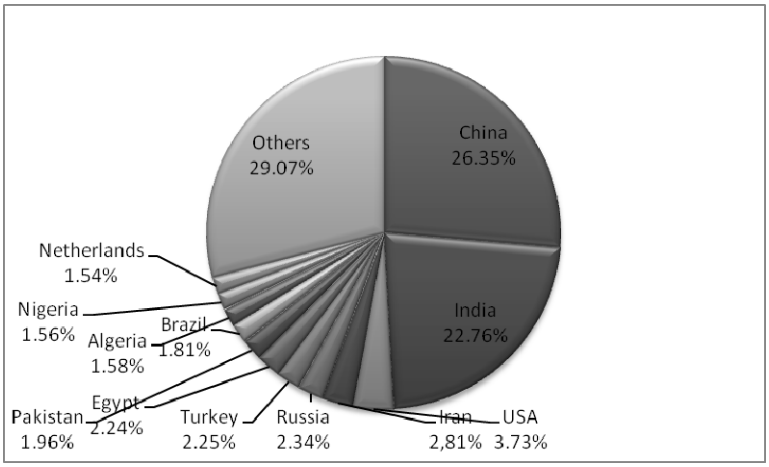


Figure 1 **The share of World dry onion production for the top-12 countries (2013)** (FAO, 2016)

Table 2

**Development of dry onion production in the world (1000 ton)**

| Countries | 1996-2000 | 2001-2005 | 2006-2010 | 2011 | 2012 | 2013 | Index |
|---|---|---|---|---|---|---|---|
| China | 11270 | 17241 | 20757 | 22065 | 22245 | 22345 | 198 |
| India | 4467 | 6584 | 13118 | 17511 | 16813 | 19299 | 432 |
| USA | 3134 | 3333 | 3407 | 3361 | 3277 | 3159 | 101 |
| Iran | 1317 | 1566 | 1869 | 2168 | 2260 | 2382 | 181 |
| Russia | 1132 | 1550 | 1591 | 2123 | 2081 | 1985 | 175 |
| Turkey | 2194 | 2150 | 1876 | 2141 | 1736 | 1905 | 87 |
| Egypt | 644 | 853 | 1778 | 2304 | 2025 | 1903 | 296 |
| Pakistan | 1218 | 1518 | 1859 | 1940 | 1692 | 1661 | 136 |
| Brazil | 949 | 1160 | 1468 | 1523 | 1519 | 1539 | 162 |
| Algeria | 351 | 555 | 854 | 1144 | 1183 | 1344 | 383 |
| Nigeria | 577 | 848 | 1285 | 716 | 900 | 1320 | 229 |
| Netherlands | 685 | 940 | 1167 | 1541 | 1353 | 1310 | 191 |
| World | 44845 | 57852 | 94488 | 84373 | 81507 | 84803 | 189 |

FAO, 2016. * Index: 1996-2000= 100

area. Its share is 27.75% and it is followed by China (23.40) and Nigeria (4.33%). Turkey is ranked number 12 in the world with a share of 1.45%.

Rapid population growth in the world caused a significant increase in the production of dry onion. The developments of the production in the major dry onion producing countries in the world are presented in Table 2. The world dry onion production reached 84.8 million tons with a 1.9-fold increase in 2013 while it was 44.8 million tons in average between the years 1996-2000. It is observed that the largest increase occurs in India when the dry onion production figures are examined for the major producing countries in the world. In the studied period, the dry onion production in India increased about 4.3-fold. The following countries having the largest increase are Algeria (3.8-fold), Egypt (3-fold), Nigeria (2.3-fold) and China (2-fold). In the same period, Turkey's dry onion production fell to 1.9 million tons with a decrease by nearly 13% in 2013 while it was 2.2 million tons in average between the years 1996-2000.

According to Figure 1 presenting the share of world dry onion production for the top-12 countries in 2013, China has the largest share (26.35%) in the world dry onion production and is followed by India (22.76%) and the USA (3.73%). Regarding Turkey, it is ranked sixth in the world dry onion production with a share of 2.25%.

The developments of dry onion yields for some countries in the world are given in Table 3. While the world dry onion yield per hectare was 17.17 tons according to the calculations made on the basis of 1996-2000 period, it reached 21.07 tons with an approximately 23% increase in 2013. It is found that the largest increase in yield is in

Table 3

**Development of dry onion yield in the world (ton/ha)**

| Countries | 1996-2000 | 2001-2005 | 2006-2010 | 2011 | 2012 | 2013 | Index* |
|---|---|---|---|---|---|---|---|
| Ireland | 28.82 | 51.84 | 62.30 | 59.64 | 62.50 | 68.75 | 239 |
| South Korea | 57.63 | 59.97 | 66.33 | 66.16 | 57.04 | 64.58 | 112 |
| Australia | 42.66 | 44.80 | 49.19 | 53.89 | 51.68 | 54.79 | 128 |
| USA | 45.93 | 49.89 | 54.25 | 56.26 | 54.62 | 54.47 | 119 |
| Spain | 41.34 | 46.34 | 48.76 | 53.31 | 51.30 | 53.69 | 130 |
| Sweden | 34.42 | 31.14 | 34.48 | 41.42 | 50.40 | 49.60 | 144 |
| Austria | 54.22 | 45.23 | 45.23 | 62.09 | 46.43 | 47.44 | 87 |
| Netherlands | 57.33 | 47.96 | 44.19 | 51.64 | 49.68 | 45.80 | 80 |
| Greece | 23.05 | 26.72 | 26.43 | 33.29 | 35.66 | 45.33 | 197 |
| Chile | 40.44 | 48.55 | 48.19 | 46.31 | 41.80 | 44.89 | 111 |
| Turkey | 21.03 | 23.73 | 28.23 | 28.94 | 27.55 | 29.86 | 142 |
| World | 17.17 | 19.05 | 20.29 | 20.84 | 20.56 | 21.07 | 123 |

FAO, 2016 * Index: 1996-2000= 100

Table 4

**Development of dry onion export in the world (ton)**

| Countries | 1996-2000 | 2001-2005 | 2006-2010 | 2011 | 2012 | 2013 | Index* |
|---|---|---|---|---|---|---|---|
| India | 316 260 | 737 219 | 1 420 613 | 1 110 139 | 1 527 800 | 1 476 575 | 467 |
| Netherlands | 506 832 | 745 008 | 1 085 015 | 1 326 576 | 1 226 751 | 1 222 270 | 241 |
| China | 131 969 | 399 992 | 587 445 | 745 027 | 620 722 | 745 818 | 565 |
| Mexico | 254 935 | 266 374 | 301 008 | 370 135 | 374 710 | 378 016 | 148 |
| USA | 299 933 | 320 018 | 311 124 | 356 159 | 332 175 | 358 003 | 119 |
| Egypt | 122 349 | 286 317 | 230 439 | 490 922 | 319 248 | 329 736 | 270 |
| Spain | 226 273 | 211 897 | 242 084 | 253 384 | 256 228 | 287 766 | 127 |
| Argentina | 258 649 | 184 217 | 219 598 | 212 038 | 149 686 | 225 088 | 87 |
| Peru | 27 173 | 47 301 | 95 421 | 177 306 | 162 364 | 196 137 | 722 |
| Turkey | 134 465 | 115 112 | 150 034 | 119 820 | 140 768 | 158 036 | 118 |
| Yemen | 7 060 | 33 208 | 70 122 | 132 423 | 112 718 | 124 924 | 1769 |
| Poland | 103 875 | 120 685 | 128 632 | 111 662 | 119 222 | 111 515 | 107 |
| World | 3 445 260 | 4 638 507 | 6 217 638 | 6 833 883 | 6 534 833 | 7 010 515 | 203 |

FAO, 2016. * Index: 1996-2000= 100

Ireland with a 2.3-fold. The dry onion yield per hectare in Ireland rose to 68.75 tons in 2013 while it was 28.82 tons in average between the years 1996-2000. Following Ireland, Greece is ranked second (2-fold). In the studied period, there is an increase of around 42% in dry onion yield in Turkey. It can be said that developments in the use of agricultural techniques such as especially fertilizer use and the proliferation of agricultural protection are effective in yield increase in Turkey. According to 2013 data, Ireland is ranked first in the world dry onion yield with 68.75 ton/ha and is followed by South Korea (64.58 ton/ha), Australia (54.79 ton/ha), the USA (54.79 ton/ha) and Spain (53.69 ton/ha), respectively. It is determined that Turkey is over the world average (21.07 ton/ha) with a 29.86 ton/ha yield. It is seen that Turkey's dry onion yield is not in the desired level. Especially in recent years, its reason is the pink root rot disease causing significant yield losses. It is necessary to plant disease resistant varieties and to apply crop rotation in order to effectively combat the disease. Although India is ranked first in the production area of dry onion and ranked second in the production, it is below the world average in dry onion yield with about 17.01 ton/ha.

The developments of dry onion export in the world are presented in Table 4. While the world dry onion export was 3.4 million tons in average between the years 1996-2000, it reached 7 million tones as showing a 2-fold increase in 2013. In the examined period, the largest increase in dry onion export is in Yemen and the increase is around 17.7-fold. The reason of such high growth in Yemen is that the average export volume is very low from 1996 to 2000. The other countries where significant increase occurs in export are Peru (7.2-fold), China (5.7-fold) and India (4.7-fold). In the same period, whereas Turkish dry onion export was 134 thousand tons during 1996-2000 period, it

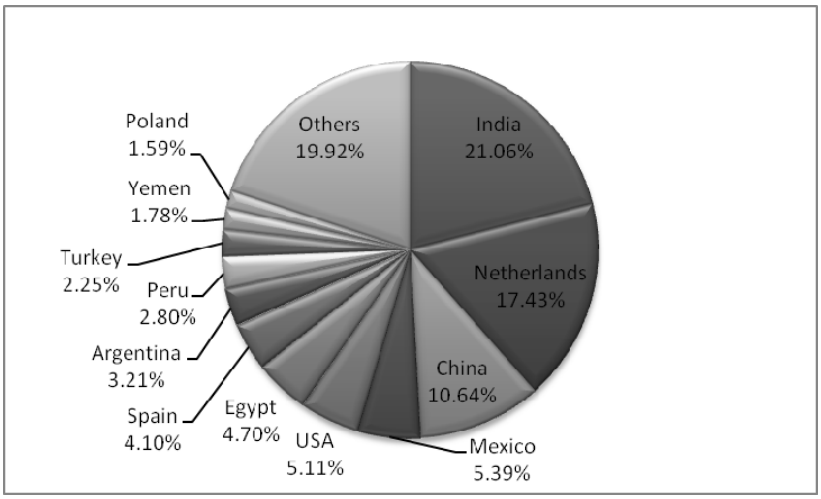


Figure 2 **The share of World dry onion export for the top-12 countries (2013)** (FAO, 2016)

Table 5

**Development of dry onion export in the world (1000 $)**

| Countries | 1996-2000 | 2001-2005 | 2006-2010 | 2011 | 2012 | 2013 | Share (%) (2013) | Index * |
|---|---|---|---|---|---|---|---|---|
| India | 56 006 | 120 046 | 375 268 | 370 736 | 294 760 | 603 519 | 18. 47 | 1078 |
| Netherlands | 128 345 | 180 953 | 407 560 | 522 293 | 411 043 | 537 413 | 16. 45 | 419 |
| China | 30 104 | 79 755 | 168 545 | 302 672 | 293 537 | 373 362 | 11. 43 | 1240 |
| Mexico | 155 861 | 201 795 | 259 408 | 301 175 | 308 031 | 363 721 | 11. 13 | 233 |
| USA | 101 896 | 124 634 | 188 633 | 215 390 | 221 542 | 257 801 | 7. 89 | 253 |
| Egypt | 12 874 | 27 654 | 88 100 | 215 617 | 157 288 | 202 553 | 6. 20 | 1573 |
| Spain | 57 798 | 60 194 | 107 134 | 122 488 | 101 716 | 146 538 | 4. 48 | 254 |
| Argentina | 49 582 | 27 504 | 64 464 | 75 063 | 51 522 | 89 532 | 2. 74 | 181 |
| Peru | 7 937 | 13 412 | 25 911 | 42 888 | 54 402 | 62 938 | 1. 93 | 793 |
| France | 18 208 | 21 745 | 41 130 | 53 289 | 40 047 | 59 317 | 1. 82 | 326 |
| Poland | 15 837 | 26 494 | 56 921 | 54 143 | 45 518 | 52 175 | 1. 60 | 329 |
| Turkey | 20 218 | 12 605 | 21 526 | 21 414 | 20 783 | 27 225 | 0. 83 | 135 |
| World | 906 951 | 1 182 302 | 2 241 068 | 2 893 539 | 2 417 376 | 3 267 614 | 100. 00 | 360 |

FAO, 2016. * Index: 1996-2000= 100

increased by 18% reaching 158 thousand tons in 2013.

According to Figure 2 showing the share of world dry onion export for the top-12 countries in 2013, India is ranked number one in the world dry onion export with a share of 21.06% and is followed by the Netherlands (17.43%), China (10.64%), Mexico (5.39%) and the USA (5.11%), respectively. Turkey has about 2.25% share in the world dry onion export with 158 thousand tons. Turkish dry onion is exported to Iraq (52%), Russia (14%), Syria (8%), Bulgaria (7%) and Georgia (7%), respectively. These five countries constitute 88% of Turkey's export (FAO, 2016).

The development of world dry onion export in value is given in Table 5. Whereas the world dry onion exports in value was $907 million in average during 1996-2000 period, it rose to around $3.3 billion as increasing by 3.6 times in 2013. India is ranked number one in the world dry onion export with a share of 18.47% and is followed by the Netherlands (16.45%), China (11.43%), Mexico (11.13%) and the USA (7.89%), respectively. Turkey is ranked number 12 with nearly $27 million export (0.83%) in the world dry onion export.

The developments in the amount of dry onion imports for Turkey and 11 dry onion importer countries in the world are shown in Table 6. In the calculations based on 1996-2000 period, it is seen that there is a significant amount of increase in Bangladesh's import. The amount of dry onion import in Bangladesh rose to 360 thousand tons with around 10-fold increase while it

Table 6

**Development of dry onion import in the world (ton)**

| Countries | 1996-2000 | 2001-2005 | 2006-2010 | 2011 | 2012 | 2013 | Share (%) (2013) | Index* |
|---|---|---|---|---|---|---|---|---|
| Malaysia | 224 888 | 303 914 | 438 264 | 453 651 | 442 495 | 459 874 | 6.71 | 204 |
| USA | 257 576 | 292 375 | 345 100 | 394 053 | 385 265 | 436 952 | 6.38 | 170 |
| England | 180 397 | 269 711 | 351 535 | 356 748 | 338 636 | 434 584 | 6.34 | 241 |
| Bangladesh | 36 639 | 173 011 | 432 722 | 268 109 | 374 213 | 360 267 | 5.26 | 983 |
| Japan | 209 864 | 257 940 | 250 095 | 373 123 | 342 293 | 302 225 | 4.41 | 144 |
| S. Arabia | 159 569 | 189 140 | 226 760 | 323 126 | 305 747 | 279 303 | 4.08 | 175 |
| Russia | 387 156 | 472 562 | 513 843 | 453 332 | 229 861 | 243 536 | 3.55 | 63 |
| Germany | 263 478 | 261 857 | 233 588 | 278 360 | 232 238 | 237 307 | 3.46 | 90 |
| Un.Arab.Em | 145 821 | 162 480 | 218 734 | 175 370 | 225 121 | 200 209 | 2.92 | 137 |
| Canada | 127 592 | 157 037 | 154 988 | 178 307 | 175 595 | 186 070 | 2.72 | 146 |
| Sri Lanka | 105 646 | 124 991 | 159 564 | 177 538 | 152 929 | 184 260 | 2.69 | 174 |
| Turkey | 1 176 | 146 | 406 | 7 548 | 365 | 1 224 | 0.02 | 104 |
| World | 3 410 725 | 4 414 713 | 5 919 572 | 6 399 757 | 6 403 811 | 6 851 023 | 100.00 | 201 |

FAO, 2016. * Index: 1996-2000= 100

Table 7

**Development of dry onion import in the world (1000 $)**

| Countries | 1996-2000 | 2001-2005 | 2006-2010 | 2011 | 2012 | 2013 | Share (2013) | Index* |
|---|---|---|---|---|---|---|---|---|
| USA | 153612 | 195355 | 260346 | 294263 | 269697 | 364058 | 10.97 | 237 |
| England | 71520 | 106966 | 202045 | 231480 | 180920 | 246102 | 7.42 | 344 |
| Malaysia | 61880 | 79277 | 132258 | 191487 | 137763 | 213423 | 6.43 | 345 |
| Germany | 87488 | 95555 | 136232 | 239393 | 133131 | 171823 | 5.18 | 196 |
| Japan | 68851 | 77157 | 99455 | 176174 | 181780 | 170468 | 5.14 | 248 |
| Canada | 45983 | 69772 | 540690 | 119148 | 125641 | 152253 | 4.59 | 331 |
| Bangladesh | 8054 | 35665 | 144791 | 89611 | 66800 | 143185 | 4.32 | 1778 |
| Russia | 75651 | 75939 | 158458 | 208171 | 106815 | 124327 | 3.75 | 164 |
| Viet Nam | 627 | 3639 | 25374 | 55138 | 78455 | 119598 | 3.61 | 19074 |
| Netherlands | 28329 | 30144 | 67751 | 131717 | 79824 | 103766 | 3.13 | 366 |
| S. Arabia | 26936 | 31041 | 334099 | 121243 | 110561 | 99213 | 2.99 | 368 |
| Turkey | 144 | 24 | 74 | 1.135 | 54 | 171 | 0.01 | 119 |
| World | 1 013 345 | 1 275 912 | 2 325 909 | 3 031 086 | 2 496165 | 3 317 301 | 100.00 | 327 |

FAO, 2016 * Index: 1996-2000= 100

was 36 thousand tons in average in 1996-2000 period. The other countries in which a significant increase in the amount of import occurs are England (2.4-fold), Malaysia (2-fold) and Saudi Arabia (1.7-fold). When the shares of importing countries in the world dry onion import are examined, Malaysia is ranked first with a share of 6.71% and is followed by the USA (6.38%), England (6.34%) and Bangladesh (5.26%), respectively.

The development of the world dry onion import in value is given in Table 7. Whereas the world dry onion import in value was $1 billion in 1996-2000 period, it reached $3.3 billion as increasing by 3.3 times in 2013. The USA is ranked first with a share of 10.97% and is followed by England (7.42%), Malaysia (6.43%), Germany (5.18%) and Japan (5.14%), respectively. Regarding Turkey, it is not an importing country in terms of dry onion and therefore its import value is very low.

The development of dry onion prices in some countries in the world is presented in Table 8. In the studied period, it is determined that the largest increase in the dry onion price occurred in Israel. Dry onion price in Israel increased to 522 $/ton with a 2.7-fold rise in 2014 while it was 197 $/ton in average in 1996-2000 period. A 2.3-fold increase occurred in dry onion price in England and it is ranked second. When Turkish dry onion price is investigated in the studied period, it is observed that there have been important fluctuations since 2011 although there was an increase in the price until 2011. The dry onion is a product marketed under free market conditions and its prices are formed by free market conditions.

Producers determine the dry onion production depending on the prices in the previous production period. When the dry onion prices are high, the producers make production in a much larger area; otherwise the production is made in a

Table 8

**Development of dry onion price in some countries ($/ton)**

| Countries | 1996-2000 | 2001-2005 | 2006-2010 | 2011 | 2012 | 2013 | 2014 | Index* |
|---|---|---|---|---|---|---|---|---|
| Greece | 366 | 394 | 621 | 695 | 482 | 619 | 620 | 169 |
| Israel | 197 | 259 | 408 | 569 | 545 | 747 | 522 | 265 |
| England | 226 | 253 | 391 | 497 | 338 | 501 | 514 | 227 |
| USA | 252 | 255 | 307 | 240 | 313 | 331 | 300 | 119 |
| Russia | 170 | 163 | 278 | 310 | 186 | 230 | 282 | 166 |
| Iran | 280 | 143 | 185 | 173 | 282 | 378 | 277 | 99 |
| Austria | 142 | 143 | 248 | 258 | 169 | 313 | 255 | 180 |
| Germany | 145 | 186 | 269 | 301 | 181 | 318 | 243 | 168 |
| Turkey | 236 | 264 | 388 | 455 | 271 | 277 | 238 | 101 |
| Ukraine | 111 | 120 | 206 | 213 | 91 | 225 | 184 | 165 |

FAO, 2016. * Index: 1996-2000=100

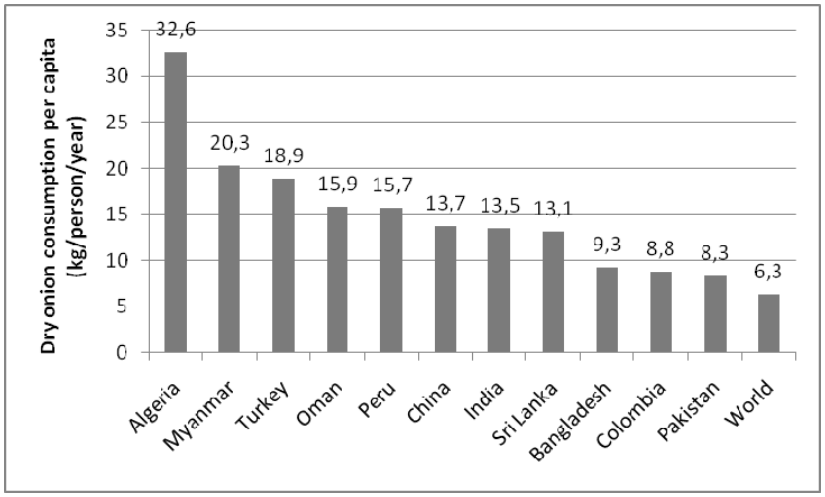


Figure 3 **Dry onion consumption per capita in World (2013)** (FAO, 2016)

smaller one. In a study covering the 1975-2006 period, it is revealed that the correlation between dry onion price and its production level is 92%. The result statistically shows that there is a very high interaction between the dry onion production and its price (Erdal, G. and Erdal, H., 2008).

The annual dry onion consumption per capita in 2013 is given in Figure 3. According to the data, the highest share of the dry onion consumption per capita is in Algeria in the world and the annual dry onion consumption per capita is 32.6 kg in this country. It is followed by Myanmar (20.3 kg/person/year), Turkey (18.9 kg/person/year), Oman (15.9 kg/person/year) and Peru (15.7 kg/person/year), respectively. The annual dry onion consumption per capita is 6.3 kg as a world average. Thus, it is seen that Turkey is ranked third in the world in terms of the dry onion consumption per capita and is over the world average.

## Problems Encountered in Dry Onion Production and Foreign Trade in Turkey

One of the most important problems encountered in onion production is the fluctuations in the production. The fluctuations in the production cause greater fluctuations in onion prices and it would harm producers in large quantities for some years. Producers often decide how much to produce as considering the prices in the previous production period. The onion production is occurred in more areas when the prices in the previous production period are high. On the other hand, the production is made in less area when the prices are low. Consequently, producers suffer when the production is excessive and consumers suffer, in case it is low. Therefore, it is necessary to do production planning to avoid this situation.

Producers could not economically organize enough. Thus, they are faced with serious issues particularly at the stage of input supply and product marketing. For this reason, it is important that the producers organize in the form of producer associations or cooperatives.

Products cannot be provided in the appropriate quality and standards for the foreign market demands. Therefore, an attention should be especially given to the contract production and a sufficient amount of variety should be provided in accordance with the wishes of the international markets. In this regard, the cultivation of resistant varieties should be provided as doing reclamation work and should be encouraged.

Produced onions cannot be stored in the cold storage facility under suitable conditions. For this reason, the losses occur in nearly 20% of the production due to the reasons such as decaying, sprouting and withering. A sufficient number of suitable cold storage facilities are required in the regions having intensive production to overcome these losses.

Especially in recent years, pink root rot disease has led to a large amount of yield losses in dry onion production. The disease occurs inside the soil. The disease resistant varieties should be chosen and the crop rotation should be applied. It is very important that the crop rotation should be performed on the dry onion because it is a tuber plant. An increase will be observed in the onion yield when the onions plant after the legumes. Education and extension activities should be increased to inform consumers on these issues.

## CONCLUSIONS

The study examined the development of dry onion production and foreign trade in Turkey and in the world during the 1996-2013 period. In the

examined period, 1.7-fold, 1.9-fold and 1.2-fold increases were obtained respectively in the world dry onion production area, production and yield. In the same period, whereas there were 39% and 13% decreases respectively in the production area of dry onion and the production in Turkey, approximately 1.4-fold increase occurred in the yield. Ireland is ranked number one and South Korea is ranked number two in the yield of world dry onion while India and China are ranked first two in the production area and production. It is determined that Turkey is ranked number 12 (1.45%) in the dry onion production area, number six in the production in the world and is over the world average (21.07 ton/ha) in the yield. India, the Netherlands and China are in the top three in the world dry onion export and Turkey is ranked number 10 with a share of 2.25%. Regarding the world dry onion import, Malaysia, the USA and England are the top three countries. Turkey is not a dry onion importing country.

Turkey is ranked third in terms of the dry onion consumption while Algeria is ranked first. The major issues faced in the dry onion sector in Turkey can be listed as the extreme fluctuations in the production and price, the lack of economic organization, not to produce in the appropriate quality and standards for the foreign market demands, and the lack of cold storage facilities under suitable conditions.

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# THE ORNAMENTATION OF TRADITIONAL FOLK HOME TEXTILES IN THE AREA OF MOLDAVIA

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**Abstract**

Amid the disruption of our society we are nowadays confronted with an apparent return to our original values, characterised primarily by nostalgia for the origins of the Romanian village, which results from a growing sense of loneliness and alienation generated by urban life. "It is not the ethnic peculiarity nor the folk genius, but rather the authentic, the universal, generally human in their original simplicity that modern man's soul searches and discovers today in the traditional folk art" - argues the prominent professor Dumitru Pop referring to the new dimensions of folk culture. The interior of the Romanian folk house is a collection that constitutes the most decisive part – as an expression of the lifestyle and spirituality, of the ideas and words of a nation, of family and social life with all that these involve. The factors that determine the structure and evolution of folk home interiors are generally of a human and historical kind.

Human, as the organization of the interiors reflects the living conditions of the community that the individual belongs to. Forms of organization of home interiors have undergone a historic evolution, since whatever may be the human side expressed by a particular home design, it can only be analysed in relation to the era when it was made and developed, within a broader style, which often is predominant to a certain period.

**Key words:** ornamentation, folk, motifs, traditional

The interior of a peasant home, even when this may mean a single room, has always had a dual function, practical and decorative. This results from the very structure of its constituent elements, i.e. the items that serve a practical role never lack decorative elements (ovens, benches, bed, cabinets, clothes hangers, bed sheets and covers etc.).

Hence, stoves feature plated profiles, are adorned or coloured, furniture items are decorated with sculpted motifs, carved or painted, while their free surfaces are covered with hand-made objects such as textiles, ceramics and paintings.

Even some natural products such as gherkins and com cobs find a spot on the surface of the stove or on windows sills. Heritage elements in interior designs are due to the influence of certain institutions such as monasteries, noble estates and even princely courts, which variously infused new elements in folk housing. Among all the categories of objects that constitute the interior of peasant dwellings, textiles serve the most important decorative role.

Regardless of the fabric they are made of - wool or cotton, hemp or silk - the way they are arranged on furniture, walls or beams, their through decorating composition and colours, textiles define the decorative style of a particular area. Even a regular towel, hanging on a hook on the door, is refreshed by several ornaments. Thus, on simple cloth, hemp, or cotton fabric, the lady of the house would stitch discrete rows of diamonds, stars, flowers, such towels serving to wrap food for those who toiled in the fields. Lucian Blaga, in his typical comparative-analytical spirit, would argued that "*... in terms of dominance and dosage, we can find that in Romanian ornaments the sovereignty of straightforward linear geometrics and stylised figures is more marked than elsewhere, while the dosage of geometrics and organically stylised motifs displays unequalled balance….*"

## MATERIAL AND METHOD

Traditional interior tissues, made of white fabric and black, red or burgundy wool, are still found nowadays in new homes. They play an important decorative role, defining the interior decoration style of the area. Beauty of rugs and other interior textiles once sparked the interest of many foreign travellers who visited the Romanian principalities, as evidenced by their writings. A. Ramasay made an interesting description "..... ***all around the rooms, against the walls, there are benches covered with exquisite home-made rugs in wool or cotton. In a corner of the room, many other rugs are usually put aside for the girls' dowry***".

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In terms of the fabric they are made of, home textiles may be:

- textiles made of animal fibres (wool, cotton, silk, etc.);
- textiles made of vegetable fibres (flax, hemp, cotton).

As regards their function inside the home, they may be:

- regular use textiles (blankets, runners, pillow usually placed on the bed or dowry chest);
- fabrics with a decorative role (rugs, carpets, tablecloths, towels);
- fabrics linked to certain occasions such as ceremonies, weddings, baptisms, etc.

In terms of function, home textiles can be classified into:

- items that hang on the wall (covers, rugs, or carpets);
- bedding and covering items (blankets, various types of bed spreads)
- items laid on the floor (floor rugs)

## RESULTS AND DISCUSSIONS

**Covering sheets** (*prostire de perete*) are put on clothes to protect them from dust and may have other functions such as when used on special occasions, i.e. wedding or funeral.

A century ago, certain styles of **covers** (*lăicer*) and **mats** (*păretar*) used to be made in dyed vegetable wool, being placed on the wall next to the bed or the benches. They were decorated with alternating transverse stripes, arranged in a rhythmic fashion, in pastel shades of green, yellow, mustard, purple, red, black and white or the natural colour of wool. The ornamental motifs used included: national ones, wheels and half-wheels, rhombus, rosette or 8-corner shapes, vine leaf, fir tree, star or "fork", symbols that once had magic and religious meanings.

**Mats** (*păretar*) were smaller carpeting items made of wool, placed on the floor near the bed. Decorative motifs used include wheels and sad figures, widely used archaic symbols.

In relation to covers and mats, **rugs** (*scoarță*) feature certain peculiarities of form and ornamental composition. Their rectangular shape and greater width provide space for a more complex composition all over the fabric surface, in all directions, without transversal divisions (as is the case of the *lăicer*). The background of rugs is monochrome: brown, beige, green, blue, yellow, sky blue or faded pink.

As regards the execution of **carpets** covering the bed or wall near the bed, we may distinguish two categories: the former is dominated by frequent geometrical and floral decor, achieved in discrete harmony, while the latter is marked by anthropomorphic and zoomorphic representations in bright colours that give a feeling of exuberance and vitality.

Many motifs are of ancient origin. Dacian and Latin elements overlapped by Byzantine motifs have contributed to an unmistakable original style. The most common compositions include motifs arranged in rows across the entire surface. Even nowadays designs include wide decorative borders with double stalks, oak or walnut leaves, ears of wheat, vines or miniaturised motifs drawn from heritage compositions. Floral elements are accompanied by zoomorphic and anthropomorphic representations. One of the motifs in Moldavian rugs is the bird, e.g. rooster, peacock, cuckoo, swan, crane, stork, etc.

The emergence of the border, viewed as a superior shape on the evolutionary scale of the ornamentation of folk fabrics, has contributed to higher profile for decor and the symmetrical and rhythmic grouping of ornaments around a central decorative element.

In the colour and arrangement of decorative elements one may distinguish clearly the aesthetic concept of Romanian folk art as a whole, with ornaments being grouped into well-defined strips of white fields, highlighting the vibrancy of colours. In the decorative interplay of ornamental motifs of rugs, covers, mats, carpets, woven blankets, etc., skeuomorphic elements, i.e. images depicting objects forged by man are included: mills, rakes, stakes, carding combs, shepherd's hook, ploughs, all symbolising wealth and abundance.

The home textiles category also includes **blankets** (*cergi*). To craft such items, the wool yarn is spun thicker and then twisted reasonably tight. In the past, rugs were monochrome (white, grey or seine), only natural colours being used as these items had a utilitarian purpose. Over time, interest in decorating rugs grew steadily, leading to remarkable polychrome textiles, with discreetly refined ornaments.

***Macatul de lână*** is a weave in two colours namely wool and cotton, placed on the wall or the dowry chest. It was also used to craft bed spreads.

***Velnița*** is patterned wool fabric with stripes or *alesături* used as linen on the bed, to decorate the walls or for wrapping.

***Țoluri de podele*** (floor mats) play a very practical and aesthetic role. They are woven at home from strips about 2 cm wide cut from different old clothing items.

**Towels** (*ștergare*) and their miniature versions, woven from hemp or cotton and used to decorate the rooms, are distinguished by geometric patterns in vivid colours (red, burgundy, blue, yellow) with floral decorations (flowers, leaves,

buds). The diversity of solar symbols and abstract shapes such as the rosette, squares, triangles, vortex, solar wheel, rhombus, crossed circle, etc., are prevalent in the decorative composition of old towels in the area of Moldavia. Many of towels have tasselled ends with red, blue, yellow, silver, white or green beads. Towels used as a scarf are a specific item, related to folk costume accessories, inherited from the time of the Gaeto-Dacians.

There is a rather high proportion of **embroidered towels**. The innovative spirit and the skill of embroidery artisans enable them to use, simplify, stylise and process motif achieving classical morphological perfection. The chief, most widespread element of embroidery compositions is the tree of life, rendered according to the Oriental influence surrounded by stylised birds (cuckoos, roosters, peacocks, pigeons, etc.).

Thanks to their shape and size, to the variety of display systems (placed on walls, at the door, near windows, icons or mirrors) within the broader collection of interior decorative items, and their decorative and chromatic composition - towels create exquisite artistic effects, highlighted against the white background of the fabric.

Pillowcases and handkerchiefs feature embroidered ornaments: star or rosette, fern, clover, dianthus, vines, which all symbolise luck and the joy of life. All traditional seams are made in a single cross (the well-known Romanian point) or the double cross.

Solar symbols are frequently associated with elements of the tree of life, a consequence of ancient links with the Mediterranean civilisation. Contemporary folk artisans regularly use textile fabrics, to craft either a towel or pillowcase, have also adopted the sun as a motif, thus extending its life. This motif is featured on carpets, tablecloths, covers. Rugs often display an interesting sequence of trees of life and feminine silhouettes in dresses with traditional cuts. The presence of horses and horsemen (on towels) is related to an visual representation fundamental to the Dacians, the "*Thracian knight of the Danube*". One may also notice an invasion of Oltenian patterns used on carpets: roses, tulips, carnations, etc.

**Tablecloths** feature complex decors, the main motifs being birds, branches with flowers or potted flowers as a variant of the tree of life. The repetition of embroidery on tablecloths creates a relationship of complicity and inclusion. Repetitions are sometimes gradual, with the same motif being rendered in simple or complex shapes and hues.

The colours once used by the ancestors on the territory of ancient Dacia, are used to this day in rural communities. They are vegetable colours, in particular:

- ***Red***: symbol of blood, sun, fire, love and joy of life; it is made from sweet apple peel, leaves and flowers of sweet apple, madder, marjoram flowers, peony flowers, rose hip shell;
- ***Blue***: represents the sky, health, vitality; it is obtained from the flowers of violets and woadwaxen, and hawthorn root;
- ***Green***: symbolises the renewal of nature, freshness, fertility, hope; it is made from raw springtime rye, mint leaves, walnut leaves, alder bark, wild apple tree bark and buds, sunflower, parsley, etc.;
- ***Yellow***: stands for light, youth, happiness, harvest, hospitality; it can be obtained from sea buckthorn fruit, onion peel, privet shell, hagberry shell, chamomile and linden flowers;
- ***Violet***: represents self-control, patience, trust in justice; it is obtained from ripened cranberry and elder fruit, bitter black cherry, well ripened hybrid black grapes;
- ***Brown***: is obtained from quince leaves, the bark of birch, linden or oak trees, hard walnut shells, tobacco leaves;
- ***Ochre***: may be obtained from the flowers of lavender, lilac branches, horseradish leaves, hop stems, marigold flowers, chestnut bark, soybean strains.
- ***Black***: is obtained from peppermint, alder and nettle.

Vegetable colours are prepared based on recipes handed down from generation to generation, involving a large variety of processes and techniques. It is important to note that plans offered a large variety of hues, depending on when they were harvested, the drying time or the ways in which they were mixed.

## CONCLUSIONS

The life experience accumulated by successive generations has been passed on using a system of plastic signs. This compels us to state that these symbolic ornaments also serve as records that encapsulate an impressive aesthetic and human experience.

The ceremonial spiritual sphere has provided a strong impetus to preserve ancient heritage. With their many implications in the folklore of family customs, the napkin, handkerchief or shawl have substituted, on a concrete level, the bridge, which holds spiritual meanings and serves in purification rituals. All worldly and spiritual gifts collected in the interplay of ages sanctify the moments of silence

when one contemplates joys of life. The shawls, towels, carpets, rugs and covers, viewed in the continuity of human dwellings, provide today poignant glimpses into the simple biography of the Romanian peasant.

Folk ornamentation, Tancred Bănățeanu argued, *"expresses a great wealth of feelings and an exquisite artistic sense of the Romanian people, resulting from the unmediated link that exists between art and life"*.

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# THE ELEGANCE, DECORATIVE MOTIFS AND THE CHROMATICS OF POTTERY IN THE REGION OF MOLDAVIA

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**Abstract**

Romanian folk art is reflected in the building of dwellings, churches, household buildings, gates and wells, crosses and in wood carvings and sculptures, the various objects that farmers use, in clothing, textiles, carpets, etc.
Within the Moldavian folk art area, pottery is among the oldest traditional crafts, originating in the ancient Gaeto-Dacian practices. In a study of Dacian ceramics, Grigore Tocilescu argued that "*pottery, in addition to its role as a historical record, is also a work of art that proves the great talent of its authors. Today our ancestors' pottery reveals abundantly its artistic virtues. Pottery therefore acts particularly as a direct historical reference*.

**Key words**: folk, pottery, ceramics, traditional

The Greek word *keramos* designates earth or clay. The role of pottery in human life was immense throughout the world. Barbu Slătineanu stated that it is hard to comprehend the place that pottery had uninterruptedly from the Neolithic up to the mid-20th century as it "... was used on the tables both of the rich and the poor.

Alongside numerous objects made of wood, textile fibres, metal or other materials, the peasant household comprises a rich collection of earthenware: pots used for cooking food on the fireplace, mugs, jugs, cups, bowls, etc. The ornamentation of utilitarian pottery has been particularly consistent over time for each particular site, with differences from one site to another and from one potter to another. Such differences are derived from the diverse creative views and the various combinations of basic decorative motifs.

The multitude of forms and their elegance, the ornamental motifs and compositions, the harmonious colours are indicative of tradition craft of modelling clay vessels and the focus on beauty of Romanian artists. The shape of traditional clay vessels was always the work of the human hand, even when modelled using the wheel. Bearing the imprint of man's skilled hand, clay vessels bear the seal of the creative calling and skill of their maker.

## MATERIAL AND METHOD

A look of pottery types according to their use reveals that nearly all pottery site produced fireplace items, objects used to serve food or water, objects with other domestic and household roles (figurines), musical instruments (ocarinas, whistles), play objects (masks), etc

Based on the type of combustion there are two categories of pottery:

- black pottery
- red pottery

*Black pottery* of Dacian tradition expanded throughout the territory of Moldavia, with a few pottery centres remaining to this day in *Marginea, Rădăuți (Suceava), Dorohoi (Botoșani), Negrești, Vulpășești (Neamț), Poiana-Deleni, Schitu Stavnic-Voinești, Dumești (Iași), Zgura, Brădești, Bârlad (Vaslui), Bacău.* Black pottery is obtained by reduction firing, i.e., ensuring that oxygen does not penetrate the kiln, with sufficient draft to allow complete oxidation. Initially, this type of firing was used due to unfavourable conditions. Vessels were fired in the past in 1.5-meter wide pits, shaped as a reversed cone. A second pit was dug nearby, communicating with the first, where the fire was made with leaves, straw and brushwood. The fire led to the red coloration of vessels in the larger pit. At this point the vessels were covered with a thick layer of wet clay, thus blocking channel between the two pits. The firing would continue without oxygen, the wares becoming gray or black

The technique has been preserved until today with few changes, as has the ancient shapes of the vessels: high pots, large pots with two handles, bowls of various kinds, mugs, etc.

Similar methods are used in black ceramics nowadays, whether for decoration purposes - by polishing (using stone or felt) and by printing or incising (with a sharp point, wheel or straw). Both actions are performed on a raw vessel, the former

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after it is slightly dry, and the latter before lifting it on the wheel. Incised ornaments on black pottery are divided into geometric and vegetal or vegetable ones. Lines are a key feature among the geometric ornamentation and can take many forms: broken lines, dotted, branched, etc. Quite often a simple spiral is used or a concentric one with two or three rings, starting from a central point. Since ancient times grid-like shapes have been used on black ceramic, covering the whole vessel. As regards the plant decoration on black ceramic, it is confined to pine leaves and fir branches.

Owing to its colour, varied sizes, clay and decor, black pottery is one of the most interesting categories in our country and unique among pottery in Europe.

*Unglazed red pottery* is an old tradition and has been preserved as a separate category in Romanian pottery. Serving utilitarian purposes, its various uses have been survived over time. Sometimes, owing to its harmonious shapes and pleasant decoration it has been used for decorative purposes.

Depending on function and capacity, such vessels include cans reminiscent of Dacian vessels, pitchers, bowls, etc. The ornamental compositions of such pottery include parallel lines of the same colour or different colours or alternating hues with wavy stripes. Sometimes, dots of the same colour are painted along the lines. Motifs include the crest, associated with either an oblique line or with a concentric line.

Unglazed red ceramic from Moldavia maintains a slightly traditional direction both in terms of shape and decoration. Sites where unglazed red pottery is produced include *Parcovaci, Harlau, Ungheni, Grozești (Iași), Zgura, Iveşti (Vaslui), Oltenești, Bicaz, (Neamț), Voroneț (Suceava)*. They are relatively few compared to black pottery and glazed red pottery centres.

*Glazed red pottery* in Romania is particularly diverse in terms of shapes and ornaments. It is beyond doubt that the Romanian people, born of the Dacians and the Romans, adopted glazed pottery tradition from the Byzantines, along with models of vessels, motifs and techniques directly related to the discovery of glazing.

Byzantine tradition is well represented nowadays in Romania, yet certain centres remain faithful to the Dacian tradition, while others to Roman tradition when it comes to red unglazed pottery. The most characteristic form of Byzantine tradition, adopted as such with all its morphological features, is reflected in pitchers (medium-sized pitchers glazed in green). Typical of Moldavia, in addition to pitchers, are the large amphorae with alveoli bands, large food jars, plates with handles, small-sized bowls, various cups, large containers, etc. One may note the recurrence of the feather motif, from the Byzantine tradition, in addition to tear-shaped decorations featured especially on bowls and saucers.

Glazed red pottery centres are located in *Schitu Stavnic, Voinești, Dumești, Tansa, Mircești, Răducăneni, Bivolari (Iași) Lespezi, Suharău, Dolhești, Siret, Păltinoasa, Rădăuți (Suceava) Trușești, Tudora, Broșteni, Ștefănești, Mihăileni, (Botoșani), Răchitoasa, Mănăstirea Cașin, Oituz (Bacău), Țibucași (Neamț) Vutcani, Brădești (Vaslui).*

*Rădăuți* is a strong centre of traditional pottery represented by *Kuty sgraffito pottery* and *Rădăuți pottery*. Particularly impressive is the wide range of motifs: geometric, avimorphic, zoomorphic, anthropomorphic and skeuomorphic. The difference between the two styles lies in the dominant colour. The former is painted in white, green, yellow and brown, i.e. four seasons, while in the latter the background is always green and brown is used for decoration.

*Cucuteni pottery* is highly particular and specific and unique in Europe. It has long fascinated by its exquisite elegance, the sense of proportion and profile line as well as through spiritual messages conveyed (whether by large one-meter high vessels or containers only a few centimetres high). This pottery exudes soothing magic, yet it also raises many questions about the significance of the spirals, whirlpools and shapes on the vessels.

The spiral motif, creating a powerful optical illusion, is combined with painted circles, ellipses, lines and bands. Spirals are arranged in horizontal or oblique rows and in various other combinations. The spiral is composed and decomposed in linked spirals, which are then cut and reduced into loops. Their symmetry is not tiring and does not lack elegance; on the contrary, it ensures that the main motifs unfold, combine or alternate so that the end result is particularly harmonious in terms of colouring and graphics.

"*Since the dawn of time, man has acted as a coherent, logical, total, complete being ..... Paleolithic or Neolithic man was not a savage. Through his religious expressions, myths and rituals he had meaning from the very beginning*. Mircea Eliade's point to how people were able to create, thousands of years ago, great objects with perfect shapes and decorations full of symbols.

The Cucuteni pottery technique is almost perfect: the clay is very well prepared and mixed with a few grains of sand, to prevent the vessel walls from cracking. Once moulded the vessels would be placed in clay and dried in the shade. After drying, they would be decorated or painted, only with mineral colours, black holding an important role. Every aspect of the development of this pottery style is a link conditioned upon a previous one, bearing in it the seed of the next link and ensuring its perfect continuity. The meandering spiral decoration sometimes overloaded with zigzagging, parallel lines, garlands, diamonds, triangles, squares, etc., painted in the specific colours of this styles has been preserved by only a few potters based in:

*Rădăuți-Prut, Dorohoi, Truşesti, Ţuguieta, (Botoşani), Valea Lupului, Corlăţeni, Scanteia, Cetăţuia, Ruginoasa, Băiceni, Cucuteni, Schitu Stavnic, (Iaşi), Brădeşti (Vaslui).*

The classic background of Cucuteni style is white, red and black. White and red are used as background or to draw the motifs, while black is used to draw the borders of white or red strips. It goes without saying that both the red and white feature a range of shades, with red being often brown or dark brick, while white has often yellowish hues. Often the black is really a dark chocolate rather than black proper. However they may be combined, the three colours provide harmonious ensembles. With respect to the Cucuteni pottery, it is worth recalling Vladimir Dumitrescu statement - "the elegance of ceramic forms, the harmony of colours, the confidence of the outlined motifs, often their syntax and combination on the surface of the vessels rightfully stir our admiration.

## RESULTS AND DISCUSSIONS

Pottery is decorated when still wet or after drying. Depending on the system of ornamentation one may distinguish:

*1. Pottery decorated by drawing and painting*

*2. Pottery decorated by scratching (sgraffito) in the Byzantine tradition, practiced to this day in Rădăuți and Botoșani*

*3. Pottery decorated with embossed ornaments*

The *incision technique* (scratching or carving vessels) usually involves geometric motifs: simple continuous line, bands, broken or zigzagging lines, parallel or vertical lines, dotted lines, spikes, wavy lines, circles, spirals, diamonds, etc. Certain vessels feature vegetal or incised motifs: stylized fir twig, four-petal flowers, flowers framed by two twigs, etc.

*Embossing* - involves an intervention on the raw clay slurry by embossing belts on large vessels (cooking pots, pitchers, etc.), be they simple, alveolar or crest-like, cylindrical studs, wires, etc.

Among decoration techniques, painting was the most frequently used over the last two centuries. Pottery chromatics includes a limited number of colours, grouped by regions, thus making it easy to recognise styles. Traditional colours were prepared from coloured paints: red, black, different shades of brown. Nowadays, additional colours include green, obtained by burning copper, as well as yellow and blue respectively.

Everywhere such vessels were painted with naturally-derived paint to represent geometric, vegetal and zoomorphic motifs. The surface of vessels (especially the larger ones) would be divided into registers, on which the decor would unfold. The two or three registers covered the central part of the vessel. They were flanked by wide or narrow borders. Geometric or floral motifs were used to draw the borders. Geometric motifs feature a wide range of ornamentation representing millennia of tradition and undoubted continuity, such as dashes, drops (points of colour), kisses (points located on the same line or grouped symmetrically), rows of dots, simple circles, concentric circles, straight, simple or parallel lines, wavy lines, tight or wide, intersecting lines, broken lines, single or double spirals, serrated lines, sequences of sharp angles, small squares, etc.

Plant motifs represent in stylised fashion: fir trees, leaves, flower buds, clover, wheat ear, edelweiss, tulips, sunflowers and daisies.

The tendency to represent figuratively plant motifs on clay vessels has increased in the past century, while the ancient tradition has faded. The latter favoured the abstract representation of objects. A special place is occupied by zoomorphic motifs (doves, peacocks, fish, cranes, etc.).

Symbolic reasons are poignant, as they hint to ancient pre-Christian beliefs that were once universal (the human eye motifs, the sun, the serpent, the twisted rope). An ornament on a simple ceramic pot can be a mere sign, yet if placed in relation to the sun, the cosmic cycles, the myth of permanence and the return, it acquires a symbolic value. Such an ornament then becomes a record of the ancient civilization on the Romanian territory.

Regarding Romanian ceramic ornamentation, Hubert Schmidt argued: "*The detachment of independent motifs from surface motifs is particularly important for the evolution of ornamentation, because it leads to a planned ordering, a synthesis of ornaments based on rules of rhythm and symmetry. Whole compositions are born, detached from free surface ornamentation*.

## CONCLUSIONS

The value of Romanian folk ornamentation originates not only in the exceptionally long history of most motifs or their essential rendering, but also in the diversity and multiplication of solutions in ornamental fields. In addition to the above mentioned qualities, raw materials also play a role in individualising pottery. To conclude, we can distinguish the elements that ensure the unity in diversity of Romanian pottery namely: ***the exquisite sense of proportion, subtlety and finesse, vigour and refinement***.

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# THE SUSTAINABLE MANAGEMENT OF ENDOGENOUS RESOURCES IN THE RURAL AREA OF SIBIU DEPRESSION

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**Abstract**

The sustainable management of endogenous resources is a research topic extensively debated on global scale that promotes an economic and social diagnosis model, meant to emphasize the specificity of territorial element in defining objectives, strategy and options for the development and diversification of economic activities in rural areas. The purpose of the paper is to put in value, in a sustainable way, with efficiency and effectiveness the endogenous resources, by adopting the most relevant possible options, to contribute decisively in reducing disparities in the studied rural area. The research was focused on rural areas in Sibiu Depression - a unitary area with a remarkable habitable and geoproductive potential; for its diagnosis it was used the PESTEL model, whose usefulness is recognized in the context of globalization, because it allows highlighting of the particular aspects of the studied community. This makes it possible to adjust the rural economy and its resilience to the more and more frequent changes occurring in the environment. The PESTEL diagnosis model was completed, for a better and exhaustive knowledge of the socio-economic characteristics of the studied rural area, by the SWOT analysis, which was backed by organizing meetings of the focus group formed by key local factors and specialists, concerned with the development and diversification of economic activities in rural areas. This research has lead to the general conclusion that the development and diversification of rural economy is achieved according to the territorial specificity, and is supported by the rural community that gives life and maintains rural areas of Sibiu Depression.

**Key words**: community, diagnosis, resources, rural, sustainability

Rural development is characterized by complexity and actuality, and relies mostly on the available resources at territory level, also requiring the active involvement of the community in the elaboration, adaptation and implementation of the best available options for the superior valorization of its potential. The complexity of rural space development is given by the size and importance of its national and international importance, and its actuality by the interest shown by the European Union, resulted in the development of adequate policies and strategies, as well by the effort made by our country in adapting and adopting policies and strategies to integrate the rural economy in the common market. The motivation of such topics is also given by the fact that in general rural resources are exploited irrationally (Iagăru R. *et al*, 2014). Rural development should be achieved by the integration of the main activities of the rural areas (agriculture, aquaculture, fisheries, forestry, manufacturing, etc.), and by the diversification of economic activities to maintain a balance between the requirement of preserving rural values, and the trend of rural life modernization (Nistreanu M. *et al*, 2009).

The forces that contribute to achieving this goal are internal and external ones, with different degrees of influence on development, in the recent years increasing the role of internal (endogenous) forces. This paper is based on the new concept of Territorial Development, that states that endogenous forces and the own development capacity are the most important levers to be pushed to achieve a sustainable endogenous economic growth. Endogenous forces involved in this process consist of local actors and various resources – natural, human, material, economic, social, cultural and spiritual - (Zaman G. *et al*, 2015). Obtaining a sustainable endogenous economic growth at the local level is the desire of every community and it is generally based on endogenous forces (Romer P., 1994), while emphasizing investment in people, innovation and knowledge. For this it is necessary to promote market competition, markets opening, research and innovation, that is promoting a process of continuous economic transformation based on territorial specificity, given that its absence is incompatible with economic growth (Howit P., 2005), i.e. rural development.

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The major objective of the research is the area diagnosis, for the adoption of strategic options for the development of the countryside in Sibiu Depression, based on territorial specificity, finally leading to the revival of economic activities, their diversification and increasing employment. Sibiu Depression is located on the southwest of the Transylvanian Plateau and in the north of Southern Carpathians, namely northwards Cindrelului and Lotrului mountains (*figure 1*).

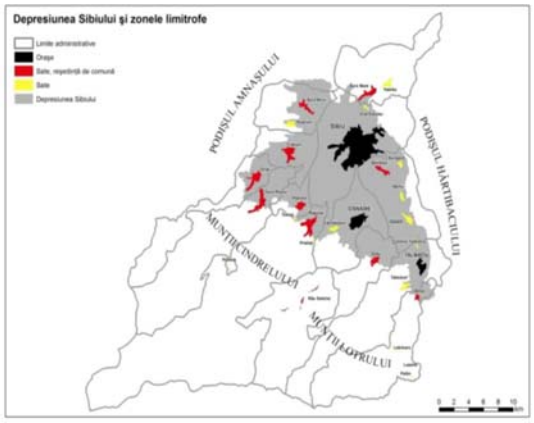


Figure 1 **Sibiu Depression and surrounding areas (Plesia N., 2008)**

The rural area of the depression is characterized by a remarkable potential that allowed a unique rural way of life and its own culture that the community is obliged to properly valorize, based on sustainability principles and precepts.

The relevance of such issues is given by the fact that economic activities in rural areas irrationally exploit the resources.

## MATERIAL AND METHOD

The research of countryside requires a research methodology able to adjust for pinpointing the territorial specificities. The case study is the method chosen for this research because it has demonstrated in numerous studies and projects its utility and relevance of the obtained results (Kerekes K. *et al*, 2010). In our case, for highlighting the specificity of rural areas of Sibiu Depression, and of its endogenous and exogenous forces it has been used both quantitative and qualitative methods, such as: secondary analysis of statistical data and relevant literature (reports, strategies, studies, monographs) PESTEL analysis, and SWOT analysis, respectively, backed by organizing focus group meetings, attended by key local stakeholders and experts concerned with the development and diversification of economic activities in rural areas. The diagnosis of the rural area of Sibiu Depression has featured its components and subcomponents, and consisted of grouping the size of the rural living framework in a set of six criteria for analyzing the macro areas for which it was used the PESTEL (political, economic, social, technological, environmental and legal) model. In order to characterize as complete as possible the rural area of Sibiu Depression, the research has been continued using the SWOT analysis which allowed combining the findings on endogenous potential with those on the non-endogenous ones, in the same time highlighting the occurred problems, providing also answers for their solving.

## RESULTS AND DISCUSSIONS

Using the PESTEL model highlights a number of issues specific to the studied community that enable a continuous economic transformation in order to its adaptation and resilience to the more frequent changes in the environment. The impact of such diagnosis enables the local actors, as forces involved in the development process, to relate better to territorial specificities and to acquire a better capacity for developing and implementing strategic choices relevant to the rural area development. The territorial specificity is highlighted by the PESTEL model following the identification, inside the six major criteria for analyzing the rural area, of the most relevant sub-criteria required for the elaboration of the strategic options to achieve the envisaged objectives. The political criterion for the macro environment analysis highlights the dependency of rural development on adopting the Common Agricultural Policy, on coherence in rural development policies, and on the creation of a business friendly environment, respectively. The economic criterion reinforces the need to adopt economic and fiscal policies that favor rural entrepreneurship, the need to provide a competent workforce and, of course, an adequate infrastructure for starting and development of business in the studied rural area. Social criterion alongside the economic one represents the base of the analysis of rural development and provides relevant information on demography, social laws, education level, lifestyle etc. Knowing the population development is the focal point of the social diagnosis because it has an impact on the economic environment and thus on rural development, being both an action factor and consumer one, benefitting also by the development. The technological criterion highlights a relatively high level of spending on innovation and the number of enterprises especially in areas such as construction, trade, food

processing industry, tourism, which means a good receptivity to innovation. However Sibiu Depression in rural areas physical and ICT infrastructure does not enjoy a level appropriate investment, and cooperation between higher education and rural entrepreneurship should be further enhanced. Diagnosis environment reinforces the need to ensure rural development in terms of sustainability which requires implementing policies on environmental protection, pollution control and waste management. Legislative criterion highlights the both innovation, and in the number of company acting in construction, commerce, food processing industry, tourism, that means a good receptivity towards innovation.

Yet, the road and ITC infrastructure are not at an adequate investment level, and the cooperation between higher education units and rural entrepreneurs must be intensified.

The environmental diagnosis emphasize the necessity to achieve a sustainable rural development, which asks for policies on environmental protection, pollution control and waste management. The legal criterion emphasizes the need of rural development in accordance with the norms related to environmental protection, labor law, health, etc.

For a better and comprehensive knowledge of the socio-economic characteristics of the rural area of Sibiu Depression, the PESTEL method was completed with a SWOT analysis. This method is commonly used to identify strengths and weaknesses, external opportunities and threats of an organization or territorial unit (Vincze M. *et al,* 2009). The processing of the obtained data allowed the following arrangement of the endogenous and non-endogenous factors, as well as opportunities and threats in the SWOT matrix (*Table 1*).

Table 1

**SWOT analysis**

| **Strong points** | | **Weaknesses** | |
|---|---|---|---|
| 1 | Exceptional tourism potential | 1 | Poor knowledge on attracting EU funds |
| 2 | Agricultural potential | 2 | Inefficient public administration |
| 3 | Hydropower potential | 3 | Low attractiveness for young people with higher education |
| 4 | Forestry potential | 4 | Irrelevant development strategies |
| 5 | Renown brands | 5 | Irrational exploitation of endogenous resources |
| **Opportunities** | | **Threats** | |
| 1 | Sources of funding for agro tourism and rural tourism | 1 | Lack of support actions of rural entrepreneurship |
| 2 | Funding sources for agriculture | 2 | Low interest in creating public-private partnership |
| 3 | Funding sources for non-agricultural activities | 3 | Low interest for farmers' association |
| 4 | Sources of funding for physical infrastructure | 4 | Low capacity of the responsible factors in attracting local development funds |
| 5 | Funding sources for infrastructure | 5 | Lack of promotion and support actions of rural products on markets |

The analysis of SWOT information highlights that the advantages of obtaining economic growth are represented by the following endogenous resources: tourism, agriculture, hydropower and forestry. These allow obtaining products constituting an important asset of Sibiu Depression countryside, officially renowned on national and international level (various Sibiu cheese products, Sibiu salami, Sibiel tourist village). The SWOT matrix also clearly shows the existence of certain issues in obtaining an endogenous growth. These are focused on human resources, whose skills fail to attract sufficient development funds, which reflects on the inability of creating attractive jobs for young people with higher education, the promotion of irrelevant strategies and an inadequate exploitation of the endogenous resources. The analysis of the macro environment of Sibiu Depression countryside has identified both opportunities and threats in the process of endogenous growth. These are briefly presented in the SWOT matrix (Table 1). The main elements that threaten the endogenous growth are the lack of support actions for rural entrepreneurs and the low interest both in terms of public private partnerships, and in forming farmers' association. These, together with the reduced capacity to attract development funds and with a lack of promotion and support actions of rural products cause a low negotiation power of the rural producers regarding their dealings with suppliers and customers, with a negative impact on their competitiveness. An asset

in the process of obtaining endogenous economic growth in the rural areas of Sibiu Depression can be represented by a better exploiting of the opportunities in this area. These opportunities are the result of collaboration between the endogenous resources and funding sources for their sustainable exploitation. Thus, an exemplary mobilization of the local actors could raise funding sources that should allow a better use of tourism, agriculture and food, energy, forestry potentials, as well as the development of an adequate road and ITC infrastructure. The synthesis of the information provided by the method recommends certain policy options for achieving endogenous growth in the rural areas of Sibiu Depression, the most relevant considered by us being:

Attracting investments for the development of road and information and communication technology infrastructure;

Adopting measures to support rural entrepreneurship;

Better use of tourism potential by initiating new business or developing existing ones;

Better use of the potential of agriculture and food by initiating / developing farms / food processing companies;

Better use of forestry potential;

Better use of the energy potential;

Increasing processing of the raw materials results from processing the endogenous resources;

Increasing the involvement of local actors in promoting rural products;

Development of consultancy services on financing rural entrepreneurship;

## CONCLUSIONS

Attracting investments for the development of road and information and communication technology infrastructure leads to increased resource efficiency.

Adopting measures to support rural entrepreneurship has a positive impact on development and diversification of rural activities.

Better use of existing resources in rural areas of Sibiu Depression is made based on a diagnosis of its components

Development of consultancy services on financing the rural entrepreneurship encourages private initiative.

Involving local actors in rural product marketing stimulates rural economy.

Increasing processing of the raw material results from processing the endogenous resources will generate added value and competitive advantages at national and international level.

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# THE MANAGEMENT OF RESOURCE SUSTAINABLE VALORIZATION BY TOURISM IN THE INTER-ETHNIC RURAL AREA OF SIBIU DEPRESSION

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**Abstract**

The management of resource sustainable valorization by tourism is always a problem, and this research will try to provide an answer. Our research is based on strategic assessment of rural area for the development of options for sustainable resource valorization by tourism and promoting an evaluation model by involving local communities, enabling selection of the most relevant ones. Thus, it is possible to harmonize the tourism requirements with those of environmental protection and sustainable development, as specified in the Europe 2020 strategy. The complexity of the research methodology, the case study, required the use of numerous methods of qualitative and quantitative research, which made possible to highlight specific elements of the rural area of Sibiu Depression in order to obtain a good orientation of the strategic actions for sustainable development of tourism and agro tourism. The main features are related to the definition of Sibiu Depression as an interethnic area of tourism interest, based on the cultural diversity and on the active involvement of the local community in specific issues. The methodology we have used consisted in bundling the dimensions of life framework in a set of six criteria for analyzing the macro-environment using the PESTEL analysis model. This analysis was complemented by a SWOT one, which has allowed us to combine the endogenous and exogenous conclusions, and enabled us to present the problems and their respective answers. The results contribute to the design of a strategic plan for sustainable resources valorization by the promotion of tourism, backed by the cultural heritage of the Sibiu Depression, an interethnic area, recognized on national and European level.

**Key words**: management, resources, rural space, sustainable tourism, valorization.

The basic characteristic of the rural economy is well illustrated by the analysis of the land use. In the studied area, two categories are prevalent: farming with a share of 61.2% (2011) which directs rural economy to farming, and 28.5% forests and similar land, that in many areas provide economic diversity by developing rural tourism and agro tourism activities (national strategic framework). Rural tourism and agro tourism activities are growing in Romania's rural economy the past 20 years due to the progressive involvement of specialists, entrepreneurs and local stakeholders. But if comparing this evolution with the tourism potential which characterizes the Romanian rural area, one can see that we are far from its proper valorization (Iagăru R. *et al*, 2014). The issue of sustainable development of rural tourism and agro tourism is an actual and complex one, occupying a special place in the economic, social or geographic practice. Sustainability of rural tourism and agro-tourism provides in the same time the perpetuation of specific rural values, satisfying both the interests of those providing tourist services, and the requirements of the beneficiaries of tourism services (Mac R. *et al*, 1999). Rural tourism is an effective solution to harmonize tourism requirements with those of environmental protection and sustainable development (Minciu R., 2004). The aim of this paper is to emphasize the orientation towards strategic management as an instrument of development, adoption and implementation of the most relevant policy options for sustainable development of rural tourism and agro tourism. For this aim, within our research, based also on existing studies and literature in the field of rural tourism and agro tourism, and on the assessment of the state of rural tourism and agro tourism in Sibiu Depression, we have addressed the following research directions: diagnosis of the state of rural tourism and rural tourism; assessing of the potential for sustainable development of rural tourism and agro tourism; promoting the need for a sustainable development of rural tourism and agro tourism and for a system of education of entrepreneurs and consumers towards these issues; promoting the importance of development funds and marketing products / services of rural tourism. The major objective of the research is the development and implementation of strategic

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options for sustainable development of rural tourism and agro tourism in Sibiu Depression. Sustainable development of rural tourism and agro tourism can be achieved starting from the strategic analysis of the rural area, to determine its specificity in developing and implementing the most adequate strategic options. For this goal, it has been organized a field research whose purpose was to assess the strategic development of rural tourism and agro tourism in the rural areas of Sibiu Depression. Sibiu Depression is situated in central Romania, namely in the south-west of the Transylvanian Plateau and northwards of Southern Carpathians, namely in north of Cindrel Mountains and of Lotrului mountains, having an altitude between 380 and 602 m (Sandu M., 1998).

## MATERIAL AND METHOD

To diagnose the condition, and for assessing the potential for sustainable development of rural tourism and agro tourism, the methodology specialists recommend the parallel and complementary use of quantitative and qualitative methods. These allow "obtaining more knowledge" (Kerekes K. *et al*, 2010), and "forming an overview image and identification of critical factors impacting rural areas" (David F.R., 2009). Specifically, it was chosen the case study as research method, because it has proven its utility and relevance in numerous studies and. The methodology consisted in: secondary analysis of statistical data and of relevant literature (reports, strategies, studies, monographs), PESTEL analysis, respectively SWOT analysis backed by organizing meetings of focus groups that have been attended by local stakeholders and professionals concerned with sustainable development of rural tourism and agro tourism. We have chosen PESTEL analysis because it is a process for thorough analyzing the components that influence directly or indirectly the sustainable development of rural tourism and agro tourism in the studied rural areas (general external environment) (Garrett B *et al,* 2009). The method comprises analyzing various factors, such as political, economic, social, technological, environmental ones, and allows identifying and understanding legal and macroeconomic forces impacting on the sustainable development of rural tourism and agro tourism. It is an important step in policymaking because it provides the operational and decision-making framework. The argument for SWOT analysis is based on emphasizing the strengths and weaknesses of the researched area, as well as of opportunities and threats respectively, all representing the starting point in preparation of strategies for sustainable development of rural tourism and agro tourism.

## RESULTS AND DISCUSSIONS

The methods we have used revealed the specificity of the rural area of Sibiu Depression, thus helping to better targeting the strategic options for sustainable development of tourism and agro tourism. The use of PESTEL model highlights some specific aspects of the studied community that allows local actors as forces involved in the development process to better target the development and implementation of strategic options for sustainable development of rural tourism and agro tourism. The political criterion of macro analysis shows that the sustainable development of rural tourism and agro tourism is driven by the local development strategy, which is politically coordinated through the Common Agricultural Policy.

The economic criterion reveals that rural tourism and agro tourism in rural areas of Sibiu Depression has recorded a continuous increase since 2007, in both the number of units specializing in such activities, (from 64 in 2007, to 77 in 2010, Iagăru R., 2012), and in turnover. The local distribution of the number of enterprises in the studied rural areas shows that most developed communes in this respect are: Şelimbăr, Răşinari, Cristian and Sadu. The social criteria highlights that the inhabitants' role in the development of rural tourism and agro tourism in the studied area is manifested differently, in both quantitative and qualitative aspects. Evolution of the population number and economic structure, of education and training has a decisive influence on sustainable development of rural tourism and agro tourism. In the rural area of Sibiu Depression there is a decrease in the number of inhabitants, excepting Şelimbăr, with an increase of 1300 inhabitants, generally due to the migration of residents from the urban area. The technological criterion underlines the existence in the rural area of Sibiu Depression, of a relatively high level of spending on innovation and of the number of agro tourism and tourism companies, which means a good receptivity to innovation. From these companies, about one third have innovated products, processes, marketing or management methods. With regard to product innovation, this was focused primarily to the company and then for the targeted market. The diagnosis of the environment emphasizes the need to provide a sustainable development of rural tourism and agro tourism by targeting activities that are consistent with the principles of environmental protection, pollution control and waste management. Considering the overall features of the rural areas of Sibiu Depression, certain relevant aspects for this study are

highlighted:

- The existence of a large number of historical monuments, some of which are affected by pollution.
- The growth of economic activity in all areas.
- The need to promote eco-tourism, because of the scale this economic activity presents in the studied area.
- Concerns on the production of green energy.
- The existence of adequate green areas, both in size, and in arrangement.
- The existence of a relatively high percentage of coverage with sanitation services, but whose practice of collecting household waste collection remains in mixed way.
- The existence in the area of an eco-friendly landfill, located on the territory of the commune Cristian.
- The existence in Cisnădie of household waste sorting station serving also the communes Cisnădioara and Sadu.

The legal criterion highlights the support of the sustainable development of rural tourism and agro tourism by regulating, using a variety of environmental protection, human health and life quality norms.

The obtained information proved to be relevant, but to complete the socio-economic characteristics of rural area of Sibiu Depression we have performed a SWOT analysis. This allows the identification of strengths and weaknesses, external opportunities and threats faced by an organization or territorial unit (Vincze M *et al*, 2009). The obtained information have led to the following display in the SWOT matrix of the strengths and weaknesses, opportunities and threats faced by the sustainable development of rural tourism and agro tourism (*Table 1*).

Table 1

**SWOT analysis**

| **Strong points** | | **Weaknesses** | |
|---|---|---|---|
| 1 | Exceptional tourism potential due to exceptional natural resources (soil, water, forests) | 1 | Poor knowledge on attracting EU funds |
| 2 | Relevant media coverage because local famous personalities (Emil Cioran, Octavian Goga ...) | 2 | Inefficient public administration |
| 3 | Traditional lifestyle and recognized brands | 3 | Lack of motivation for young people with higher education |
| 4 | Advantageous geographical position in the vicinity of Sibiu | 4 | Irrelevant strategies for developing rural tourism and agro tourism |
| 5 | Renown interethnic cultural zone, well-preserved local traditions | 5 | Irrational exploitation of natural resources that are favorable rural tourism and agro tourism |
| **Opportunities** | | **Threats** | |
| 1 | Sources of funding for agro tourism and rural tourism | 1 | Damage tourism heritage through degradation or uninspired management. |
| 2 | Sources of funding for non-agricultural activities | 2 | Low capacity of the stakeholders in attracting development funds |
| 3 | Sources of funding for road infrastructure and ITC | 3 | Poor development of recreational areas and activities outside tourism companies. |
| 4 | Close cooperation between the remaining population and emigrants. | 4 | Lack of action to support entrepreneurship in rural tourism and agro tourism |
| 5 | Introduction of certain localities in the network "European Destinations of Excellence in Tourism" | 5 | Shyness of support and promotion actions for tourism and agro tourism products / services |

From the information presented briefly in the SWOT matrix, the following conclusions can be drawn:

- the advantages of sustainable development of rural tourism and agro tourism are considered the exquisite natural resources (soil, forests, water); geographic position; media coverage; traditional lifestyle; the existence of brands; recognition as interethnic cultural area and the affiliation to relevant touristic networks, respectively;
- the weaknesses of the sustainable development of rural tourism and agro tourism are the poor skills on attracting development funds; The inefficiency of public administration; lack of attraction of young people with higher education; adoption of irrelevant strategies or inappropriate exploitation of favorable natural resources, favorable (soil, water, forests).

The external environment fully participates in the sustainable development of rural tourism and agro tourism and the SWOT matrix briefly presents its both sides: opportunities and threats.

- The opportunities of sustainable development of rural tourism and agro tourism are considered the sources of funding for rural

tourism and agro tourism, for non-agricultural activities, and for road infrastructure and ITC. This is supplemented by the possibility of collaboration with immigrants or cooptation of certain communes in successful tourism networks.

- The threats on sustainable development of rural and agro tourism envisage the damage of tourism heritage, the poor development of areas and recreational activities, lack of actions to support entrepreneurship in tourism, shyness in support and promotion actions for tourism on the markets.

The sum of the information provided by the methodology recommends a number of policy options for the sustainable development of rural tourism and agro tourism in the Sibiu Depression, the most relevant being considered as:

- Attracting investment for the development of road infrastructure and information and communication technology;
- Actions to support entrepreneurship in tourism and agro tourism;
- Superior valorization of the favorable natural resources in rural tourism and agro tourism;
- Superior valorization of human potential involved in specific activities of rural tourism and agro tourism;
- Increasing the capacity to integrate specific activities of agro tourism and rural tourism;
- Increasing the involvement of local actors in promoting products / services of rural tourism;
- Development of consulting services on financing entrepreneurship in tourism and agro tourism.

## CONCLUSIONS

The socio-economic analysis of rural Sibiu Depression leads to the identification of success factors and shortcomings in the management of tourism and agro tourism activities, namely in their sustainable development. There have also been identified the external factors that favor the development of these activities and those hampering them.

The superior valorization of the favorable natural resources of rural tourism and agro tourism in rural areas of Sibiu Depression is based on a diagnosis of its components.

Attracting investments for the development of road infrastructure and information and communication technology contributes to increase the interest in consumption of tourism and agro tourism services.

Developing consultancy services on financing entrepreneurship in tourism and agro tourism initiative encourages the sustainable development of rural and agro tourism.

Involving local actors in marketing of products / services of rural tourism has a positive impact on the sustainable development of rural tourism and agro tourism.

Increasing the capacity to integrate specific activities of rural tourism and agro tourism into the rural economy contributes to their sustainable development.

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# UNITY IN DIVERSITY –THE ATTRIBUTE OF MAJOR SEMIOSIC NON-VERBAL CONSTRUCTIONS

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**Abstract**

The vast domain of the gardens – defined from a semiotic perspective as major semiosic non-verbal constructions, is usually made up of heterogenous elements connected to each other through various relationships, so that to create a meaningful whole. The heterogenous elements – be they natural or artificial, created by people– are selected, arranged, combined and ordered in a targeted manner to form a coherent whole, producing a unity in diversity – the attribute or the defining characteristic of any garden. The constitutive elements are involved in different levels of communication, starting from biological communication up to cultural symbolism, from personal cognition up to social identities, enabling a better understanding of the garden's design, related to the multitude of social, philosophical, religious, and cultural discourses, as well as the traditions which give them a meaning. The gardens represent a space of convergence where nature and culture (art, science, techniques) intertwine, complementing each other, creating a whole, in other words a unity in diversity.

**Key words**: spatial semiological structure, non-verbal communication, cultural symbolism

Any garden is the result of man's action, as he projects and designs it, but also of the nature's involvement, so we can say that the garden is a cultural alive phenomenon, continuously modifying itself, exhibiting a high semiotic heterogenousness. The art of gardening produces significant semiological structures being a combinatorial art, an art which is born fromand within the tension between art and nature. Starting from the definitions of the two founding poles of the garden: culture and nature, the paper aims to highlight the way in which the particular elements, arrangements or parts of the garden have been assembled and connected to form a coherent, meaningful whole, providing that unity in diversity which is present in almost any major semiosic non-verbal construction.

## MATERIAL AND METHOD

In specialized literature assigned to biosemiotics, it has been evidenced that any relationship between a living organism and its environment is always a semiotic one, so gardens have been considered by (bio)semioticians asmajor semiosic non-verbal constructions, made up of heterogenous elements, with a complex semiotic potential, connected to each other through various intrinsic meaningful correlations to create a significant whole. Gardens can differ enormously in appearance and purpose: they can be large or small, geometric or natural, bound or unbound, wild or tamed, with flowers or without. They can contain blossoms, trees, shrubs, flowers, lawn, rocks, sand, fountains, canals, ponds, temples, ruins, follies, statues, and other elements semiotically interelated, or can contain none of these.

Each elementfrom a garden usually holds an individual symbolic content.This is why it is not enough to understand the garden itself as simply a combination of parts. The aesthetic principles are embedded in the spiritual and intellectual experience.The garden may be considered a spatial structure or a stage which facilitates a dialogue between nature and culture, in other words a place of communication between people and nature, or humanity and universe, where art, science, and nature become most intimately interlocked.

Taking a historical perspective and examining the development of garden art, we can assume that as a cultural phenomenon, this spatial entity organized by people, may involve a combined semiotic approach, unifyingSaussurian and Peircean semiotic paradigms. Regardless of the ancient time or modern period, through its gardens, each civilization has expressed its own image about happiness and desire to live in a beautiful natural environment. "Garden - making is a significant activity in man's pursuit for a happy life. East and West alike, over thousands of years,

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different people had been performing this practice, which has formed an individual subject of art and science". (*Chou W*.,1993).

We have already mentioned that gardens have two founding poles: culture and nature. What does culture mean? How can we define nature? We can hardly give firm answers to these questions. The etymology of the modern term "culture" has a classical origin. In English, the word "culture" is based on a term used by Cicero (106 BC – 43 BC), in his *Tusculan Disputations*, meaning the cultivation of the soul or *"cultura animi"*. Using an agricultural metaphor, the Roman philosopherwanted to describe the development of philosophical soul which was understood teleologically as the one natural highest possible ideal for human development. To understand better what we mean by garden as a *cultural* phenomenon, here are some definitions of culture as we have found in the dictionaries, but nevertheless culture is more than the sum of its definitions.

Culture refers to the cumulative deposit of knowledge, experience, beliefs, values, attitudes, meanings, hierarchies, religion, notions of time, spatial relations, concepts of the universe, and material objects and possessions acquired by a group of people in the course of generations through individual and group striving.

Culture is a way of life of a group of people - the behaviors, beliefs, values, and *symbols* that are passed along by *communication* and imitation from one generation to the next.

Culture is *symbolic communication*. Some of its *symbols* include a group's skills, knowledge, attitudes, values, and motives. The meanings of the *symbols* are learned and deliberately perpetuated in a society through its institutions.

Culture consists of patterns, explicit and implicit, of and for behavior acquired and *transmitted* by *symbols,* constituting the distinctive achievement of human groups, including their embodiments in artifacts.

Semiotics of culture was of particular interest for linguists and semioticians from the Tartu School (Estonia), who viewed culture as a hierarchical semiotic system consisting ofa set of functions correlated to it. The study received a research ground also in Japan where the idea that culture and nature should not be contrasted and contradicted but rather harmonized. From semiotic perspective, culture may be defined as a type of human symbolic activity, creation of signs and a way of giving meaning to everything around, in other words culture is understood as a system of symbols or meaningful signs.

From the definitions presented abovetwo outstanding aspects should be highlited: 1) culture means communication and communication is culture; 2) culture represents a system of symbols or meaningful correlated signs.

Speaking about the other founding pole of the garden – the nature, within the various uses of the word, in the broadest sense, Nature is the natural, physical, or material world or universe.

In his paper, *Semiotic ecology: different natures in the semiosphere*, (1998), Kalevi Kull, a well known biosemiotics professor at the University of Tartu, Estonia,has pointed out that without understanding the semiotic mechanisms which determine the place of nature in different cultures, one has little hope of solving many serious environmental problems, and of finding the stable place of culture in nature. Kull Kalevi speaks about the "multiple natures" and he delimits or splits nature in various ways. Nature is not unique, there is not one nature, but several. When living with nature we cannot avoid the building of a second nature and the replacing of the first According to the Estonian biosemiotician, Zero nature is nature itself (e.g., absolute wilderness). First nature is the nature as we see, identify, describe and interpret it. The second nature is changing as a result of "material processes" again, this is a "material translation "in the form of true semiotic translation, since it interconnects the zero and the first (or third), controlling the zero nature on the basis of the imaginary nature.The third nature is a virtual nature, as it exists in art and science.The third nature is entirely theoretical or artistic, non-natural nature-like nature, built on the basis of the first (or third itself) with the help of the second. The Estonian biosemiotician Kalevi Kull assumes that nature is a complex of processes and not a pattern.This aspect may be considered as an example of unity in diversity as an attribute of any major semiosic non-verbal construction.

## RESULTS AND DISCUSSIONS

In his work *Semiotic ecology: different natures in the semiosphere*, 1998, Kalevi Kull has stated thatwhen people apply certain models, or certain general linguistic patterns upon nature "we have in view the building of second nature". This can be easily demonstrated when considering the notions used to describe gardens. The rules of "order"can be seen as belonging to (and coming from) certain traditions of gardening schools. However, these are probably something much deeper, since regardless of the particular school, the rules always apply idealised forms to nature. Namely, rules like these originate from the discretisised descriptions of nature, from the linguistic nature, as limited by the general mechanisms of perception and operation.

If garden and landscape design is concerned with the relations between humankind and nature, it is largely determined by one or the other of the conflicting philosophies about how human beings do or should relate to nature. Specialized literature about garden art has emphasized different attitudes towards nature reflected in Eastern and Western

gardening.The difference is mostly subjected to different gardening ideas with the infiltration of philosophical foundation, aesthetic ideology and cultural background, which reflects the evolution of a nation's view of nature, life and world. The relationships between humans and nature are always connected to deep cultural processes.Gardens, though to a great extent depend on nature, are the creation of mankind. Therefore, mankind's thought, especially their attitude towards nature has full expression in the styles of gardens. In ancient times, mankind lived harmoniously with nature, either in East or West.However, mankind's aesthetics changed profoundly in that the development of productive forces enabled mankind to overcome nature, making mankind go against nature. Human beings tended to believe that "man dominates nature" and "mankind is the dictator of nature", showing man's contempt for nature. In this respect, human beings separated themselves from nature and went to the opposite direction to realize their existence. The Western classic gardens of geometrical style exemplified this trend of thought. East Asian traditional philosophy, conversely, pursued harmony between mankind and nature. On this basis, the garden makers in the East (we have in view especially Chinese gardens), at the very beginning, regarded beautiful nature as an aesthetic object, and their aim was "to study from nature, to recreate through artistic sublimation", creating landscape gardens.(Zhou Wuzhon, 2005) Harmony between man and nature - one of the themes of sustainability - was an integral part of the philosophy and way of life of the ancient cultures of Japan, China, and other far-eastern counteries. This is reflected in their traditional styles of garden design, and still has an impact on their modern societies. East Asiangarden is inspired by the notion of humans as a part of nature.The garden respects nature: the nature cannot be controlled or changed, because nature has its own law and its ongoing track. Nature is always the ideal one must strive for in an Eastern garden. Nothing overly fancy or against the natural flow we see in nature will fit well in such a garden. East Asian gardens demonstrate the wisdom, experience and the mystery, the unique relation between man and nature, when the human being is able to improve the nature, by showing its essence, by not pressuring, but relating to its laws. The Eastern garden promotes natural beauty, focusing on the beauty of nature. Most often Eastern garden making is characterized by freedom, change and winding. It originates from nature, but goes beyond nature. It integrates perfectly artificial beauty with natural beauty, demonstratingpeople's profound understanding and appreciation of natural beauty.

The Eastern garden is intended to engage the viewer in an elevated, transcendental, level of engagement. From the beginning of garden making, this interaction between viewer and garden, has been one of the driving forces in the creation of the Japanese gardens. Without this pronounced concern of the garden-makers, the gardens would have become relatively sterile spaces, filled with grand artifice, but lacking soul. The use of symbolism in the gardens is intended to provide a certain language of engagement, formulating a common ground between viewer and garden. (Ketchell R., 2015).

The Western traditional nature philosophy believes that man can conquer nature, emphasizing the idea that humans are nature's masters. The Western gardens demonstrate man's ability to tame and control nature, or the triumph of man over the environment, and the new scientific understanding of space as infinite. For example Versailles, in its gardens and palace, communicates a visual story of power of Louis XIV. It is a symbol of the system of absolute monarchy, which Louis XIV espoused.

Western-style gardens pay attention to architectural order and organization of geometric patterns, presenting the style of uniform layout and order. The line and geometry have been thought as the aesthetic standard. With neat, precise, and uniform expression of art, Western-style gardens stress the beauty of artificial creation and skills of mankind. The garden style dominating the Western European continent was geometrical style, though there once were various others. In the layout of a garden, geometrical style emphasized on the axial symmetry of geometrical patterns-even flowers and plants are regularly trimmed into geometrical symmetry. The style laid emphasis on artificial beauty or geometrical beauty, rather than natural beauty.

Due to the differences in natural conditions, historical origins, social environments, cultural backgrounds and religious factors, the gardens inthe East and the West developed in a diametrically opposite way from the very beginning. The former has been seeking natural beauty, and the later was in pursuit of artificial beauty.

## CONCLUSIONS

Gardens are a place where culture and nature combine to form a single entity, a place where different cultures can co-exist,providing that unity in diversity which is present in almost any major semiosic non-verbal construction.The specific

organization of the garden space within its natural environment contributes to a different aura for each garden. In this way, the particular implementation of the elements contributes to a unique experience for each visitor.Most gardens consist of a mix of natural (flora, fauna, soil, water, air and light),and constructed elements (paths, patios, decking, sculptures, systems for drainage, lights and buildings, but also living constructions such as flower beds, ponds and lawn) although even very "natural" gardens are always an inherently artificial creation, which is in fact"the second nature".

It must also be remembered that gardens are always a work in progress, never a finished production, so that the individual elements one encounters today may not have been part of the original design, and may not be in the future. The heterogenous elements (natural and artificial), are selected, arranged, combined and ordered in a targeted manner to form a coherent wholeand are involved in different levels of communication, starting from biological communication up to cultural symbolism, producing a unity in diversity – the defining characteristic of any garden. In a garden the communicative processes are achieved through a wide range of sign systems: iconic, indexical and conventional (symbolical). To illustrate cultural symbolism we may use as an example the dry garden, or flat garden, which is perhaps the most well-known style of Japanese garden. In this garden, pebbles are used to suggest water, and ripples are suggested by lines made by raking. Several upright boulders are typically placed inside the pebbled area, suggesting islands. Each elementfrom an Eastern garden usually holds an individual symbolic content. For instance, in the Chinese gardens, the rocks, mountains, trees, cloud, and wind were all endowed with spirit, which for Chinese people was a type of energy that flowed through all elements of the universe. Specific spirits were also believed to live in wild and sacred areas, and the spirits of the ancestors were believed to play an active role in day-to-day life. Speaking about the symbolism of the Japanese garden, Robert Ketchell says: " the garden was a creation that proceeds from the idea of concentrating, refining, condensing the elements of Nature, to recreate Nature in a supercharged form. In doing so the garden is intended to act a filter, removing the impurities (stresses) of daily existence, and rekindling a positive charge or energy within the viewer. The garden acts as a healing or restorative space, protecting and nurturing the household and the occupants" .

These lines underline the fact that Nature is not unique, there is not one nature, but several (multiple natures). We may consider this aspect as anexample ofunity in diversity: the first nature is nature as filtered via human semiosis, through the interpretations in our social and personal knowledge; second nature is the nature which we have materially interpreted, this is materially translated nature, i.e. a changed nature, a produced nature; the third nature is the interpretation of interpretation, the translation of translation, the image of image of nature.

The presence and use of symbolism, especiallyin the Eastern garden, adds layers of meaning and communication to the garden for the viewer. The sources of symbolism and reference are varied drawing on religion as well as cultural references. The various signs, symbols and references contained and used in the gardens have a language of their own, they are incorporated into the garden fabric, in order to allow the viewer of the space to "travel" through his imagination. The garden lays out a certain set of moulds into which the viewer is invited, through intuition, belief and imagination, to add his or her own contribution. This is then a "coming together into Unity", garden and viewer fusing, the one beginning to flow into the other, with the flowing comes a healing. Which was after all, the primordial purpose of garden space not only in Eastern gardens but in almost any major semiosic non-verbal construction.

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# POSSIBILITIES OF STIMULATING INTELLIGENCE IN STUDENTS DURING THE BIOLOGY LESSONS USING MOZAWEB ONLINE PLATFORM

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**Abstract**

The purpose of this paper is to highlight how the various intelligences of students can be stimulated within the lessons of biology in middle school, through the use of 3D models and images existing on the mozaWeb online platform, choosing for certain forms of organization of student work, and applying various teaching methods. As a research method we used the analysis of current programs and textbooks, and also the analysis of digital materials made available to teachers by mozaWeb platform. Analyzing the 3D models and images existing on the mozaWeb online platform, and the content of textbooks for fifth and sixth grade, we identified the possibility of stimulating several types of intelligences during the biology lessons. Thus, at sixth grade, within the lesson on "Long-legged birds – Stork", held into a classroom equipped with "intelligent board", the verbal, visual logical and interpersonal intelligences of students can be stimulated. At the seventh grade, within the lesson on "The ear. The ear's function in the process of hearing", if the lesson is held into the computer laboratory equipped with a "intelligent board", and the activity will be carried out by groups of students, the verbal, visual, logical, musical and interpersonal intelligences of the students will be stimulated. Also, at the seventh grade, within the lesson on "The ear. The ear's function in maintaining the balance" held into a classroom equipped with a "intelligent board", can be stimulated the verbal, visual, logical and kinesthetic intelligences of the students. The most frequently challenged intelligences of students, both for lessons carried out into a classroom equipped with "intelligent board", and those carried out into the computer laboratory, were the verbal, visual, logical and interpersonal/intrapersonal intelligences.

**Key words**: lessons of biology, mozaWeb online platform, multiple intelligences

Intelligence is "the ability to understand easily and well, to discern what is essential, to solve new problems or situations based on previous experience" (DEX on-line). It is "a higher form of knowledge and behavior, wherein the adjustment and balancing of individual interaction with the environment is realized through images, representations, ideas and mental actions" (Dicționar de pedagogie, 1979).

In psychology, there is no uniformity of views on the definition of intelligence. As mentioned by Zlate (2006), the intelligence (lat. *intelligere* – to relate with, to organize; lat. *interlegere* – to establish relations between relations) in considered by many psychologists as "the general ability of the acquisition of knowledge, reason and problem solving". Other psychologists, among whom the aforementioned author remembers Gardner, believes that intelligence "involves different kinds of skills" (Zlate M., 2006).

Gardner, the author of Multiple Intelligences Theory (MI theory), has defined the intelligence as follows: "To my mind, a human intellectual competence must entail a set of skills of problem solving - enabling the individual to resolve genuine problems or difficulties that he or she encounters and, when appropriate, to create an effective product - and must also entail the potential for finding or creating problems - and thereby laying the groundwork for the acquisition of new knowledge." (Gardner H., 1993).

Based on the results of his research, Gardner states that there are no identical persons, and consider that each person is unique and possess a certain intelligence profile. Thus, "each learner's intelligence profile consists of a combination of relative strengths and weaknesses among the different intelligences: linguistic, logical-mathematical, musical, spatial, bodily-kinesthetic, naturalistic, interpersonal, intra-personal, and (at least provisionally) existential" (Gardner F., 2006; Moran *et al*, 2006).

Armstrong, referring to the theory of multiple intelligences, states that the number of intelligences may be higher, but other intelligences "have not been identified yet", and each type of intelligence identified by Gardner "can be

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described by certain traits, activities and passions" (Armstrong Th., 2011).

Moran, Kornhaber and Gardner consider that "Intelligences are not isolated: they can interact with one another in an individual to yield a variety of outcomes". […] "And as in an orchestra, one intelligence (instrument) in an individual can interfere with other, compensate for others, or enhance others." (Moran *et al*, 2006).

Gardner consider that "any individual can develop an intelligence if well motivated, if he/she lives in a culture that values that intelligence, and if there are human and artifactual resources (eg, texts, computer programs, study groups) that he/she can use" (Gardner H, 2006; Petruța G.P., 2014).

In educational practice it is important both the identification of student's intelectual profile, and selection and application of teaching strategies during lessons to activate those intelligences considered to be their strengths. However, the teacher will have to have in mind that "no one set of teaching strategies will work best for all students at all times", as suggested by MI theory (Armstrong Th., 2009). Consequently, as pointed out by Armstrong, "any particular strategy is likely to be highly successful with one group of students and less successful with other groups (Armstrong Th., 2009).

A teaching mean that can be used within the teaching strategies applied by the teacher in lessons for stimulating different intelligences in students, is the computer. Armstrong believes that if a multimedia software is used, the following intelligences can be developed:

- linguistic, by the text that is presented;
- spatial, by the images displayed;
- musical or linguistic, by sounds;
- bodily-kinesthetic and other intelligences, by video (Armstrong Th., 2009).

Given the possibility of stimulating intelligences of students using a computer, the aim of our research was highlighting how can be stimulated the different intelligences of students in the lessons of biology in middle school through the use of 3D models and images existing on the mozaWeb online platform. Thus, the main objectives of our work were the following:

- highlighting the digital materials available to teachers of biology on the mozaWeb online platform;
- identification of images and 3D models that can be used in biology lessons at secondary school;
- highlighting the possibilities of using digital materials aforementioned in biology lessons, to activate different intelligences in students.

## MATERIAL AND METHOD

"In the didactical activity, the personal computer or its portable variant, named laptop, is a modern didactic tool which can perform the teaching activity carried out usually by the teacher, when an educational soft is used." (Petruța G.P., 2010). Currently, through the computer, in addition to collections of Ael and Intuitext interactive lessons, the teacher can use also the digital materials existing on the mozaWeb online platform.

To highlight the ways by which the use of mozaWeb online platform can stimulate the various intelligences of students within the biology lessons in the middle school, we used as method of research the analysis of actual programs and educational materials, as well as the analysis of educational materials existing on the mozaWeb platform.

## RESULTS AND DISCUSSIONS

By creating an account on the mozaWeb online platform, any person involved in teaching, teacher or student, has the possibility of studying weekly, free, 10 images, 10 videos, and 10 3D models elaborated for the various school subjects, among which can be found biology. The 3D models "are a way of representation of relief images, three-dimensional, using the computer" (Stanciu M., 2015). The digital materials can be used both in lessons conducted in middle school and high school.

When designing a lesson, the teacher's creativity and originality are important in using the digital materials mentioned above, in order to stimulate students' intelligences.

Thus, at 6th grade class, within the lesson on "Long-legged birds – The stork", held into a classrom equipped with an "intelligent board", verbal intelligence of the students can be stimulated in the stage of capturing attention through a riddle about the stork, told by the teacher, or a few lines about migratory birds from different poems recited by students, for example, the first verse of the poem "Guests of spring" of Alecsandri, or "Heralds of spring" of Coşbuc.

Thanks to the Internet connection, and using the "intelligent board", the lyrics can be presented to the whole class. This type of intelligence can be stimulated also by requiring students to complete a crossword puzzle developed before by the teacher. Through conversation can be found the solution (answer) to each question, and the students will fill in the crossword using smart board markers. Finally, by solving the crossword puzzle, they will

identify some of the lesson title, namely "The stork". How the teacher moves to the new lesson, remain at its discretion. Further, based on the images existing on the mozaWeb online platform about stork (*figures 1, 2*) and by applying the cube method, can be stimulated visual, verbal and interpersonal intelligences of the students.

Figure 1 **The stork in the environment**
(http://www.mozaweb.com)

Students in the class will be divided into five groups and each group will be given a workload, which they will need to solve using images from the text of lesson in the textbook, and those from the atlas. Group 1 should describe stork's environment, body shape and color.

Group 2 will have to compare the domestic duck (a previously studied bird) and stork, noting some similarities and differences regarding their shape and body size, beak shape, limb length, way of moving around and propagation mode.

Figure 2 **Flight of the stork**
(http://www.mozaweb.com)

Group 3 will have to associate certain anatomical features of stork with the living environment and way of feeding. Group 4 will have to analyze the living environment and limbs in white stork, black stork, crane, gray heron and great egret, and to determine the general characteristics of long-legged birds. Group 5 will have to argue why the stork is a migratory bird, and why is considered a useful bird.

At the end of the lesson, students will be introduced to the educational videos existing on the mozaWeb portal about pink flamingo. By deductive discovery, the students will be asked to establish whether pink flamingos are long-legged birds, by applying the general characteristics of long-legged birds to this species.

Looking carefully at the images and data presented in the video on the living environment of the pink flamingo bird, anatomical features (height, weight, wingspan) way of living (how they live, and how they sleep), food and age in this species, the students will solve this task. Implicitly, will be stimulated the visual and logical intelligences of the students.

At 7th grade class, within the lessons on the ear, the teacher can use many 3D models to highlight the function of ear in the process of hearing and maintenance of balance, as well as to present the otitis media.

Thus, the lesson "The ear. Function of ear in the process of hearing" can be carried out into the laboratory of informatics equipped with an "intelligent board", and using the 3D model "The ear and the mechanism of hearing" (*figure 3*) existing on the mozaWeb platform.

Figure 3 **The ear and the mechanism of hearing**
(http://www.mozaweb.com)

The musical intelligence of the students can be stimulated in the stage of capturing attention by listening a recording, such a piece of music, the song of birds, or the noise produced by car horns. Following the conversation with students, it is emphasized that both treble and bass, and weak or strong sounds, are captured by ear, thus leading them to the title of the lesson. This type of intelligence can be stimulated by using the 3D model, as the presentation of images is performed on a musical background.

By accessing the icon "The mechanism of hearing", the teacher will demonstrate and explain the section made through the skull, which can be enlarged and rotated, the three components of acoustic-vestibular analyzer: peripheral segment, intermediate segment and the central segment. Thus, will be stimulated the visual and verbal intelligences. Students will observe the components of outer ear, pinna (or auricle), and the ear canal (external auditory meatus). At the level of middle ear they will observe the ear drum and the three tiny bones known as ossicles: the hammer (malleus), the anvil (incus) and the stirrup (stapes); at the level of inner ear they will notice the bony cochlea and the three semicircular canals. Then, the students will observe the formation of acoustic-vestibular nerve (colored in yellow) and the route of acoustic nerve to the cortical projection area - the superior temporal gyrus (colored in green).

Further,the students grouped in pairs will access independently icon "The ear" and will observe, by rotating the image, the location of the eardrum outer layer (also known as tympanic membrane), stapes, oval window and round window, Eustachian tube, acoustic and vestibular branches of the acoustic-vestibular nerve, and auditory cortical projection area.

Then, they will access one after other the icons "Ear bones" and "Cochlea", observing the localization of the three ossicles and structure of cochlea, which is presented as a cross section. In this learning activity, in addition to visual and verbal intelligences, the interpersonal intelligence will be also activated.

Directed by the teacher, students will study the structure of the organ of Corti, formation and conduction of nerve impulses through the auditory nerve by accessing the icon "Organ of Corti". Then, they will access the icon "Tonotopy" to understand that high frequency sounds stimulate basal cells of the organ of Corti, and those of low frequency boosts its apical cells. Next, the teacher will access the icon "Animation" in the "intelligent board", showing how the sense of hearing is formed.

At the end of the lesson, it will be stimulated the logical intelligence of students, who are asked to solve everything in pairs with a simple choice test by accessing icon "Quiz" and a dual choice test with visiting icon "True or false". Each test is composed of five items. The marks obtained by students to the test, for example, "Excellent", "Be more carrefully" or "try again" (the first test) or the statement "You can go forward" (the second test) are a sign, both for the teacher and for students, of the extent to which new knowledge has been acquired by students.

Students can solve numerous tests at home after they have learned the lesson content, as they are very effective in learning the scientific content, whereas the previous test questions, that were answered incorrectly, are included in the next test.

The next lesson, on "The ear. The ear's function in maintaining the balance", can be held into a classroom equipped with an "intelligent board", the teacher having the possibility to use the 3D model "Sense of balance" (*figure 4*) or the videos "Sense of balance" (*figure 5*) existing on the mozaWeb platform.

Figure 4 **Sense of balance**
(http://www.mozaweb.com)

Figure 5 **Sense of balance**
(http://www.mozaweb.com)

Checking the knowledge acquired previosly about the ear can be achieved by accessing icon "The ear". By using demonstration of a 3D material realized by students, observation and conservation, in this stage of the lesson will be stimulated the visual and verbal intelligences of students.

Among the questions that the teacher may ask students to answer, we mention the following: What is the role pinna? What importance is the Eustachian tube? What is the route that vibrations go through up to auditory cells of membranous cochlea? What is the intensity of sound waves perceived by the human ear? But their frequency? Where the sensation of hearing is formed?

In the stage of transition to the new lesson, the students may be asked to make some lateral and rotational movements of their head and body, in which they can keep or lose their balance. This will stimulate the kinesthetic intelligence of students. The teacher will emphasize that the ear plays an important role in both hearing and stability (maintaining balance).

Visual and verbal intelligences of students can be further stimulated by accessing the icons.

By accessing the icon "Inner ear", the teacher will demonstrate and explain the orientation of the three semicircular canals in the three planes of space and the formation of acoustic-vestibular nerve. It will state that dilation of each semicircular canal is called the ampoule and that at its level is the ampullary crest, which is the sensory organ comprising the receiver cells.

By accessing the icon "Detection of angular acceleration" students will observe in the three 3D video materials presented what happens in the inner ear when a person tilts his head from left to right, it rotates and tilts it from right to left. They will also notice which semicircular canal receives angular acceleration in the three cases mentioned, this canal being colored blue, and what happens at the level of receiver organ from this channel. Thus, the students will understand how the receiver ciliated cells are stimulated by the movement gelatinous mass that covers them, produced due to the movements of endolymph.

Then, the teacher will access icon "Detection of head motion and position", and will demonstrate and explain the structure of otoliths existing in the saccule or utricle of the inner ear, specifically in the vestibular labyrinth. Students will observe the supporting cells and receptor cells provided in the apical pole with cilia, covered by a gelatinous mass that contains otoliths. Based on this information, students will understand how nerve impulses are produced when detecting the head motion or changed position, or the change of linear velocity, due to the movement of otoliths.

At the end of the lesson, can be activated the intrapersonal intelligence, the students being asked to describe individually on a worksheet what happens when a person moves his head in a certain direction, at their choice.

## CONCLUSIONS

In the biology classes, there are numerous possibilities of stimulating students' multiple intelligences. This depends on the teacher's creativity and originality. Thus, when designing the lessons, the teacher can choose for the use of certain methods and teaching aids, and for certain forms of organization of student work, aiming at stimulating different intelligences in students, and taking into account the students' intelligence profile.

By using images, videos and / or 3D models available on the mozaWeb online platform, presented using an "intelligent board" either in the classroom or in the computer lab, can be stimulated in students 4-5 types of intelligences, according to the strategy chosen by the teacher on conducting the lesson. These should be considered as highly valuable learning tools, as the intelligences stimulated and developed by them, such as verbal, visual, logical and interpersonal/ intrapersonal intelligences are often required.

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# INTERNATIONAL EXPERIENCES RELATED TO THE MODERNIZATION OF THE ACADEMIC DIDACTIC APPROACH BY MEANS OF THE FLIPPED CLASSROOM

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**Abstract**

*Flipped classroom* represents an action directive aimed at modernizing the educational approach by which the school should prepare the youth for tomorrow's great challenges. Our communication will aim at presenting the history of this idea, its characterisation, the presentation of several international experiences at the academic level and the expression of suggestions for the Romanian universities. The first experiments on this issue were made by Eric Mazur (Harvard, 1990), Jon Bergmann and Aaron Sams (2007) and Salman Khan (2004).

We shall present briefly several experiences related to the organisation of the flipped learning within the universities: Washington in Seattle, British Columbia, Michigan, Paris Descartes (Faculty of Medicine), Catholic University of Lille (Free Faculty of Sciences and Technologies), Paris-Est Marne-la-Valleé.

*Flipped Learning* makes an inversion of the didactic approach: the direct instruction from the traditional perspective will be done before the meeting with the teaching staff whereas the laboratories and the seminar rooms will host interactive learning activities, pointing out the group activities, with applicable and creative character. The four pillars of *Flipped Learning*: **F-** Flexible Environment; **L-** Learning Culture; Intentional Content; **P-** Professional Educators (Flipped Learning Network, 2014). We are presenting below the characteristics of organising the teaching-learning process under the shape of the flipped classroom (Jon Bergmann *et al*, 2011). We are using the contributions of the Belgian professor Marcel Lebrun (2011) with the purpose of pointing out the main force lines of the didactic approach of the flipped classroom type (Stanciu M., 2015).

The implementation of this teaching-learning strategy supposes the existence of a technological support, which involves a modernization of the academic didactic space in accordance with the real tendencies of the daily life. We have in view the existence of learning platforms for the students who attend the daily courses; the posting, on these platforms, of video sequences related to the themes of the course, to other support materials for the individual learning, to guides for the tasks that have to be done by students (individually or in a group) etc.

The implementation of this kind of approach involves, on the other hand, an ample continuous training process of the involved teaching staff. Therefore, we are also thinking of the possibility to access structural funds that should bring along the necessary logistic support and the achievement of experimental research on this issue.

**Key words**: flipped classroom; the Technology of Information and Communication; focus on the student; group learning.

The first experiences on the issue *Flipped Learning* were made by Eric Mazur, a Physics professor at Harvard in 1990. Mazur published in 1991 the first guide of his Physics teaching method in an interactive way (called *Peer Instruction*) (Mazur E., 1997; Dumont A., Mazur E., 2016). Jon Bergmann and Aaron Sams, two Chemistry professors at a high-school in Colorado (the USA), recorded in 2007 their courses with the help of soft and they posted them on YouTube which was watched by pupils before taking part in the educational activity. The classical classes were used for applicative activities and individualized support.

Sams consider that the paternity of this concept belongs to the British author Daniel Pink who used the phrase *Fisch flip* in an article in *Telegraph* (2010), which presented the teaching method of the Maths trainer and blogger Karl Fitsch «Lectures at night, "homework" during the day. Call it the Fisch Flip» (Pink, 2010).

The mathematician Salman Khan published his presentations on YouTube in 2004 in order to help the children study Maths more easily. About 2,400 video presentations are currently posted on the platform called Khan Academy for different fields (Maths, Sciences, Economics, Human Studies, and Computer Studies) (Khan Academy).

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The current educational system is socially built and it relies on the standardization of the education (Khan, 2013). The American studies pointed out that the educational practices in the USA remained the same in the period 1893 and 1979 (Gallagher M., Pearson P.D., 1989).

In Khan's vision, the education must be characterised by flexibility and it must consider the pace of each pupil or student. The stimulation of the creativity represents an important finality of tomorrow's school. The contents of the learning is important but it is especially important to teach pupils and students how to teach themselves (Khan, 2013).

The *Flipped Learning* represents "a simple but radical way to make the courses more appealing for all the participants" (Khan, 2013). This flipping hypostasis has in view that the lesson is taught at home and the homework is done in the classroom. Speaking strictly about universities, Khan suggested that the teaching should be done in teams of professors and even of great specialists with whom universities collaborate. Students must attend practice internships and they must be involved in making complex educational projects. While criticising the current standardised tests, Khan suggested that students should elaborate real creative portfolios during their academic studies (Khan, 2013). In conclusion, such an education must teach the young people the joy of learning and not one made by constraint.

## MATERIAL AND METHOD

### *Flipped Learning*- definition and general characterization

The leaders of *Flipped Learning Network* (FLN) proposed the following definition for the *Flipped Learning* concept: "Flipped Learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and are involved creatively in the subject" (FLN, 2014).

The same network (FLN, 2014) suggested the four pillars of *Flipped Learning*:

**F-** *Flexible Environment*;

**L-** *Learning Culture*;

**I-** *Intentional Content* ;

**P-** *Professional Educators*.

Jon Bergmann, Jerry Overmyer and Brett Wilie (2011) pointed out the characteristics of organising the teaching-learning process under the shape of the flipped classroom:

a) It increases the interaction and the personalised contact among students and professors.

b) It creates an environment where students undertake responsibility for their own learning.

c) From *the wise man on the stage,* the professor becomes a *guide* of the efficient learning.

d) It combines the direct teaching with the constructive learning.

e) It allows the students who are absent for different reasons not to stay behind.

f) The contents of the learning may be revised at all times.

g) It helps students be involved actively in the learning process.

h) It personalizes the educational approach for all students.

"Inverting the classroom means that events which have traditionally taken place *inside* the classroom now take place *outside* the classroom and vice versa." (Lage, M.J. *et al*, 2000)

The way in which the didactic approaches are organised and carried out in the *Flipped Learning* system adds value to the contributions of great theoreticians in the learning field (Dewey, Piaget, Vygotsky, Kolb, Lewin), of the learning styles (Felder R.M., Silverman L.K., 1988) (Lebrun M., Lecoq J., 2015; Bishop J., Verleger, M., 2013).

Marcel Lebrun, a professor of informational technology at the Catholic University in Louvain-la-Neuve, the manager of the Academic Pedagogy and Multimedia Institute, the president of the International Association of Academic Pedagogy, made **a model of the flipped classroom** (Lebrun M., 2011):

a) A hybrid device

From a pedagogical point of view, a device represents a coherent group of strategies that should bring along an efficient process of teaching and learning (Lebrun, 2005). The hybridization may be considered as a mixture between the daily education and the remote one (Charlier *et al*, 2006), between the transmitted education and the one based on the individualised support (Lebrun, 2011). This definition of the device involves, in our opinion, *a systemic approach* to the following elements: finalities (objectives and competences), means (resources, instruments, methods) and evaluation (Lebrun, 2011).

b) A teaching device

The teaching can be considered as a provider of learning opportunities for students, an intentional and interactive process (Brown and Atkins, 1988).

c) A learning device

From this perspective, Marcel Lebrun (2007) identified several factors inside a pragmatic learning model.

d) Questions about the implementation of the model which are related to the factors that stimulate the learning:

- *Information*: Which will be the relevant information to stimulate the learning? May the information source be found only in the

professor's speech or may there be other sources?

- *Motivation:* Does the context convey a meaning to the learning?
- *Activities:* What instruments are at the student's disposal and generate new knowledge and transferable competences?
- *Interactions:* How will the group activity be combined with the individual one and professor's synthesis one?
- *Productions:* What will the products be? In what conditions will they be made? What are the signs of the efficient learning?

e) Concrete elements by which the device can be made

The flipped classroom may be done at three levels (Lebrun M., 2014):

a) Level I is *a hybrid model* of the performed didactic process, which combines the pupils' possibility to watch video sequences at home before actually doing that_homework during the class, an approach put in theory by the American authors Jonathan Bergmann and Aaron Sams (2007).

b) Level II has in view mainly a diversification of the activities (group or individual) which may be done elsewhere, not in class: the search for information; the lecture of an article, of a chapter, of a blog; the preparations for a presentation; interviews; observations or field investigations etc. The results may be included in a platform that may have a forum for discussions. The class activities may be diversified, too: theme presentations; diverse group activities; the creation of conceptual maps.

c) Level III represents a real hybrid of the first two levels, which may be structured in four tempos: $t^1$ (level II at the distance); $t^2$ (level II by presence); $t^3$ (level I at the distance); $t^4$ (level I by presence). In this context, Marcel Lebrun suggests adding value to the theoretical model of D. Kolb (the experience learning), of I. Nonaka and H. Takeuchi (1995) (SECI: Socialization, Externalization, Combination and Internalization).

*Flipped learning* represents more than a strategy to modernize the teaching-learning at the level of the academic education but also a new paradigm by which the universities may respond to the multiple challenges of the 21st century, with an approach focused on the students' needs and interests, on the creation of professional and transversal competences required by the social economic and cultural dynamics of the world we live in (of post-modern essence) (*figures 1 and 2)*.

## RESULTS AND DISCUSSIONS

### *Academic experiences*

We shall present briefly a few experiences related to the organisation of the *flipped learning.*

a) Washington University of Seattle

Scott Freeman aimed at improving with at least 17 % the success rate of the Biology course. He started with the observation that students could not apply critically the knowledge they acquired during the courses. The course support had been given previously and the students had to answer a test *online* before the course. In class, each student had to motivate the answer to the other student sitting nearby. The *peer instruction* technique is used here, written in theory by Eric Mazur at Harvard (The Seattle Times, 2012).

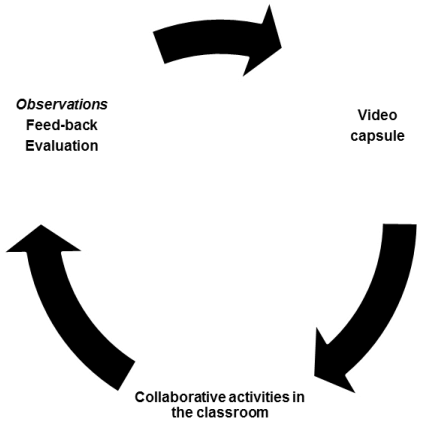



Figure 1 **The flipped classroom concept, adaptation after Marcel Lebrun (2014)**

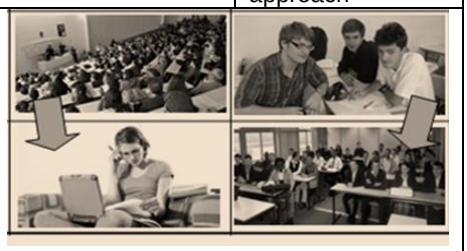
| | "Classical" approach | "Flipped classroom" approach |
|---|---|---|
| Assimilation of the scientific knowledge |  | |
| Learning | | |

Figure 2 **A comparative approach between the classical learning and "the flipped classroom",** Adaptation after "Une expérience de classe inversée à Paris-Est"

b) British Columbia University

At this University in Vancouver (Canada) there was an experiment related to teaching Physics to groups of 250 students/each specialisation. The course was taught in a traditional way until the last week. At that moment, two less experienced professors started to teach the *flipped* -type learning to the experimental group. The students studied the course support at home and they answered a test. In class they had learning activities in small groups and there was a personalised feedback. The students of the experimental group improved their presence by

20% and their involvement degree by 40% (Deslauriers L. *et al*, 2011).

c) Michigan University

The Maths Department of Michigan University made an experiment in which the students solved problems independently elsewhere, not during the seminar. Then they verified the solving methods in groups during the seminars. There was a test that evaluated the understanding of the used concepts (*concept inventory*-that included 22 questions) and that validated the working way (Berrett, 2012).

d) Paris Descartes University (Faculty of Medicine)

There is a licensing programme called "Frontières du Vivant" (The Frontiers of the Living), that works according to the principle of the reversed pedagogy. The students study independently at home from reference works in the field or *online* alternative sources (by video examples). Also, the platform called *Mastering Biology* includes proposed exercises and preliminary tests related to the acquired knowledge. The students are encouraged to share their opinions before the course and during the course as well as to answer the questions of their fellow students. During the laboratories, there are case analyses in groups, discussions related to the difficult aspects and evaluations of activities according to a grid. The entire course is described as an ecosystem in a permanent evolution as a consequence of the students' suggestions.

We can see the modern organisation of the laboratories and the two hours "of the course" without any stress (Cailliez J.Ch., 2014). In the first quarter of an hour a few students present the essential elements of the theme with the help of a designed scheme. The professor behaves as a real conductor of an orchestra and stimulates the students to tell their opinions and to ask questions. He does not intervene to impose his opinion, he helps them to walk on the knowledge path which has a few errors, doubts and ...small mistakes.

e) Catholic University of Lille (Free Faculty of Sciences and Technologies).

This case is about a course of *Molecular Genetics* (Cailliez J.Ch., 2013). We shall follow the presentation scheme made by the author of the blog. *The basic principle* has in view the removal of the main course in favour of an innovating and collaborative methodology. The change is major both for the student and for the professor. The student overcomes a consumer attitude and a co-constructor of the didactic approach. The professor becomes an organizer of learning situations, an animator and an orchestrator. This methodology exceeds the organization according to the flipped classroom because the students organized in groups will build the entire course. The group activity is stimulated by a competition *(serious game).*

*The activity organization* is made on 6 teams, each with 7-8 students. Each student will be involved with his/her team to build two chapters among the 12 ones of the courss (established by a prior protocol) and to acquire the other 10. The teams carry out their activities independently from the others but they can also interact if the exercises require it. The responsibilities are clearly delimitated within each team. The module is organised in the second semester and includes 12 meetings (laboratories), each of two hours. *The materials and the instruments* made available for the students make sure that the team work is efficient. Also, there are different integrated platforms and informational instruments (Google Groups, Google Works, Google Drive, Facebook, Padlet, Moodle, Twitter, etc.), that should allow the students to post the performed activity and that should be used by the other teams in the learning process.

*The activity of the laboratory* is carried out after organising the students on groups. Each meeting starts with a question addressed by the professor to all the groups. Each group is allowed 10-15 minutes to answer in a collective way whereas the answer is posted on the platform. Only one mark will be given to the answer of each group. Each group presents the construction of the chapter established beforehand according to the following algorithm: title, authors, summary, principles, definitions, paragraphs, explanations, adnoted schemes, tables, film and animations, bibliography, tests and questions. There will be organized 1-2 group activities related to the essential elements of the chapter (questions-answers, conceptual maps, explanations given by the professor etc.). At the end of the laboratory, each group will post on the platform the results of the activity on that day, even for a temporary period, which they will be able to modify during the following week.

*Serious game* constitutes the practical and "serious" modality to evaluate the activity of that group by all the students who took part to that laboratory/seminar. Each student can distribute 5 points by taking into account three criteria (the comprehension degree, the iconography, and the subjective appreciation), maximum two points for each criterion. Each student can modify their own votes from one laboratory to another whereas, at the end of the module, the first five ones get a bonus.

*The evaluation* is continuous and it has essentially in view the activity of the group. Three marking levels are conceived: interpersonal (the involvement in the activity of the own group); inter-groups (understanding the essential elements of a chapter that are presented by the established group); by the professor. In the exam session, there is an individual anonymous test of knowledge. The students can express their opinion at all times about the performed activities, including the professor's evaluation at the end of the semester.

f)University Paris-Est Marne-la-Valleé

The project called *PédagInnov* was initiated with the help of the created innovative structures (IDEA - *Initiative d'excellence en formations innovantes*). Its main objective is to be a reflection framework related to the experience of the flipped classroom (Chevalier, L., Adjedj, P.-J. and PÉDAGINNOV, 2014). The logo of IDEA suggests the major directions of the project: individualisation, diversification, evaluation and counselling (*accompagnement*). We can see a modification of the professor's roles as he becomes more a promoter of the practical issues, an animator of the debates, a counsellor (*accompagnement*) in the learning process. The first course of this university was Mechanics of the Deformable Solids and it was presented by Luc Chevalier, then, in the second year, there was a course about the deformation of the solids presented by Yun Mei Luo.

The didactic approach is carried out according to the following algorithm:

- *An introductory session* that will include: the objectives of the course; the flipped classroom concept; the aimed competences and the mixture in four-hour-sequences.
- *A four-hour meeting* will go through five stages: a) resources accompanied by evaluation questionnaires; b) the results of the questionnaire, comments; c) corrections brought to the questionnaire and the structuring of the knowledge on that day; d) applicative activities; e) the evaluation of the activity on that day. Additional exercises may be proposed for the ones who had understanding difficulties. The activities will end with an exam of brief evaluation.
- The last session is dedicated to the presentation of *a synthesis project* that starts as a role game in the preliminary study stage.

**Flipped Learning and the technology of information and communication**

The implementation of this teaching-learning strategy supposes the existence of a technological support, which involves a modernization of the academic didactic space in accordance with the current tendencies of the daily life.

The video capsules made with the teaching staff must meet certain qualities (Guo Ph. J. *et al*, 2014):

a) The video capsules should be at least six minutes short (the essential recommendation);

b) The presentations that are *combined with Power Point slides or with the help of an interactive flipchart* are more appealing;

c) The shooting of the film should be made in *a personalised framework.*

d) *The live given explanations* are more appealing;

e) *The main courses divided into small modules* are more engaging;

f) The language in use must be characterised by *enthusiasm;*

g) The creation of the video supports will have to consider their use. The conferences must be conceived so that they should be watched once whereas the tutorials must be thought so that they should be watched several times.

The creation of these video supports is an important activity in the preparations for this type of innovative didactic approach, for the achievement of which the professors must be helped by the experts in the field. We are making only a few bibliographic suggestions: (Bachelet R., 2013; Lebrun M. 2015).

## CONCLUSIONS

*Flipped Learning* represents another paradigm, another philosophy about the achievement of education in the 21st century. *Flipped Learning* combines the focus of the didactic approach to the student (Jones L., 2007; Wright G.B., 2011) with the active learning, the creation of competences (professional and transversal ones), the integration of the technology of information and communication into the modernization of the academic didactic process. Certainly, there are various obstacles in this case, too: the quality of the materials elaborated by professors or their lack (Lebrun M., Lecoq J., 2015).

The implementation of this kind of approach involves, on the other hand, an ample process of continuous training of the involved teaching staff. Therefore, we are also thinking of the possibility to access structural funds that should bring along the necessary logistic support and the achievement of experimental research on this issue.

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# TRENDS IN THE DEVELOPMENT OF THE VITI-VINICULTURAL SECTOR IN THE REPUBLIC OF MOLDOVA

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**Abstract**

The viti-vinicultural sector has always offered hope to the Republic of Moldova. After periods of glory and decline, we now increasingly realise that harnessing the potential of this sector would give a new impetus to the economic development of the country. Moldova has favorable pedo-climate conditions for developing viticulture and winemaking, achieving outstanding results in the postwar period. The viti-vinicultural production is an important source of products for export, while its domestic consumption contributes to the formation of the State budget, and the social effect lies in the fact that the viticulture grants, on a large part of the population, employment, income for maintainance and raising the standard of living. The factors that influenced the wine-growing sector stagnation were the cause of the negative phenomena of the period of transition to a market economy, such as: the ban on alcohol consumtion, imposed during the Soviet era; improper privatisation in the early 1990s; natural disasters; frosts in winter 1996-1997. As a result of the catastrophic reduction areas of vineyards and grape harvest, there was insufficiency of circulating assets for the renovation of the sector, and providing cars and equipment for maintenance of vineyards and the production of planting stock is at a low level at the present stage too.

**Key words**: viti-vinicultural sector, export, viti-vinicultural industry

The viti-vinicultural sector has enjoyed in recent years numerous problems and challenges. However, some reforms instituted in the viti-vinicultural industry appear to be the basis for revival. The country's viticulture heritage (all households) to 01.01.2015, according to statistical data, constituted 140,4 thousand ha, including on harvest – 129.2 thousand ha. In the marketed production farms the vineyard surface was 92.0 and respectively 82.8 thousand ha, of which worked – 76.0 thousand ha. Of the total area, about 96 percent are managed by households from private sector. In the marketed production vineyards structure by about 83 percent consists of varieties for wine and 17 percent for the table. Of the total area of vineyards, at about 90% are occupied with European varieties of the species *Vitis vinifera*, 9.3% - *Vitis labrusca* ("Isabella") and 0.7% with varieties of rootstock. A large part of marketed production vineyards (31 thousands ha) are of considerable age and inefficient from the economic point of view, being in a deplorable condition. This plantations have over 50% of gaps, they are advanced contaminated of diseases and pests, and have low productivity of about 2.3-3.0 t/ha and less, basically being degraded (http://statistica.md).

## MATERIALS AND METHODS

The objective of the given research is the viti-vinicultural sector of the Republic of Moldova in development process. The research methodology is based on the following methods: logical and dialectical methods, analysis, synthesis, scientific abstraction. We studied the data provided by both the National Bureau of Statistics of the Republic of Moldova, Ministry of Agriculture and Food Industry.

## RESULTS AND DISCUSSIONS

Unfair distribution of profits between the three segments: agriculture – industry-commerce, carried out to agricultural disadvantage, resulted in the reduction of vine plantations. It is known that the efficiency of the wine-growing areas is subject to: restitution, as a basis of raw material for primary and secondary wine-growing; diversification of types of wine products; competitiveness of Moldovan wines and cognacs; quality of wines; packaging; advertising; cutting their production. (Bostan I.A., 1998). The methodology regarding the increasing effectiveness of viti-vinicultural sector includes elements such as: organizational and market infrastructure; the network of banks, insurance

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companies, investment funds; marketing; pricing mechanism; competition; the system of State support of viti-vinicultural enterprises; normative-legal insurance of households. All these instruments work in the Republic and are reflected, greater or less, on the viti-vinicultural sector enterprises.

In order to ensure effective functioning of the viti-vinicultural sector it is necessary:

- to assess the economic resources of the branch (labour, capital, raw materials, information, etc.);
- to study the market;
- to detect the vinicultural products demanded on the local and international markets;
- to conquer consumers through originality and quality of the vinicultural products;
- to ensure economic efficiency for each stage (segment) of the viti-vinicultural branch;
- to balance processing capabilities and raw material volume.(Balzer R.L., 1984)

Currently, Moldovan winemaking can function normally because in the viti-vinicultural branch of the Republic have been noted several trends within companies, there were fitted lines of bottling of wine production, modern technological equipment; considerable success in producing wines and cognacs are starting to get a lot of economic subjects and the viti-vinicultural industry of the Republic of Moldova continues the process of restructuring and transition to a new model of organisation at the sector level and towards a business level. This process is a complex one and requires effective coordination of the sector policies, through technical and financial support.

Embargoes imposed by Russian Federation have shaken the Moldovan wine market in recent years; the value of wine exports made by the Republic of Moldova was in a downward trend over the period 2009-2014.

Also against the background of the geopolitical crisis from neighbour country, Moldova has lost Ukraine too, among the most important consumers of Moldovan wines. Amid the embargoes imposed by the Russian Federation, viti-vinicultural producers were geared towards European Union.

With the initiated reforms, as well as following the cancellation by the European Parliament the export quotas for the wines of Moldova, Moldovan wine exports to the Eu countries rose from 15.1% in 2009 to 29.9% in 2014 (http://maia.gov.md).

If by the year 2006, the indicators that characterize the viti-vinicultural industry were apparent proof of a consistent economic contributions, in reality it was about the dependence on a single market, that of the Russian Federation. Negative aspects related to this lack of diversification of markets have experienced with losses of hundreds of millions of dollars generated by the various embargoes imposed by Russia from 2006 onwards. Thus, the viti-vinicultural sector has entered into a structural crisis, at which, unfortunately, it has not reacted right away.

At the same time, Moldova was not prepared to enter other markets, more competitive, more knowledgeable and more difficult to conquer. That's because the aging plantations, inadequate equipment, lack of clear marketing strategies and resources for financing in amounts comparable to those of competitors; and all this within a burden economic and regulatory environment, based on a Soviet model of intervention. In this difficult context, both Moldovan wine-makers and the State had to take some strategic decisions to get winemaking out of the vicious circle in which it was entered in the post-Soviet period, and to put the industry in a modern development course.

According to the data presented by the customs service in 10 months of the year 2015 the alcohol exports recorded the following indicators for:

- Wine. Wine exports overall have seen an increase in the volumes exported with 11.4% but a decrease in the value expression of 11.8% compared to the previous year, representing a value of 79.1 mil. US $. Exports to the CIS market resulted in a decrease in both volumes 1.5% and 24.4% of value. At the same time, it noted a rise in exports to EU countries and other countries. Wine exports to the EU increased by 4.6%, while on other States market recorded an increase of 8.3%. At the same time the situation in EU markets at the moment is a difficult one, because of a huge competition from producers from France, Spain, Italy and the new world (Argentina, Australia) at the chapter price - quality.
- Wine distillates. Exports of wine distillates are also down by 31.3%, reaching a value of 37.2 million US $. The main decrease is on CIS market (37.1%). There is also an essential decline on EU market-21.6%.
- Vermouth and other wines. Exports of Vermouth and other wines show a decrease by-7.3%, reaching the value 0.7 mil. US $. The main destinations are Kazakhstan, Kyrgyzstan.
- Other fermented beverages. Exports of fermented beverages show us a decrease by 20% (value 2.5 million US $). Main destinations are Belarus, Ukraine, Poland, Baltic States, USA, China.

Table 1

**Analysis of export of alcoholic production, 10 months of the year 2015 as regards commodity markets**

| Markets | 2013 | | 2014 | | 2015 | | 2015 compared to 2014 % | |
|---|---|---|---|---|---|---|---|---|
| | Quantity thousand dal | Sum mln US dollars | Quantity thousand dal | Sum mln US dollars | Quantity thousand dal | Sum mln US dollars | Quantity | Sum |
| **wines, total** | **10538.5** | **126.0** | **8326.5** | **89.7** | **9274.5** | **79.1** | **11.4** | **-11.8** |
| Including:CIS | 7650.9 | 89.3 | 5476.6 | 52.5 | 5392.9 | 39.7 | -1.5 | -24.4 |
| UE | 1625.4 | 22.3 | 1634.1 | 23.0 | 2267.5 | 24.1 | 38.8 | 4.6 |
| Other | 1262.1 | 14.4 | 1215.8 | 14.2 | 1614.1 | 15.3 | 32.8 | 8.3 |
| **aromatized wines, total** | **26.0** | **0.6** | **23.0** | **0.6** | **29.1** | **0.4** | **26.9** | **-35.9** |
| Including:CIS | 17.2 | 0.3 | 17.3 | 0.4 | 3.6 | 0.1 | -79.0 | -79.4 |
| UE | - | - | - | - | 20.6 | 0.1 | | |
| Other | 8.8 | 0.3 | 5.7 | 0.2 | 4.9 | 0.2 | -14.7 | -25.3 |
| **fermented beverages, total** | **124.1** | **2.5** | **158.7** | **3.1** | **133.4** | **2.5** | **-15.9** | **-19.9** |
| Including:CIS | 80.4 | 1.7 | 110.8 | 2.1 | 100.7 | 1.9 | -9.1 | -11.0 |
| UE | 2.5 | 0.04 | 4.1 | 0.1 | 7.5 | 0.1 | 80.0 | 45.1 |
| Other | 41.3 | 0.7 | 43.7 | 0.9 | 25.2 | 0.4 | -42.3 | -47.9 |
| **alcohol and distillates, total** | **15.7** | **0.2** | **140.5** | **1.3** | **485.8** | **2.7** | **245.8** | **100.8** |
| Including:CIS | 0.01 | 0.000 | - | - | 12.5 | 0.1 | | |
| UE | - | - | 110.1 | 9.3 | 466.6 | 2.6 | 323.7 | -72.5 |
| Other | 15.6 | 0.2 | 30.3 | 0.4 | 6.7 | 0.1 | -78.0 | -86.4 |
| **spirits, total** | **1190.3** | **77.0** | **810.1** | **54.1** | **608.2** | **37.2** | **-24.9** | **-31.3** |
| Including:CIS | 799.4 | 45.0 | 451.3 | 25.4 | 317.8 | 16.0 | -29.6 | -37.1 |
| UE | 88.4 | 3.3 | 78.9 | 3.5 | 70.2 | 2.7 | -11.0 | -21.6 |
| Other | 302.5 | 28.7 | 279.9 | 25.2 | 220.1 | 18.5 | -21.3 | -26.8 |
| **Total alcoholic products, total** | x | 206.4 | x | 148.8 | x | 121.8 | | -18.1 |
| Including:CIS | x | 136.3 | x | 80.4 | x | 57.8 | | -28.2 |
| UE | x | 25.7 | x | 35.9 | x | 29.6 | | -17.6 |
| Other | x | 44.4 | x | 49.5 | x | 34.5 | | -30.4 |

Source:http://maia.gov.md

- Ethyl alcohol and distillate. Exports of alcohol show an increase by about 100% (value in 2015 is 2.7 ml. US $ while in 2014 represented 1.3 mil. US $). The main destinations that have spurred the growth are EU countries (Bulgaria, Greece, Poland), however, we have an increase in volume with 320%, but a drop in value by 70% (http://customs.gov.md).

In this context, the harvesters have to be able to put into practice their knowledge in economic matters and environmental protection in order to obtain the best results in the context of the liberalisation of the markets, because they will increase the competitiveness of wine on domestic and foreign markets, adapting the viti-vinicultural production to market requirements, protecting wine heritage, increasing producers' incomes and adapting wine-growing holdings to the new economic conditions.

In recent years, with the support of USAID CEED II project, the viti-vinicultural sector has opened new markets, exports to CIS markets being deflected towards the European Union, China and the USA. Thus, exports to non-CIS markets have increased annually by 12-15% and in the segment of wines with real value has widened by about 10% in the last three years. (http://usaid.gov)

In the context of the reform of the legal viti-vinicultural framework, there were amended the Law on vine and wine, the Law on making and circulation of ethyl alcohol and alcohol production, and the Law concerning the regulation of licensing the entrepreneurship activity. Also, there are more than 30 other normative acts.

By changing the regulatory framework, the viti-vinicultural industry has started the development of the viti-vinicultural State register, one of the most essential attributes of control and traceability. This project has been funded with more than 1 million US dollars jointly by USAID and the Czech Development Agency. By the year 2017, this information system will become a

functional one. The part pertaining to institutional Reformation, an important role played the creation of the National Office of Vine and Wine (NOVW). Thus, if previously (until 2009), there were agro-industrial agency "Moldova-Vin", which was a public authority, financed from the State budget and assumed both functions of elaboration and implementation of policies and control.

Starting from the year 2013, in the Republic of Moldova there were registered the first four Protected Geographical Indications: “Valul lui Trajan” (southwest), Stefan Voda (Southeast), Codru (Center) and Divine (wine distillates obsolete).

Another important decision was the establishment of Vine and Wine Fund for financial support of the development measures of the viti-vinicultural sector. The means of the Fund come at the rate of 50% to 50% of the contribution of the State and the private sector.

## CONCLUSIONS

Viti-vinicultural products arrived on the table of the consumer are the result of economic activities in the three segments of viticulture-wine-trade. Currently, it operates inefficiently first segment: in viticulture, it has significantly reduced the vine plantation areas, it has decreased considerably the productivity of vineyard, it has increased average age of vine plant, there have been worsened their condition essentially. To solve issues related to the functioning of the viti-vinicultural sector shall be ensured sustainable development of this sector, harnessing the maximum potential; the volume of raw material, production capacity and the volume of wine products placed on the market must be balanced. The Republic of Moldova must diversify its finished wine product structure, because this will allow to the Republic of Moldova to diversify its export market relations. The country must specialize not on export of raw materials, but on that of some finished products. As a consequence the country will increase its revenue on the basis of export, creating new jobs, which will require some formal training. For stabilization and economic efficiency of the viti-vinicultural sector, it is necessary to create a normative economic and legislative basis, which will strengthen the policy of taxation, investment and licensing, it would allow avoiding losses and financial risks. Wine and viticulture in Moldova needs an image, a clear marketing strategy and the necessary tools to conquer new markets and to reduce the risks of reliance on CIS countries. Competitiveness in the sector will continue to develop through deepening legal reforms, streamline controls and legislative provision of a believable quality framework. Special emphasis will be placed on supporting producers to reorganise themselves and to increase sales of wine with value-added. The viti-vinicultural sector will prosper by encouraging a new generation of small and medium-sized wineries. The industry has demonstrated its commitment to reforms and to implement them, with a strong state brand, a sustainable institutional framework and quality products. Through these reforms, the viti-vinicultural industry of Moldova aims not to be victim of embargoes, to consolidate its roots and to be considered a solid legacy for generations to come.

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# DETERMINING CROPS ECONOMIC EFFICIENCY USING CROP BUDGETS FOR THE NORTH-EAST REGION OF ROMANIA

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**Abstract**

The paper aims to highlight the necessity of using the crop budget as a comprehensive tool in determining the crop related expenditure - stage that precedes economic efficiency calculation. The drawn up form comprises two interconnected elements that communicate through associated formulas. We designed a table with specific data based on recommendations from the economic literature that reflects the entire production process in agriculture, results being used to determine the crop economic efficiency items represented also as tabular form. The tables made in Microsoft Excel can be used for any crop, with characteristic changes related to technology, any value change in the crop budget resulting in changes for the economic efficiency sheet. Thus it can be viewed and recorded immediately the economic effects of production variation with one or more units. There are taken into account the expenses regarding mechanical and/or manuals operations and materials used as well as the income from primary and secondary production, highlighting the main economic indicators associated. In calculating the efficiency there were taken into consideration also the subsidies - elements with significant weight in the structure of total revenue for a particular crop, related to the specific conditions of the North-East region of Romania. The form can be used in agricultural management as a tool for analysis of the various technological options applicable for the same crop in order to ensure the highest level of economic efficiency and establishing the level of production necessary to achieve a minimum outcome aimed under the specific circumstances.

**Key words**: crop budget, economic efficiency, total expenses, production cost, net profit

Unlike the companies from other sectors of the economy agricultural production presents a wide range of features that need to be taken into account since they have a strong influence on the production process in time and space *(*Brezuleanu S., 2009*)*.

These features needs to be studied in order to understand their social an economic impact. In order to achieve this objective the analyse must take into consideration also the benefits.

Romanian agriculture benefit, like other Member States, and other forms of support, including semi-subsistence restructuring, community support from structural funds for investment in agricultural and other economic activities in rural areas, substantial support for rural development and environmental protection (Ungureanu G. *et al,* 2013).

In agriculture as in any oher domain it is needed to be determined the economic efficiency. It indicates and justify continuing the agricultural activity and adding new investments regarding future development.

Economic efficiency is linked to profit as the difference between the value of marketable production and total production costs, which relate to factors that the entrepreneur has to purchase on the market (explicit costs), being a ratio between the economic result realized with this effort (Ştefan G. *et al,* 2006).

Development and modernization of agricultural holdings will be achieved through the expansion, improvement and rational use of material and technical resources that are acting in the complex process of obtaining and supply of agricultural products (Brezuleanu S. *et al,* 2010).

One of the most important and common tool that precedes economic efficiency calculus is represented by the crop budget.

Crop budget is a table in which there are presented in chronological order of performing, all work processes and all works referring to production technology, indicating optimal periods for their execution and determining, based on norms adapted to local conditions the necessary amount of work resources (tractors, machinery, vehicles, equipment, seeds, fertilizers, etc.), workforce, production expenses in order to obtain agricultural production with minimum costs per product unit (Ciurea I.-V. *et al,* 2001*)*.

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Crop budgets can be used to provide an estimate of overall profitability and resource requirements (land, machinery, labor). Budgets also can be used to estimate borrowing needs and cash flow for the farming operation (Greaser G. *et al,* 1994).

The economic efficiency calculation uses analysis of the specific costs for the inputs necessary for the production process.

Cost analysis is a technique for enterprise performance evaluation that helps at reflect the usage of material and human potential of the company and identify cost reduction of existing stocks in the company (Chiran A. *et al,* 2012).

Enterprise budgets represent estimates of receipts (income), costs, and profits associated with the production of agricultural products. The information contained in the enterprise budgets can be used by agricultural producers, extension specialists, financial institutions, governmental agencies, and other advisers making decisions in the food and fiber industry (Greaser G. *et al,* 1994).

There is no guarantee that resources will be fully employed or that they will be used in the most efficient way *possible (Sloman J., 1999)* but a well-structured plan of expenditure and income and may increase the level of functioning towards optimum.

## MATERIAL AND METHOD

The paper used an aeconomic model in order to illustrate the way it can be customized and applied to every crop considering the specific technology. The drawn up model comprises two interconnected elements that communicate through associated formulas. It was designed a table with specific data based on recommendations from the economic literature that reflects the entire production process in agriculture, results being used to determine the crop economic efficiency items represented also as tabular form.

The tables made in Microsoft Excel can be used for any crop, with characteristic changes related to technology, any value change in the crop budget resulting in changes for the economic efficiency sheet. Thus it can be viewed and recorded immediately the economic effects of production variation with one or more units. Economic efficiency analysis utilised values from the crop budget regarding the expenses and adding information regarding the income, the taxes or the subsdidies.

The crop budget - as an important tool in creating an agricultural activity overview ensures identifying details that can lead to a positive or a negative economic result. The current model uses data according to North-East Region conditions and the entry data are as a rough guide indicating that it is a functional model.

## RESULTS AND DISCUSSIONS

In order to fill in the drawn up spreadsheet containing the table form of the crop budget there was needed to identify the entry data: crops included in the production plan of the farm, the area occupied by each crop, the previous crop, the total production and the yield of each crop (primary production and secondary production), technological works in chronological order of their execution, times of execution and duration of the work, the means the works are executed (mechanical, manual), the cost of mechanical works, irrigation norms and cost of irrigation water, the cost of of manual work per category, taxes for the CAS, unemployment, risk and insurance, specific depreciation, the materials needed in technological process, the supply expenses share and the share of indirect expenses (general and common).

The crop budget can be applied only on a crop at the time, the process being needed to be restarted and separated once we add a new crop.

Elaborating the crop budget consist in following the following main steps:

- identifying the specific crop;
- recording into the spreadsheed data regarding the area and the yield. The yield is planned in relation to the variety, soil fertility, fertilizer quantities applied, etc.;
- specifying technological works in their execution order, adding optimum execution period and the duration of each work;
- determining for each work the volume of work, the sums required for its execution, materials needed and their cost;
- calculating for manual works in relation to the volume the number of z.o. The wage fund results by multiplying the number of z.o. necessary for carrying out the work with tariff per z.o. according to work category.

The model uses as example values characterizing North-East Region *(figure 1).*


Figure 1 **Development regions of Romania**

There are taken into account the expenses regarding mechanical and/or manuals operations and materials used as well as the income from primary and secondary production, highlighting the main economic indicators associated. In calculating the efficiency there were taken into consideration also the subsidies - elements with significant weight in the structure of total revenue for a particular crop, related to the specific conditions of the North-East Region of Romania. The evolution of area cultivated and production recorded for maize crop in this region indicate the level of importance at the national level considering that North-East Region owns 16.7% from the total maize production *(table 1)*.

Table 1

**The evolution of area cultivated and production recorded for maize crop in North-East Region in comparison to the others regions and to the national level**

| Region | | U.M | Year | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2011 | 2012 | 2013 | 2014 | 2015 |
| TOTAL COUNTRY | Area | to | 11717591 | 5953352 | 11305095 | 11988553 | 8984743 |
| | Production | ha | 2589667 | 2730157 | 2518268 | 2512809 | 2604475 |
| NORTH-WEST | Area | to | 1060818 | 648234 | 1094982 | 1226272 | 873385 |
| | Production | ha | 239673 | 237459 | 256501 | 265360 | 276771 |
| CENTER | Area | to | 675837 | 406965 | 644116 | 789254 | 647428 |
| | Production | ha | 144772 | 160100 | 149846 | 153338 | 160834 |
| **NORTH-EAST** | **Area** | **to** | **1966518** | **977220** | **2057116** | **2261309** | **1497386** |
| | **Production** | **ha** | **463941** | **494583** | **453051** | **455280** | **475646** |
| SOUTH-EAST | Area | to | 2454524 | 839806 | 2055168 | 2127758 | 1565550 |
| | Production | ha | 515777 | 500112 | 481659 | 469681 | 471829 |
| SOUTH-MUNTENIA | Area | to | 2381534 | 1388692 | 2519407 | 2449250 | 2032933 |
| | Production | ha | 479875 | 544146 | 484636 | 462541 | 499903 |
| BUCHAREST - ILFOV | Area | to | 38721 | 12555 | 48989 | 52475 | 47324 |
| | Production | ha | 8663 | 7305 | 10387 | 9804 | 11081 |
| SOUTH-WEST OLTENIA | Area | to | 1569294 | 604181 | 1475745 | 1444982 | 1066284 |
| | Production | ha | 386455 | 414269 | 346643 | 349284 | 360465 |
| WEST | Area | to | 1570345 | 1075699 | 1409572 | 1637253 | 1254453 |
| | Production | ha | 350511 | 372183 | 335545 | 347521 | 347946 |

Data provided by National Institute of Statistics

After the general results were obtained by automatic calculation using the entry data filled in the model, the next step is to draw the economic efficiency table that consist in data from the crop budget but also new element needed to determine the crop profitability.

The model can be extended adding the lease in case the entrepreneur does not own land or he wants to extend his cultivated area. In this case the expenditure is modified and the final economic result is influenced.

The crop budget for maize *(table 2)* indicates resources utilised in the agricultural activity as detailed as possible offerind data regarding the norms for manual works, the diesel fuel consumption in standard conditions, aggregate productivity, the quantities of fertilizers based on necessary for the active substance previously determined etc.

The most common changes for the same crop reffers to the yield (that can vary from a year to an other, from a region to an other or from a farm to an other) and the price of main production determined by the demand and the supply in the market.

The form model may be added-up (using the crop budget and the economic efficiency analysis) with break-even analysis. The interconnected formulas lead to the fact that filling the crop budget form generates automatically economic efficiency calculation and break-even point production quantity. This will represent the topic for a future scientific paper.

Table 2

## Crop budgets for maize, version with mechanical harvesting - 2016

Area: 100 ha Yield: main 8500 kg/ha Total production: main 850 t MECHANICAL HARVESTING
secondary 9500 kg/ha secondary 950 t

| Work | Month/ ten-days period | U.M. | Vol. | Norm zo/UM | Manual works Total z.o. | Wage category | lei/ z.o. | **Wages (lei)** | Mechanical works Unit | Price ha/a.n. | conversion factor | Ha a.n | **Total ( lei)** | Materials | Materials consumption onsumptio /ha | Total kg | Price lei/kg | **Total (lei)** | **Norm** per unit | z.a | **Price mechan** | **Wages mechan. ( lei)** | **F.c.** | Diesel fuel consumpt. litres | **Total works ( lei)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | **9** | 10 | 11 | 12 | **13** | 14 | 15 | 16 | 17 | **18** | 19 | **20** | 21 | **22** | **23** | 24 | **25** | **26** |
| Loading, transporting CF (PK) | IX/1 | t | 26 | 0,11 | 2,86 | II | 40 | **114,40** | 2RM2 | 370 | 0,05 | 5,0 | **1850,00** | superphosphate | 140 | 14000 | 1,6 | **22400,00** | 25 | 1,04 | 60 | **62,40** | 1,6 | 41,6 | **24426,80** |
| Unloading CF (PK) | IX/1 | t | 26 | 0,11 | 2,86 | II | 40 | **114,40** | | | | | | potassium chloride | 120 | 12000 | 1,8 | **21600,00** | | | | | | | **21714,40** |
| Administer and serv. CF (PK) | IX/1 | ha | 100,0 | 0,06 | 6,00 | III | 45 | **270,00** | Amazone | 370 | 0,2 | 20,00 | **7400,00** | | | | | | 14,5 | 1,79 | 65 | **116,55** | 2,6 | 260 | **7786,55** |
| 25 cm plowing + harrowing | IX/1 | ha | 100 | | | | | | PR-3-30 | 370 | 1,1 | 110 | **40700,00** | | | | | | 3,9 | 25,64 | 65 | **1666,67** | 28 | 2800 | **42366,67** |
| **TOTAL PROD BEFORE SPRING** | | | | | **11,72** | | | **498,80** | | | | | **49950,00** | | | | | **44000,00** | | 28,47 | | **1845,62** | | 3101,60 | **96294,42** |
| Loading, transporting CF (N) | IV-1 | t | 16,00 | 0,11 | 1,76 | II | 40 | **70,40** | 2RM2 | 370 | 0,05 | 5,00 | **1850,00** | urea | 160 | 16000 | 2 | **32000,00** | 25 | 0,64 | 60 | **38,40** | 1,6 | 25,60 | **33958,80** |
| Unloading CF (N) | IV-1 | t | 16,00 | 0,11 | 1,76 | II | 40 | **70,40** | | | | | | | | | | | | | | | | | **70,40** |
| Administer and serv. CF (N) | IV-1 | ha | 100 | 0,033 | 3,30 | II | 40 | **132,00** | Amazone | 370 | 0,1 | 10,00 | **3700,00** | | | | | | 14,5 | 6,90 | 65 | **448,28** | 2,6 | 260 | **4280,28** |
| Water transport and solution prep. | IV-1 | mii l | 1 | 0,09 | 0,09 | IV | 50 | **4,5** | RCU-4 | 370 | 0,05 | 5,00 | **1850,00** | water | 1000 | 100000 | | | 60 | 0,02 | 60 | **1,0** | 1,6 | 1,6 | **1855,50** |
| Herbicide and serv. | IV-1 | ha | 100 | 0,04 | 4,00 | I | 35 | **140,00** | Technoma | 370 | 0,25 | 25,00 | **9250,00** | MISTRAL | 1 | 100 | 165 | **16500,00** | 50 | 2,00 | 70 | **140,00** | 3,5 | 350 | **26030,00** |
| Tillage and prep. Soil | IV-1 | ha | 100 | | | | | | LEMKEN | 370 | 0,23 | 23,0 | **8510,00** | | | | | **0,00** | 11,5 | 8,70 | 65 | **565,22** | 7,5 | 750 | **9075,22** |
| Loading, transporting grains | IV-2 | t | 2,00 | 0,11 | 0,22 | II | 40 | **8,800** | 2RM2 | 370 | 0,05 | 5,0 | **1850,00** | STIRA | 20 | 2000 | 15 | **30000,00** | 25 | 0,08 | 60 | **4,80** | 1,6 | 3,200 | **31863,60** |
| Sowing +serv. | IV-2 | ha | 100 | 0,08 | 8,00 | III | 45 | **360,000** | SPC-8 | 370 | 0,3 | 30,0 | **11100,00** | | | | | | 16 | 6,25 | 70 | **437,5** | 7 | 700 | **11897,50** |
| Mechanical and manual weeding I | V-1 | ha | 100 | 2,78 | 278,00 | III | 45 | **12510,000** | CPU | 370 | 0,2 | 20,0 | **7400,00** | | | | | | 6,5 | 15,38 | 70 | **1076,92** | 4 | 400 | **20986,92** |
| Mechanical and manual weeding II | VI-1 | ha | 100 | 3,03 | 303,00 | III | 45 | **13635,000** | CPU | 370 | 0,2 | 20,0 | **7400,00** | | | | | | 12 | 8,33 | 70 | **583,33** | 3,5 | 350 | **21618,33** |
| **TOTAL TRIMESTRE II** | | | | | **600,13** | | | **26931,100** | | | | 0,0 | **52910,00** | | | | | **78500,00** | | 48,30 | | **3295,45** | | 2840,40 | **161636,55** |
| Maize harvesting | IX-3 | t | 850 | | | | | **0,000** | CLAAS | 370 | 0,32 | 272,0 | **100640,00** | | | | | | 100 | 8,50 | 70 | **595,00** | 3,5 | 2975 | **101235,00** |
| Transporting grains | IX-3 | t | 850 | | | | | | 2RM2 | 370 | 0,05 | 42,50 | **15725,00** | | | | | | 25 | 34,00 | 60 | **2040** | 1,6 | 1360 | **17765,00** |
| **TOTAL CURRENT YEAR** | | | | | **0,00** | | | **0,000** | | | | | **116365,00** | | | | | | | 42,50 | | **2635,00** | | 4335 | **119000,00** |
| | | | | | | | | | | | | | | | | | | | | | | | | | **0,00** |
| **GRAND TOTAL** | | | | | **611,85** | | | **27429,900** | | | | **592,5** | **219225,00** | | | | | **122500,00** | | **119,27** | | **7776,07** | | **10277** | **376930,97** |

The model of conomic efficiency for the maize crop consist in values and indicators calculated with specific formulas *(table 3)*.

Taxes on the wage fund are calculated by applying rates unemployment fund, health insurance fund and tax on the amount representing the wage fund. Specific depreciation value is determined in relation to the asset value and useful life.

The share of expenditure for supply is calculated by applying a percentage of the value of the materials used. Summing up costs for mechanical works, irrigation, manual work, taxes on wages, materials (including supply costs) other expenses, direct costs are obtained.

To direct costs there is applicable the share of common and general expenditure and by summing them there are determined the production costs. After each quarter thare are made totals. There are calculated following indicators: cost of production per hectare and the cost per tonne of product. Expenditure per hectare results from the ratio of total production costs and area. The cost per unit of production is calculated reporting product costs for the main product to the planned quantity of products.

Table 3

**Economic efficiency of maize crop, version with mechanical harvesting - 2016**

| Entry data | | | Obtained results | | |
|---|---|---|---|---|---|
| 1 | Crop area (ha) | 100.00 | 1 | Total main production (tone) | 850.00 |
| **2** | **Yield for main production (kg/ha)** | **8500.00** | 2 | Total secondary production (tone) | 950.00 |
| 3 | Yield for secondary production (kg/ha) | 9500.00 | 3 | Fuels expenditure (lei) | 51385.00 |
| 4 | Total workforce consumption (z.o.) | 611.85 | 4 | Wages - total (lei) | 35205.97 |
| 5 | Wages for manual works (lei) | 27429.90 | 5 | Contribution on wages for manual works (lei) | 4388.78 |
| 6 | Mechanical works expenditure (lei) | 219225.00 | 6 | Contribution on wages for mechanical works (lei) | 1244.17 |
| 7 | Expenses for materials (lei) | 122500.00 | 7 | Total contributions (lei) | 5632.95 |
| 8 | Unit days (z.a.) | 119.27 | 8 | Unemployment fund (lei) | 176.03 |
| 9 | Wages for mechanizers(lei) | 7776.07 | 9 | Supplementary pension (lei) | 528.09 |
| 10 | Total diesel fuel consumption (liters) | 10277.00 | 10 | C.A.S. (lei) | 7322.84 |
| 11 | Fuel price (lei/l) | 5.00 | 11 | Health fund CASS(lei) | 1830.71 |
| 12 | The tax rate for manual works wages (%) | 16.00 | 12 | Total taxes (lei) | 15490.63 |
| 13 | The tax rate for mechanizers wages (%) | 16.00 | 13 | Supply expenses (lei) | 18375.00 |
| 14 | Unemployment fund (%) | 0.50 | 14 | T.V.A. (lei) | 24500.00 |
| 15 | Supplementary pension (%) | 1.50 | 15 | Depreciation(lei) | 100000.00 |
| 16 | C.A.S. (%) | 20.80 | **16** | **Total direct costs (lei)** | **527520.53** |
| 17 | Health fund - CASS(%) | 5.20 | **17** | **Other direct costs (lei)** | **79128.08** |
| 18 | Supply expenses (%) | 15.00 | 18 | Common expenses (lei) | 26376.03 |
| 19 | T.V.A. (%) | 20.00 | 19 | General expenses (lei) | 52752.05 |
| 20 | Irrigation( lei / ha) | 0.00 | **20** | **Total indirect expenses (lei)** | **79128.08** |
| 21 | Depreciation ( lei / ha) | 1000.00 | **21** | **Total operating expenses (lei)** | **685776.68** |
| **22** | **The selling price of main production (lei/kg)** | **0.85** | **22** | **Income from main production (lei)** | **722500.00** |
| 23 | The selling price of secondary production (lei/kg) | 0.10 | **23** | **Subsidies** | **101992.00** |
| 24 | Share of common expenses (%) | 5.00 | 24 | Income from secondary production (lei) | 95000.00 |
| 25 | Share of general expenses (%) | 10.00 | 25 | Total income (lei) | 919492.00 |
| 26 | The tax rate on profits (%) | 16.00 | **26** | **Production cost (lei/t)** | **806.80** |
| 27 | Share of other direct costs (%) | 15.00 | **27** | **Total gross profit (lei)** | **233715.32** |
| **28** | **Subsidies per ha** | **207.5** | 28 | Tax on profit (lei) | 37394.45 |
| | Payments per hectare = value euro / ha year 2016 * Exchange rate | 77.08 | 29 | Net profit (lei) | 196320.87 |
| | Redistributive payment -5 to 30 ha | 46.75 | 30 | Net profit (lei/t) | 230.97 |
| | Greening payement | 53.9 | 31 | Profit per area unit (lei/ha) | 1963.21 |
| | Young farmers | 29.77 | **32** | **Net profit rate(%)** | **28.63** |
| | Diesel subsidies = 1 leu / l | 10277 | 33 | Work productivity (lei/z.o.) | 1502.81 |
| | | | 34 | Work productivity (z.o./kg) | 0.001 |

## CONCLUSIONS

Crop budget represent an essential tool in determining economic efficiency in agricultural management regarding the vegetable sector. Drawing an organised and detailed representation of expenses related to specific agricultural works helps to identify the specific weaknesses in order to overcome them or to diminish their effects and to find the means to optimize the agricultural production process.

Minimizing expenses is one of the most important goals in any business. Achieving this goal may lead to competitive advantage and to economic increase. The model formed by the two related main tables explores a variety of ways to ensure this goal common to all companies at the global level.

The form can be used in agricultural management as a tool for analysis of the various technological options applicable for the same crop in order to ensure the highest level of economic efficiency and establishing the level of production necessary to achieve a minimum outcome aimed under the specific circumstances.

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# IDENTIFICATION OF BIOGENIG AMINE IN SALAD DRESSINGS

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**Abstract**

The presence of biogenic amine in food represents a quality indicator of acceptability. The intake of foods containing biogenic amines can present a health hazard through the direct toxic effect of these compounds. The biogenic amine contents in four samples of sauce used for salad enrichment were determined using HPLC. From the sampled fresh open after purchase, just two were identified with traces of biogenic amines. Of the nine biogenic amines under study, six of them were identified after 7 days after -sauces were open and stored in refrigeration: putrescine (1%), spermidine (1%), spermine (1%), tryamine (4%), phenylethylamine (72%) and histamine (21%). The total content for the identified amine in each sauce was 150.45 mg/g with a range from 2.55 mg/g to 112.75 mg/g. After 14 days in three sauces was identified one type of biogenic amine namely: putrescine, spennidine and phenylethylamine.

**Key words**: quality indicators, refrigeration, sauces

The sauce is a semi-solid food not normally consumed by consumers; it is used to add flavor, moisture, and visual appeal to another dish. Depending on the purpose, sauces can be strongly flavored, hot and spicy, or even sweet to be served with a dessert (Chong Y.Q., 2016).

In the case of commercials sauces, once opened, the freshness and flavor will slowly deteriorate. The sauce is still safe to use beyond this time but the quality may not be best all the time. Therefore, after opening it is recommend the sauce refrigeration (Tiersky E., 2013). Refrigeration helps the flavor and quality characteristics to remain at their peak for a longer period. In general, a change in flavor and/or color is the first indication that a sauce is beginning to lose its freshness. The proposed chemical indices used for the identification of the early signs of sauces alteration are: pH, water activity and the biogenic amine content (Weaver C.M. *et al*, 2013).

In the last period a wide variety of foods such as vegetables, wines, cheese, fish, and meat have been subjected to researchs in order to identified biogenic amines.

The biogenic amine occurrence is the result of the enzymatic decarboxylation of the precursor amino acids although microorganism activities (Baston O., Barna O., 2010). The main factors that acts on the biogenic amine formation are the availability of the amino acid substrate, the level of decarboxylase activity, and the specific bacterial strain(s) present (Linares D.M. *et al*, 2009). The quantitative production of biogenic amines is usually reported to be temperature and time dependent (Zaman M.Z. *et al*, 2009).

The most common biogenic amines found in foods are histamine, tyramine, cadaverine, 2-phenylethylamine, spermine, spermidine, putrescine, tryptamine, and agmatine. From the biogenic amine usually analyzed, polyamines spermine and spermidine are natural amines produced by the body (Biji K.B. *et al*, 2016). Histamine and tyramine are considered as the most toxic and food safety relevant, and fermented foods are of particular biogenic amine concern due to associated intensive microbial activity and potential for their formation (Naila A. *et al*, 2010).

According to European Food Safty Authority the amount of biogenic amine in fermented foods for which no adverse health effects were observed varies between 50 and 600 mg/kg (*table 1*). The biogenic amine identification is important because of their potential use as freshness indicators and their toxicity (Baston O., Barna O., 2010). As Naila A. *et al* (2010) mentioned in their study, the existing method for controlling biogenic amines in food is refrigeration.

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Table 1

**Biogenic amine levels in food for which no adverse health effects (NOAEL) were observed**

| Biogenic amine | Concentration (mg/kg) | Reference |
|---|---|---|
| Putrescine | 600 | Rauscher-Gabernig E. *et al* (2012) |
| Cadaverine | 510 | |
| Spermidine | 300 | Bobba M. *et al* (2015) |
| Spermine | 50 | |
| Tryptamine | - | - |
| Phenylethylamine | 120 | Bobba M. *et al* (2015) |
| Histamine | 200 | EFSA (2011) |
| Tyramine | 600 | |
| Agmatine | - | - |

Although certain bacteria can develop at low temperature biogenic amines may be formed. Consequently refrigeration exclusively cannot ensure the biogenic amines absence.

The purpose of the present study is to evaluate the influence of refrigeration process on four comercial sauces quality by identifying the development of biogenic amines.

## MATERIAL AND METHOD

Samples

Samples (n = 4) of sauce were purchased at supermarkets in Suceava, Romania, in April, 2016. From the different brands available in the market the sauces included in this study were choose based on the statistics made according to the sales achieved in the near period. The sauces were American Cesar dressing (C), salad dressing with yoghurt and willed garlic (U), dressing vinaigrette (V) and salad dressing with aromatic herbs (D).

The products, according to the labels contain water, vegetal oils, vinegar, refined salt, sugar, egg yolk, and xantan. American Cesar dressing also listed butter and hard cheese as ingredients on the label. Salad dressing with yoghurt and willed garlic contains milk proteins and yoghurt aroma. Salad dressing with aromatic herbs contains yoghurt and some condiments.

For the proposed determinations the samples were taken immediately after opening the containers, then the sauces were kept at refrigerated temperature.The samples stored under refrigeration conditions were analysed after 7 and 14 days of storage.

Reagents and solvents

The reagents used were purchased from Sigma-Aldrich: standards solution of biogenic amines with 95-99% purity (putrescine (Put), cadaverine (Cad), spermidine (Spd), spermine (Spm), tryptamine (Try), 2-phenylethylamine (Phe), histamine (His), tyramine (Tyr) and agmatine (Agm)), perchloric acid, sodium hydroxide, benzoyl chloride, diethyl ether and acetonitrile.

Sauces sample preparation:

Over the estabilished amount of the sauce sample, weighed at analytical balance, perchloric acid (0.4 M) was added. The sample was homogenized and centrifuged at 4000 rpm. The supernatant obtained was diluted with perchloric acid (0.4 M). 2 ml of extract were taken NaOH (2 M) and benzoyl chloride was added. The obtained solution was heated to 30°C and NaCl saturated solution was added. The resulting sample was extracted with diethyl ether and the extract was taken to dryness using the water bath.

The residue obtained was dissolved in acetonitrile and before being placed in vials was passed through a filter was filtered through an filter of 0.22 µm pore size.

Biogenic amines determination

Biogenic amines were determined using Shimadzu HPLC detector's SPD M20 Diode Array A (254 nm) from Faculty of Food Engineering (Stefan cel Mare University of Suceava) laboratory.

In order to estabilish the biogenic amines concentration (mg BA/g product) in the analized samples equation (1) was used:

$$C = C_0 x A/As \quad (1)$$

where: C is the determined biogenic amine concentration, $C_0$ is the standard concentration of biogenic amine A is the biogenic amine area from the sample and As is the standard area for the biogenic amine.

## RESULTS AND DISCUTIONS

The biogenic amine contents in four samples of sauce used for salad enrichment were determined using HPLC. From the fresh sampled opened after purchase, just two were identified

with traces of biogenic amines, namely the C and D sauces (*table 2*). Of the nine biogenic amines under study, six of them were identified in the samples collected on 7 days ~~seven~~ after the opening and stored in refrigeration conditions: putrescine (1%), spermidine (1%), spermine (1%), tryamine (4%), phenylethylamine (72%) and histamine (21%) (*table 3*). The total content for the identified amine in each sauce was 150.45 mg/g with a range from 2.55 mg/g to 112.75 mg/g (*figure 1*). The samples analyzed after 14 days of storage showed that the C, D and U sauces contain one type of biogenic amine namely: spermidine (0.61 mg/g), putrescine (0.22 mg/g) and phenylethylamine (861.67 mg/g), respectively.

According to FAO&WHO (2012) refrigeration storage at 4°C will prevent the growth of histamine-producing bacteria. The study conducted by Guidi L.R., Gloria M.B.A. (2012) found in fresh soy sauce the following biogenic amine: tyramine, putrescine, histamine, phenylethylamine and cadaverine. No researches were reported related to refrigeration and biogenic amines development in sauces.

Table 2

**Identified biogenic amine in the analized samples**

| Sample | Biogenic amine | | |
|---|---|---|---|
| | Fresh open | After 7 days | After 14 Days |
| C | Put | Phe | Spd |
| D | Put | Phe | Put |
| U | - | Put, Spd, Spm, Try, Phe, His | Phe |
| V | - | Try, Phe, His, Tyr, Agm | - |

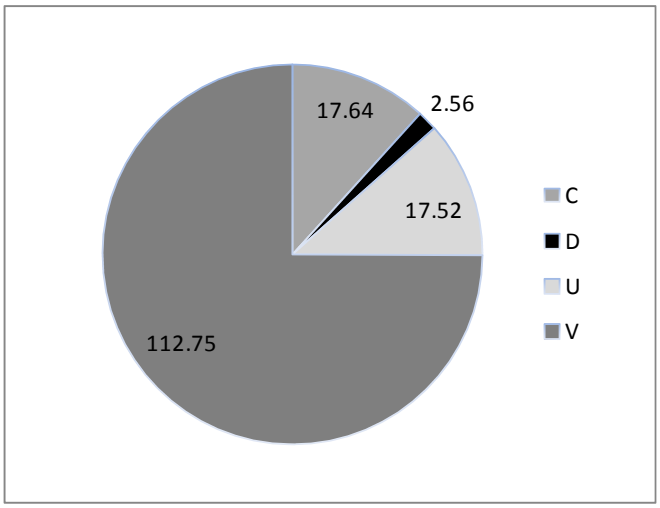


Figura 1 - **Total biogenic amine identified after 7 days of refrigeration**

Table 3

**Percentage (%) of Biogenic Amine Identified After 7 Days of Refrigeration in the analyzed sauces**

| | C | D | U | D |
|---|---|---|---|---|
| Put | - | | 0.50 | - |
| Cad | - | | - | - |
| Spd | - | | 0.92 | - |
| Spm | - | | 0.35 | - |
| Try | - | | 3.78 | 0.92 |
| Phe | 100 | 100 | 72.81 | 46.68 |
| His | - | | 21.64 | 48.45 |
| Tyr | - | | - | 0.20 |
| Agm | - | | - | 3.75 |

## CONCLUSIONS

Refrigeration helps the flavor and quality characteristics to remain at their peak for a longer period. The biogenic amine of four commercial sauces were taken immediately after opening the containers, then the sauces were kept at refrigerated temperature and sample for analysis were carrying in day seven and fourteen.

In the case of the fresh open sauces putrescine was identified in C and D sauces. After seven days the higher amount of biogenic amine was determined in V sauce (112.75 mg/g), followed by C and U (17 mg/g) and D (2.55 mg/g).

In the fourteen day the C, D and U sauces were found to contain one type of biogenic amine namely: spermidine (0.61 mg/g), putrescine (0.22 mg/g) and phenylethylamine (861.67 mg/g).

Sauces refrigerated storage can prevent the growth of biogenic amine producing bacteria in the case of three sauces and inhibited the development of the existing ones.

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# STUDIES REGARDING THE INFLUENCE OF THE DRYING PROCESS TECHNOLOGICAL PARAMETERS ON THE CORN SEED QUALITY

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**Abstract**

In some special harvesting conditions of corn grains, the seeds have humidities between 25% ... 30%, and they are subjected to the drying operation in order to be safetly stored. Corn seeds subjected to drying, behave differently according to their condition and the operation parameters of the drying technology. Corn seeds do not support aggressive drying conditions characterized by non-uniform temperatures and rates of the drying agent, when passing through the product layer.

The purpose of the paper is to establish the optimal operating parameters for the drying process to maximize the technological effect and to conserve the quality of the corn seeds. In the investigations, corn seeds with four initial humidities were dryed in a layer thickness of 150 mm. During the investigations, was studied the influence of the drying agent's velocity and temperature on the protein content and germination of the seeds. The drying process for corn seeds was carried out using four velocities and five temperatures of the drying agent. To achieve the goal, a laboratory dryer for agricultural products was designed and built.

Experimental research results show that both the protein content as well as the germination capacity of corn seeds were affected by temperatures of the drying agent higher than 50°C. The optimal drying variant of corn seeds, regardless the initial moisture content, was obtained for the drying agent's velocity of 2.5 m/s and the temperature of 50°C. For temperatures of the drying agent higher than 50°C, the protein content and seed germination capacity decreased up to 5.46% and 88%, respectively.

**Key words**: corn seed drying, protein content, germination capacity

The grain is a living organism in which occur different biochemical processes whose intensity depends on the drying and storage conditions. During the storage, the seed humidity should not overcome 13% - 14% for cereal seeds and 7% - 8% for technical plant seeds.

In the moist grain the breathing process intensifies, this leading to the water and carbonic acid elimination. During the breathing process of the grain a certain quantity of heat is released which depends on the storage conditions. The temperature increase contributes to the enhancing breath (Hefnia and Witthöftb, 2012).

As a result of the temperature influence, the cereal seeds suffer qualitative changes; the drying systems at high temperatures prevent the seed biological activity, diminish the growing power and at exceedingly high temperatures partial or even total losses of the germination power may occur.

After the drying process, grain seeds for consumption or for animal feeding, are able to be stored and to respond properly to processing and handling.

Corn seeds do not support aggressive drying conditions characterized by non-uniform temperatures and rates of the hot air when passing through the product layer (Qiang *et al*, 2011).

In the past, efforts have been made to experimentally study the drying process of corn seed.

Currently, for drying the corn seeds, convective dryers are used worldwide, vertical and horizontal with continuous and discontinuous function, which do not solve the problem of the distribution's uniformity of temperature and velocity in the drying seed layer.

The corn seeds, which are subjected to the technological drying operation, behave differently depending on the physicochemical characteristics.

The purpose of the paper is to establish the optimal operating parameters for the drying process to maximize the technological effect and to conserve the quality of the corn seeds (protein content and germination capacity).

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## MATERIAL AND METHOD

The main objective of the experimental researches consisted in the study of the drying process of corn seeds, aiming the optimized drying.

The targets of the experimental researches in this study were corn seeds, collected at different stages of ripeness, at four predetermined humidities, which were submitted to the drying process by means of an installation for dehydration in laboratory conditions (*figure 1*).

The temperatures during the drying process were 40ºC, 50ºC, 60ºC, 70ºC and 80ºC, and the velocity values of the thermal agent were 1 m/s, 1.5 m/s, 2 m/s, and 2.5 m/s. Each sample of material, regardless the initial humidity, had the same volume.

The experimental investigations were conducted in the laboratory of food industry and agricultural mechanization from the University of Agricultural Sciences and Veterinary Medicine "Ion Ionescu de la Brad", Iaşi.

For these experiments, a rectangular drying box has beed built (*figure 2*). It was provided with three layers of seeds, next to each other and well delimited, each of them 50 mm thick.

The parallelepiped shaped box has been made according to the current drying conditions and technologies.

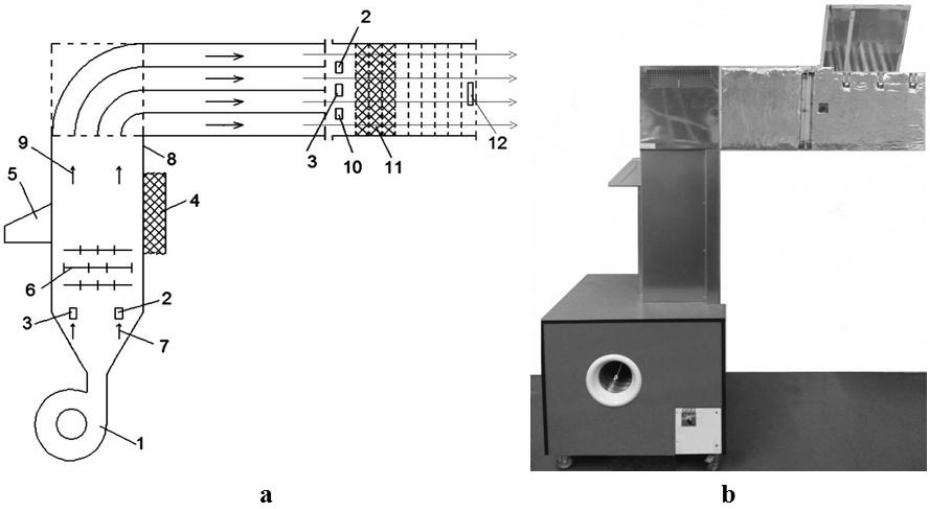


Figure 1 **Laboratory dryer scheme with rectangular box**: **a** – functional scheme; **b** – general view; 1 – fan; 2 – temperature sensor; 3 – humidity sensor; 4 – isolating layer; 5 – control panel; 6 – electrical resistances; 7 – cold air; 8 – body; 9 – hot air; 10 – velocity sensor; 11 – drying cells; 12 – humidity sensor for the used drying agent.

Throughout the research, a special watch was attributed to the influence of the constructive and functional parameters of the dehydration installation on the variation of the humidity and temperature in the three layers of seeds up to the point of reaching the conservation humidity. The drying time, the protein content of the corn seeds and the seed germination have also been recorded.

By varying the velocity and temperature of the hot air between 1 m/s and 2.5 m/s and between 40°C and 80°C were studied a total of 20 experimental variants for each initial moisture content.

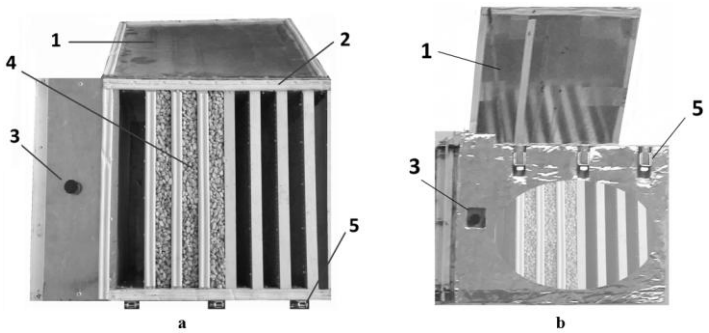


Figure 2 **Rectangular galvanized box and stainless steel sieves used for seed drying:** **a** – view from above; **b** – side view; 1 – cover; 2 – seals; 3 – opening for measuring; 4 – drying cells separated with stainless steel sieves; 5 – sealing cap system.

## RESULTS AND DISCUSSION

In order to achieve those proposed, corn seeds were subjected successively to be dried in the three adjacent cells, starting from four humidities of 25%, 22%, 19% and 16%. The initial protein contents were 9.53%, 9.73%, 9.78%, 9.81% and the initial germination capacities were 93%, 93%, 95% and 96%.

The results regarding the protein content of the dried corn seeds are presented in *table 1*.

For the air temperatures of 40°C and 50°C there were no significant changes in terms of protein content. Since the air temperature rises above 50°C, the protein content decreases up to 5.46%. The most affected protein content was obtained after drying corn seeds at the air temperature of 80°C and the air velocity of 1.5 m/s.

Table 1

**The results regarding the protein content of dried corn seeds**

| No. | Drying agent velocity (m/s) | Drying agent temperature (°C) | Initial moisture content (%) | | | |
|---|---|---|---|---|---|---|
| | | | 25 | 22 | 19 | 16 |
| | | | Protein content (%) | | | |
| 1. | 1 | 40 | 9.54 | 9.71 | 9.78 | 9.82 |
| 2. | | 50 | 9.53 | 9.78 | 9.74 | 9.81 |
| 3. | | 60 | 9.31 | 9.69 | 9.60 | 9.63 |
| 4. | | 70 | 9.27 | 9.55 | 9.52 | 9.49 |
| 5. | | 80 | 9.01 | 9.30 | 9.23 | 9.24 |
| 6. | 1.5 | 40 | 9.52 | 9.76 | 9.85 | 9.82 |
| 7. | | 50 | 9.53 | 9.74 | 9.83 | 9.83 |
| 8. | | 60 | 9.33 | 9.51 | 9.57 | 9.61 |
| 9. | | 70 | 9.29 | 9.44 | 9.49 | 9.61 |
| 10. | | 80 | **9.00** | 9.17 | 9.22 | 9.34 |
| 11. | 2 | 40 | 9.50 | 9.69 | 9.68 | 9.80 |
| 12. | | 50 | 9.52 | 9.69 | 9.78 | 9.79 |
| 13. | | 60 | 9.33 | 9.53 | 9.58 | 9.61 |
| 14. | | 70 | 9.30 | 9.50 | 9.54 | 9.56 |
| 15. | | 80 | 9.03 | 9.45 | 9.36 | 9.32 |
| 16. | 2.5 | 40 | 9.54 | 9.74 | 9.76 | 9.81 |
| 17. | | 50 | 9.53 | 9.71 | **9.86** | 9.79 |
| 18. | | 60 | 9.34 | 9.62 | 9.65 | 9.53 |
| 19. | | 70 | 9.35 | 9.61 | 9.68 | 9.60 |
| 20. | | 80 | 9.13 | 9.33 | 9.37 | 9.38 |

The least affected protein contents were obtained at higher air velocities and lower air temperatures. It was also observed that the longer the drying process takes, the more affected is the protein content.

This means the lower the initial humidity is, the higher the protein content remains after drying.

At temperatures higher than 50°C, the germination capacity varies inversely with temperature, but at the same time it varies directly proportional to the air velocity. The high temperatures strongly affect the germination capacity up to 88%, as it can be seen in *figure 3*.

According to the graphic, the germination capacity decreased slightly for the dried corn seeds with the initial moisture contents of 25% and 22%, even at low temperatures. As in the case of the protein content, for a low initial humidity, the drying process takes less and that means less protein loss.

The optimal drying variant of corn seeds, regardless the initial moisture content, was obtained for the drying agent velocity of 2.5 m/s and the temperature of 50°C.

For these parameters the seed quality was not affected and more than that, the seed layers temperatures and humidities varied close to each other.

These facts conclude to a uniform seed drying in all the three layers.

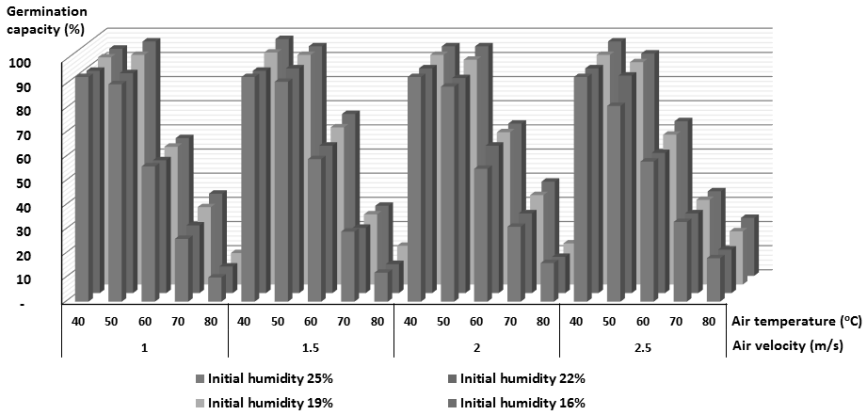


Figure 3 **The variation of germination capacity for the dried corn seeds**

The statistical analysis (*table 2*) regarding the protein content variation for dried corn seeds showed that at different air velocities there weren't any significant differences for the protein content, because the test conditions are not fulfilled ($p < 0,05$ şi $F > Fcrit$). However, for different air temperatures, significant protein content differences were obtained.

For different air velocities there were also no significant differences obtained regarding the germination capacity. Significant differences were obtained for different air temperatures, because the test conditions were satisfied.

In conclusion, the *temperature* variable had the only influence on both protein content and germination capacity.

Table 2

**ANOVA test results with two variables for corn seeds**

| Analysis | Variables | |
|---|---|---|
| | Velocity | Temperature |
| protein content | ns | * |
| germination capacity | ns | * |

* – P<0,05; ns – not significant.

## CONCLUSIONS

Analyzing the results of the physical parameters obtained throughout the experiments, one can conclude that the best results concerning the protein content and the germination power of corn seeds have been recorded for the variants in which the drying process was done by using high air velocities and low air temperatures.

From the point of view of the uniform drying of corn seeds the final humidity values in the seed layers were also closer at the maximum velocity used of the drying agent and at low working temperatures.

For the air temperatures of 40°C and 50°C there were no significant changes in terms of protein content. Since the air temperature rises above 50°C, the protein content decreases up to 5.46%.

At temperatures higher than 50°C, for the germination power of the seeds the values obtained vary inversely proportional to the temperature, but at the same time, vary directly proportional to the thermal agent velocity. The germination capacity decreased up to 88%.

After the statistical analysis, significant differences for the protein content and the germination capacity of dried corn seeds were obtained for the air temperature variation.

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# INFLUENCE OF THE PULP MACERATION TEMPERATURE ON WINE RAW MATERIAL QUALITY FOR ROSE SPARKLING WINES PRODUCTION

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**Abstract**

In the article the comparative assessment of different pulp maceration temperatures on the chromatic characteristics and foaming properties of wine raw material for sparkling rose wine production was carried out.
Based on the conducted study the influence of different pulp maceration temperatures (16, 20 and 24ºC) on the quality of raw materials for rose sparkling wines was established. All wines were obtained at different temperatures with maceration for 6 hours from Merlot grape variety, harvested at SPIHFT plantations and processed under microvinification conditions, as well as standard parameters and chromatic indices such as the concentration of phenolic substances, the concentration of anthocyanins, color intensity, hue and foaming properties (maximum height of foam (HM) mm, height of foam stabilization (HS) mm and stabilization time (TS), s) characterizing the composition and quality of raw material for rose sparkling wines were determined. Sensory appreciation and physical-chemical analyzes showed that the pulp maceration temperature significantly affects the aroma, flavor, color and foaming properties of rose wine materials for sparkling wines production. According to the obtained results, it was found that pulp maceration temperature of 16ºC allows obtaining of high quality raw rose wine for sparkling wines production.

**Key words**: rose wine material, temperature, phenolic compounds, anthocyanins, foaming properties

According to investigations, one of the most important operations in the technological scheme for obtaining of raw rose wine material is the duration time of pulp maceration, which allows enrichment the wine with phenolic compounds, organic acids, minerals, aromatic substances, nitrogen and together with other components, which participate in the formation of quality indicators (color, aroma, taste and foaming properties).

Color, flavor and foaming properties are the most important characteristics of raw material for sparkling wines. The rose wines color are influenced both by temperature as well as the duration of contact of the must with the solid phase, directly depending on parameters such as anthocyanins extracted from the skin of the grape during short maceration and reactions involving these compounds and other compounds phenolic during vinification.

Rose wine production is difficult because of a minimum color extraction with a maximum of flavor in a short time. However, an optimal content of phenolic compounds and an improved flavor can be achieved by controlling both the duration and the temperature of the maceration process.

The main objective of this research was the optimization of maceration process for obtaining high quality rose raw material for sparkling wines

The present document is arranged so that it can be used as a model. It is also a template on which you can work directly by replacing the corresponding paragraphs.

## MATERIAL AND METHOD

In order to establish the influence of the pulp maceration temperature for rose raw material wine production, different temperatures of pulp maceration (16, 20 and 24°C) for 6 h were studied. In this study raw material was obtained from Merlot grapes, harvested from the SPIHFT plantations and processed under microvinification conditions. As a control the feedstock rose wine obtained by the free flow of wort was used.

In the research the standard methods for determining the physical and chemical indices, specific (phenolic substances, anthocyanins, tone and color intensity) and foaming properties as according to OIV requirements were applied

## RESULTS AND DISCUSSION

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Physical and chemical indices of rose wines obtained at different maceration temperatures are shown in *table 1*.

Table 1

**Physical and chemical indices of Merlot rose raw material wines obtained at different maceration temperatures**

| N. | Maceration temperature | Alcoholic concentration, % vol. | Mass concentration of: | | | pH | OR potential, mV | Organoleptic evaluation, points |
|---|---|---|---|---|---|---|---|---|
| | | | sugars, g/dm$^3$ | Titratable acids, g/dm$^3$ | Volatile acids, g/dm$^3$ | | | |
| 1. | Control | 11.6 | 2.0 | 6.1 | 0.26 | 3.14 | 194 | 7.8 |
| 2. | 16ºC | 11.6 | 2.0 | 6.4 | 0.26 | 3.39 | 192 | 8.15 |
| 3. | 20ºC | 11.3 | 2.1 | 6.7 | 0.33 | 3.33 | 193 | 8.0 |
| 4. | 24ºC | 11.4 | 2.5 | 7.0 | 0.39 | 3.31 | 199 | 7.9 |

As shown in *table 1*, increase of pulp maceration temperatures lead to a lower alcoholic strength in obtained wines which varies from 11.6 up to 11.3% vol. and increase of titratable acids concentration from 6.4 to 7.0 g/dm$^3$ compared to the control sample. Simultaneously with the increase in pulp maceration temperature in studied rose wines a decrease in pH from 3.39 up to 3.31 was observed.

Sensory appreciation of rose raw material for sparkling wines obtained at different temperatures of pulp maceration showed a significant influence of this factor on the quality of wines. Conducted organoleptical analysis allowed to emphasize the rose wine produced by pulp maceration at 16ºC, which was appreciated at maximum of 8.15 points and is characterized by a pink color, clean aroma with notes of exotic fruits, the taste is full and balanced. Rose wines obtained by pulp macerating at 20ºC and 24ºC were appreciated with 8.0 and 7.9 points, respectively, and are characterized by a dark rose color, clean flavor with notes of red fruits, but with more extractive and harsh taste. Rose wine obtained by the free flow of wort was characterized as pale rose, with simple flavor, sweet taste, being appreciated with 7.8 points.

For further analysis of the influence of the pulp maceration temperature on the quality of obtained wines the concentrations of anthocyanins and phenolic substances were determined and results are presented in *figure 1*.

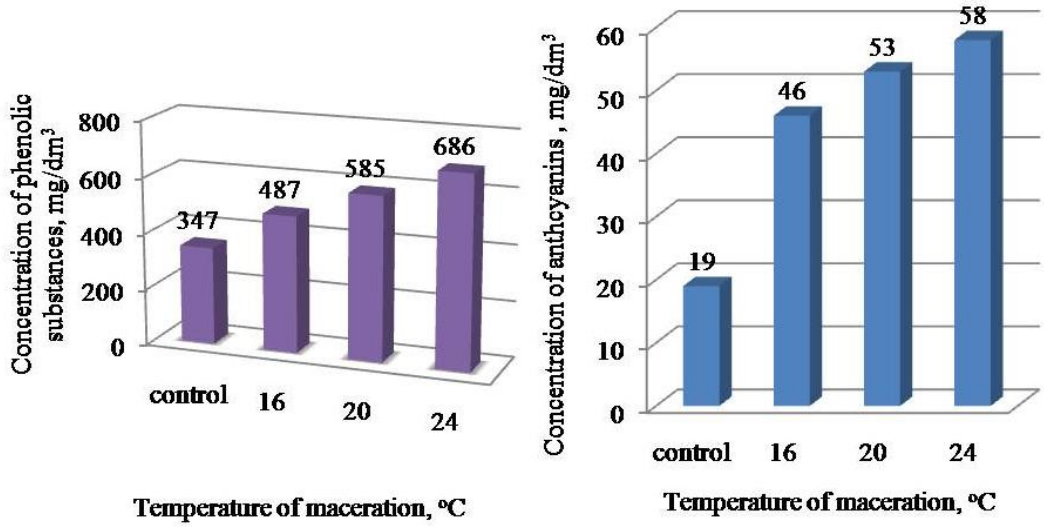


Figure 1 **Influence of pulp maceration temperatures on concentrations of anthocyanins and phenolic substances**

According to results shown in figure 1, it can be mentioned that the pulp maceration temperature contributes to anthocyanins and phenolic substances extraction. The temperature of 16ºC for pulp maceration contributed to an increase of phenolic substances concentration with 140 mg/dm$^3$ and maceration temperatures of 20 ºC and 24ºC contributed to increase the concentration of phenolic substances with 238 mg/dm$^3$ and 339 mg/dm$^3$ respectively in comparison with control.

The same regularity and for anthocyanin content was highlighted. Thus, at the pulp maceration temperature of 16ºC an increase in the concentration of anthocyanins of 27 mg/dm$^3$ was observed and temperature of pulp maceration of 20ºC and 24ºC contributed to the increase with 34 mg/dm$^3$ and 39 mg/dm$^3$ respectively of the antocyanins concentration in comparison with the control obtained by the free flow of wort.

Furthermore, the intensity and shade of color were investigated and obtained results are presented in *figure 2*.

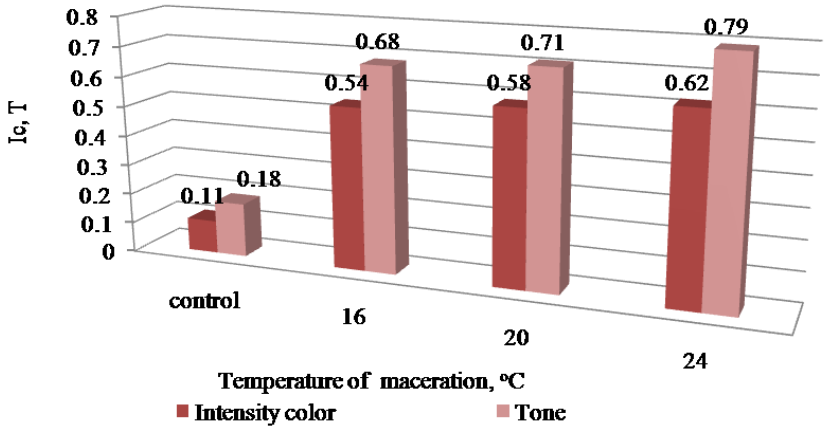


Figure 2 **Influence of pulp maceration temperature on the intensity and color tone in rose raw material wines**

The data presented in Figure 2 indicate that the pulp maceration temperature of 16°C contributed to obtaining of raw material wine with light shades of rose color and maceration temperatures of 20°C and 24°C have contributed to production of raw material wine with dark shades of the pink color. Wine obtained by the free flow of worth was characterized by pale rose color.

A particular interest presents the studies relating to the determination of the influence of different pulp maceration temperatures on foaming properties of obtained raw material for rose sparkling wines production. The foaming properties were determined using up-to-dated equipment "Mossalux" (France).

In *table 2* foaming properties of rose wines at different temperatures of pulp maceration are shown.

Table 2

**Influence of pulp maceration temperature on the foaming properties of rose wines**

| Maceration temperature | Foaming indices | | | Note* |
|---|---|---|---|---|
| | Maximum height, (HM), mm | Height of stabilization, (HS), mm | Time of stabilization, (TS), s | |
| control | 50 | 29 | 19 | + |
| 16°C | 66 | 49 | 38 | +++ |
| 20°C | 60 | 41 | 29 | ++ |
| 24°C | 56 | 35 | 26 | + |

Legend: +++ maximum foam; ++ medium foam; + minimum foam

According to results presented in *table 2* can be concluded that pulp maceration temperature influences the foaming properties of raw material rose wines. Thus, the temperature of 16°C contributed to producing of raw materials wine with the highest values of foaming indices, where the maximum height of foam (HM) is 66 mm and the height of foam stabilization (HS) is equal to 49 mm, followed by temperatures of 20ºC and 24ºC, which have contributed to obtaining of raw material rose wines with values of maximum height of foam equal to 60 mm and foam stabilization - 41 mm respectively, HM – 56 mm şi HS – 35 mm. The lowest values of foaming indices were detected in rose wine obtained by the free flow of worth.

The analysis results indicate that increasing the pulp maceration temperature contributes to reduction of foaming properties in studied rose wines.

Therefore, according to obtained results it is arguable that pulp maceration temperature has a significant influence on organoleptic characteristics, extraction of phenolic substances and anthocyanins, foaming properties of rose raw material for sparkling wines production.

In order to obtain the raw material for rose sparkling wines with high foaming properties, it is recommended to perform the pulp maceration process at 16ºC.

## CONCLUSIONS

The influence of different pulp maceration temperatures on the quality and

physical and chemical indices of raw material for rose sparkling wines.

On the base of obtained results, in order to obtain the raw material for rose sparkling wines with high foaming and organoleptic properties, it is recommended to perform the pulp maceration process at 16ºC.

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# CHARACTERIZATION OF SOME LOCAL TOMATOES (*SOLANUM LYCOPERSICUM*) ASSORTMENTS BASED ON ASCORBIC ACID CONTENT

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**Abstract**

A diet rich in fruits and vegetables is associated with a lower incidence of degenerative diseases (such as cardiovascular disease and certain types of cancers). The biochemical components variability in fruits and vegetables is relatively high, due to the many varieties of each species, to the applied technology and not least due to environmental conditions.
Tomato (*Solanum Lycopersicum*) is known as a rich source of bioactive compounds. Nutraceutical properties of fruits can be correlated with their ascorbic acid content and its capacity to neutralize free radicals responsible for oxidative damage at the cellular level. A nutraceutical˝ can be considered a food product, or a part of a food, which can be represented by isolated nutrients, herbal products, or dietary supplement that can provide health benefits.
This study aimed to evaluate differences in nutritional (dry matter, soluble solids content, total mineral content (ash) and total acidity) and bioactive values (ascorbic acid) of tomato genotypes harvested from native populations in Romania from areas with tradition in cultivation of tomatoes (Dolj and Timis counties).

**Key words**: tomato fruit, chemical properties, vitamin C

Romania is one of the richest European countries in terms of plant diversity, due to its specific geographic position in South-East Europe and characteristic ecological, climatic and geomorphologic conditions.

Tomato fruits are fleshy fruits, commonly consumed in fresh and processed forms.

Tomato is the second-most important vegetable in the world after potato (Kalogeropoulos *et al*, 2012; Lenucci *et al*, 2013; Dávila-Aviña *et al*, 2014; Torbica *et al*, 2016). This horticultural crop constitutes an excellent source of health-promoting compounds due to the balanced mixture of minerals and antioxidants including vitamins C and E, lycopene, b-carotene, lutein and flavonoids such as quercetin (Dorais *et al*, 2008).

Tomatoes are horticultural crop with an annual production of around 122.9 million tones of fresh weight (FW) (*FAO, 2005*), and are a high source of carotenoids. Tomato is consumed mostly as fresh fruit, but also after processing into various products such as tomato juice, paste, sauce, puree and ketchup (Lenucci *et al*, 2013).

The popularity of this horticultural crop may arise not only because of the taste, but also from the growing public awareness of tomato products' health benefits. The beneficial effects on human health are due to the balanced mixture of minerals and antioxidants including ascorbic acid and vitamin E, lycopene, b-carotene, lutein and flavonoids such as quercetin (Dorais *et al*, 2008). Vitamin C (ascorbic acid) is an important phytochemical of tomato fruit, while being a most effective antioxidant in plants (Smirnoff, 1996). The limited caloric supply, relatively high fibre content, and provision of minerals, vitamins, and phenols such as flavonoids make the tomato fruit an excellent ''functional food'' providing additional physiological benefits as well as meeting basic nutritional.

In the present study, physicochemical investigations have been undertaken in order to reveal the chemical composition, nutritional values and antioxidant potentials (content of acid ascorbic) of the tomato species in Romania.

## MATERIAL AND METHOD

### Reagents and procedure

All reagents employed in this study were of analytical grade and were purchased from Sigma–Aldrich (Germany).

As working parameters we have chosen optimum parameters according to the apparatus description.

The burning operation in order to determine ash content was made in an oven Nabertherm

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model 6/11 with automated programming and electronic display.

**Collection and preparation of tomato fruit samples**

Seven common farmer' varieties of tomato widely cultivated in rural communities from Dolj and Timis counties (Romania), were chosen according to the morphological and sensorial characteristics which determine their use, as defined by our informants (t*able 1a*). The tomato varieties were: round tomato (CM, MRI, MRP, AB, MAB, CATSG), long tomato (MRP, CATSR) and heart tomato (MRI), yellow tomato (CATSG).

The tomato fruits were collected from different Dolj and Timis county farmers in the summer-autumn of 2015. Treatments consisted of washing fruit under tap water and gently drying with blotting paper. Then, tomato fruits were selected according to uniformity of shape and color, and then stored in polyethylene bags at 4 °C (up to 1-2 days) until analysis. For each variety (seven) it was taken fruits from 5 individual plants, two fruits per plant. Fruit weight, moisture, total dry weight and acidity were determined by using fresh fruit samples.

**Determination of basic properties: fruit weight, moisture, total solid content, ash, total acidity and ascorbic acid content**

The following basic nutritional parameters of harvested fruits were determined: total dry matter, moisture, total acidity and total mineral content (ash).

Average fruit weight (g) was measured by using a digital balance with a sensitivity of 0.001 g. For each determination, three replications have been considered – each one obtained from analyzed fruits.

The moisture of samples has been determined by drying at 100 ± 5 °C until they reached constant weight (*AOAC, 2002*). Total solid content can be determined from moisture content, as shown below:

*Total solids (Dry matter) = 100 – % Moisture*

Ash content (total mineral content) was determined using 5 g of fruit sample in an oven at 500°C in two sessions of 4 h each.

The acidity determination was performed by titrimetric method, used 0.1N NaOH. Acidity is expressed in degrees of acidity.

***Ascorbic acid determination***

Ascorbic acid was determined following a procedure previously described by the authors (Bordean *et al,* 2006) with *2,6-dichloro-indophenol* by titration method.

***Statistical analysis.***

All determinations were performed in triplicate, calculating their arithmetic mean of three separate determinations. The data were statistically analyzed using the program Microsoft Excel and PAST.

## RESULTS AND DISCUSSIONS

The results physical–chemical characteristics of tomato fruits: fruit weight, moisture, total dry weight (TDW) contents and total acidity of tomato species are given in Table 2. The fruit weight of tomato species ranged between 6.49 g and 374.6 g, with AB variety having the biggest fruit. Fruit weight is dependent on the species and on the soil. It is noted that the total acidity range is tight, the values ranged from 3.10 to 6.7. CM tomato variety has the higher value of acidity, and the lower value is for AB variety.

The ash content (%) is an indicator of the mineral content as a quality criteria that is offering information about analysed fruits origin. The variability in the fruit ash content could be due to harvesting processes and storage conditions (Kaur and Das, 2011). From our data presented in Table 1 it can be observed that the higher ash content in case of analysed fruits was found in CATSR tomato cultivar 2.04 % and the lowest in CM tomato variety 0.52%.

We can observe that the moisture contents of analysed fruits were of 89.57% (CATSR cultivar) up to 93.49% *(*AB cultivar*)*. From the analysed data presented above, the highest value of the total solid content was found in CATSR cultivar.

According to these results, tomato *fruits* may be recommended for fresh fruit production, since they have an attractive fruit, and *also* may be recommended for processing, due to their higher TDW contents.

The ascorbic content in fruit of tomato species was determined and the results are provided in Table 2. The ascorbic acid content of the tomato variety were found to range from 5.1 mg /100g FW (CATSG variety) to 10.13 mg /100g FW (MRI variety) (Table 2).

The obtained data are in accordance with George *et al,* 2004 (ascorbic acid content ranged from 8–56 mg/100 g in the skin, and 8–32 mg/100 g in the pulp of Indian tomatoes.), Toor and Savage, *2005* (6-18 mg/100 g fw;) and *Pinela et al, 2012* (10.85-18.56 mg/100 g fw- Portuguese tomato varieties) but lower than the values found in Czech Republic (21.7-25.8 mg/100 g fw, Kotkov *et al,* 2011), Spanish (39-63 mg/100 g fw; Guil-Guerrero and Rebolloso-Fuentes, 2009).

Table 1

**Several morphologic characteristics and description of eight different tomato Romanian farmer' varieties**

| Variety (Abreviation) | Predominant fruit shape | Fruit size | Fruit weight (average) | Exterior colour of mature fruit | Seeds number |
|---|---|---|---|---|---|
| CM | Rounded shape | Intermediate (3.1–6 cm) | 62.1 | Red | Hight |
| MRI | Heart-shaped | Intermediate (4.1–8 cm) | 146.2 | Pink - red | small |
| MRP | Ellipsoid (plum-shaped) | Intermediate (3.1–6.5 cm) | 47.4 | Orange/red | Intermediate |
| AB | High rounded potato-shaped | Very large (>10 cm) | 374.6 | Red | Small |
| MAB | High rounded shaped | large (5.1– 6.1 cm) | 276.5 | Red | Small |
| CATSR | Ellipsoid (plum-shaped) | Small (3–5 cm) | 14.5 | Red | Intermediate |
| CATSG | Flattened (oblate) | Small (3–5 cm | 6.49 | Yellow | Hight |
| Average of 10 fruits from different plants | | | | | |

**Legend:** AB and MAB = tomatoes originated from Timis county; MRI, MRP, AB, MAB, CATSG, CATSR = tomatoes originated from Dolj county

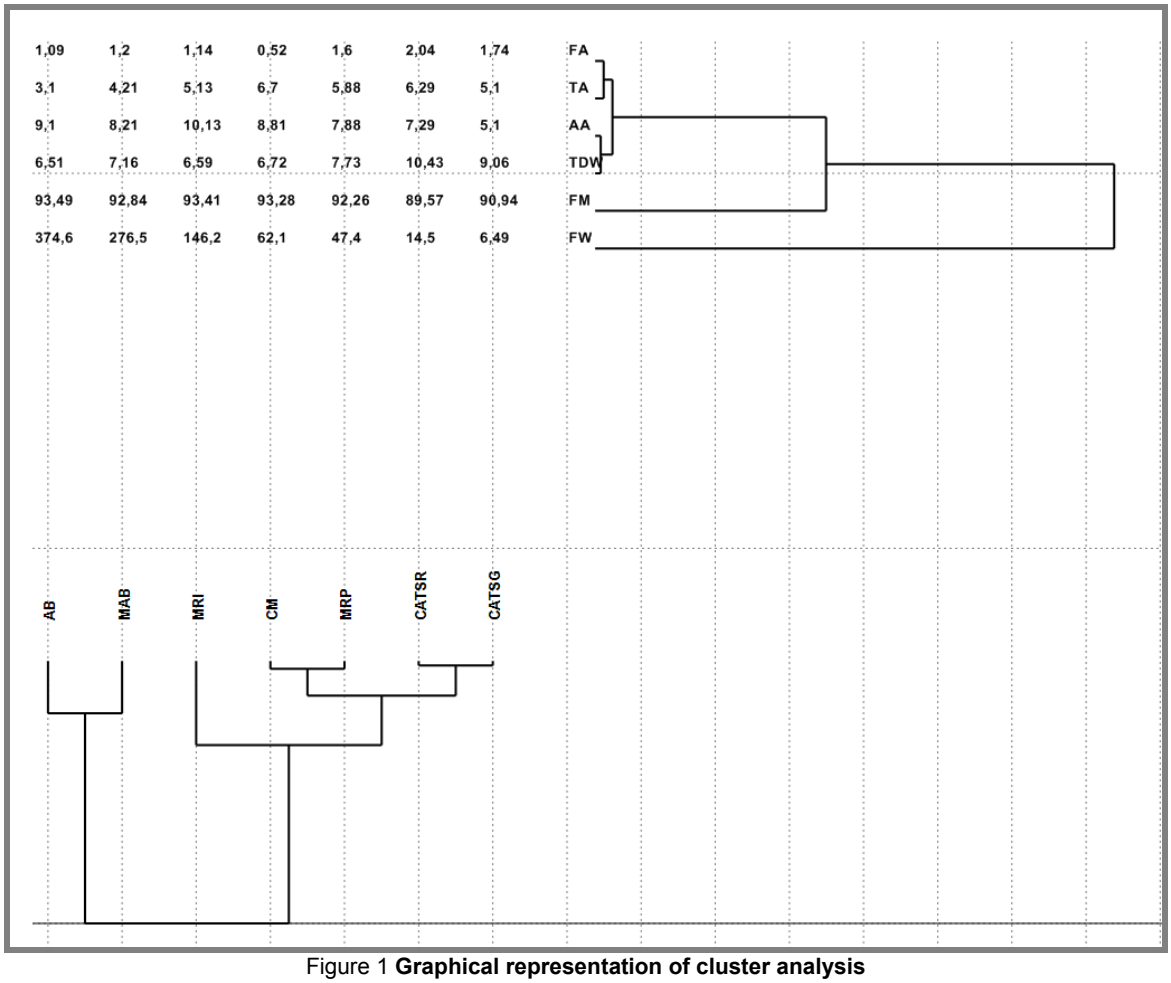


Figure 1 **Graphical representation of cluster analysis**

**Legend:** AB, MAB = tomatoes originated from Timis county; MRI, MRP, AB, MAB, CATSG, CATSR = tomatoes originated from Dolj county; FW= Fruit weight [g]; FM= Moisture [g/100g FW]; TDW= total dry weight content [%]; FA= Ash [g/100g FW], TA = Total acidity [º acidity], AA= Ascorbic acid content [mg /100g FW].

Table 2

**Fruit weight, total dry weight, moisture, total acidity and ascorbic acid of tomato cultivars fruits**

| Cultivar | Fruit weight (g) | Moisture (g/100g FW) | TDW (%) | Ash (g/100g FW) | Total acidity [º acidity] | Ascorbic acid content (mg /100g FW) |
|---|---|---|---|---|---|---|
| CM | 62.1 | 93.28 | 6.72 | 0.52 | 6.7 | 8.81 |
| MRI | 146.2 | 93.41 | 6.59 | 1.14 | 5.13 | 10.13 |
| MRP | 47.4 | 92.26 | 7.73 | 1.60 | 5.88 | 7.88 |
| AB | 374.6 | 93.49 | 6.51 | 1.09 | 3.10 | 9.10 |
| MAB | 276.5 | 92.84 | 7.16 | 1.20 | 4.21 | 8.21 |
| CATSR | 14.5 | 89.57 | 10.43 | 2.04 | 6.29 | 7.29 |
| CATSG | 6.49 | 90.94 | 9.06 | 1.74 | 5.10 | 5.10 |
| TDW: total dry matter content weight; tomato variety, FW- fresh weight | | | | | | |

**Legend:** AB and MAB = tomatoes originated from Timis county; MRI, MRP, AB, MAB, CATSG,CATSR = tomatoes originated from Dolj county

## CONCLUSIONS

Tomato fruits are a source of vitamin C, having beneficial properties for health. All the differences observed in the content of vitamin C of tomato varieties are related to genotype, but also to several factors such as ripening stage, cultivation practices (water availability, mineral nutrients), and climatic environment (mostly light and temperature).

The present indications lead us to the conclusion that tomato fruit is a potential candidate for bioactivity study as well as functional fruit development.

The results indicate that tomato fruits are a valuable horticultural product, based on their rich and beneficial nutrient composition and may be useful in a balanced diet. In addition, this study brings numerous arguments in order to use these fruits as potential healthy foods for different health issues and it's recommended for patients with cardio and neurodegenerative diseases.

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# RESEARCHES CONCERNING THE INFLUENCE OF PRESSURE ON THE DRIP RATE FOR DIFFERENT DRIP WATERING TAPE MODELS

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**Abstract**

This research shows the influence of the operating pressure on the water flow dispersed through the drip watering tapes. The experiments were organized on a stand in the Laboratory of Horticultural Machinery at the University of Agricultural Sciences "Ion Ionescu de la Brad" in Iasi. In carrying out the experimental researches, there were used 10 types of drip watering tapes and the operating pressure varied from 0.025 to 0,2MPa. Following the experiments, there have been found differences in the flow value of each drainer and each watering line, depending on the working pressure and the type of tape used.

**Key words**: stand, drip irrigation tape, work pressures

Drip irrigation is made localized and with low water flow, in the plant roots, having continuity in space, but discontinuity in time (Țenu I., 2004).

Irrigation facilities are various in terms of construction, but the most used today are those with drip devices placed on the tubes and ramps located along the plant rows.

Drip watering facilities are made of: water preparation group, which provides connection to the water source, water filtering, devices for the co-administration of fertilizers and irrigation water, systems for regulating and measuring the flow rate and the working pressure; proper watering equipment, consisting of transmission lines, watering pipelines, with provision of water supply to the plant and monitoring system equipment (Biolan I. *et al*, 2010).

An important feature of the drip irrigation system is that it can be used to distribute chemicals (fertilizers and pesticides), by injection into the irrigation system, those being distributed directly to the root zone of the plants (Bevacqua R.F. 2001).

Drip irrigation reduces water's contact with leaves, stems and fruits, creating less favorable conditions for developing a disease (Shock C.C., 2013).

Drainer pipes are parallel with the plant rows and have single or double walls. Watering pipes are subassemblies of the watering facility, which are designed to transport and supply water (Grumeza, Drăgănescu, 1983).

## MATERIAL AND METHOD

The experiments were organized on a stand in the Laboratory of Horticultural Machinery at the University of Agricultural Sciences and Veterinary Medicine "Ion Ionescu de la Brad" in Iasi. In carrying out the experimental research, there were used 10 types of drip watering tapes, and the operating pressure varied from 0.25 to 2 bar.

The stand on which the experimental research was conducted (*figure 1*) is made of a supporting metal frame (P), placed on a wooden platform, used for placing the containers that are necessary in measuring the amount of water passing through the drainers, PEHD pipe watering (K) with a diameter of 32 mm and a length of 130 cm, fitted at the ends with plugs (R) and watering tapes.

The watering tapes (M), 10 in number, had a length of 80 cm, each having different characteristics in terms of flow, type and number of drainers, as shown in *table 1*.

The water demand used in the experiment was provided by a tank (D) with a capacity of 300L, connected to the plant watering facility. The filter (I ') was meant to filter the water from the tank, in order to avoid clogging the drainers with debris.

The work pressure was measured with the help of a pressure gauge (C). In order to achieve the pressure, an AIRMASTER (H) air compressor was used.

The watering tapes were numbered from 1 to 10 (A), starting with the main opening valve connected to the water tank. Also, each drainer (N) on each line was numbered according to the number of drainers, starting with the main pipeline.

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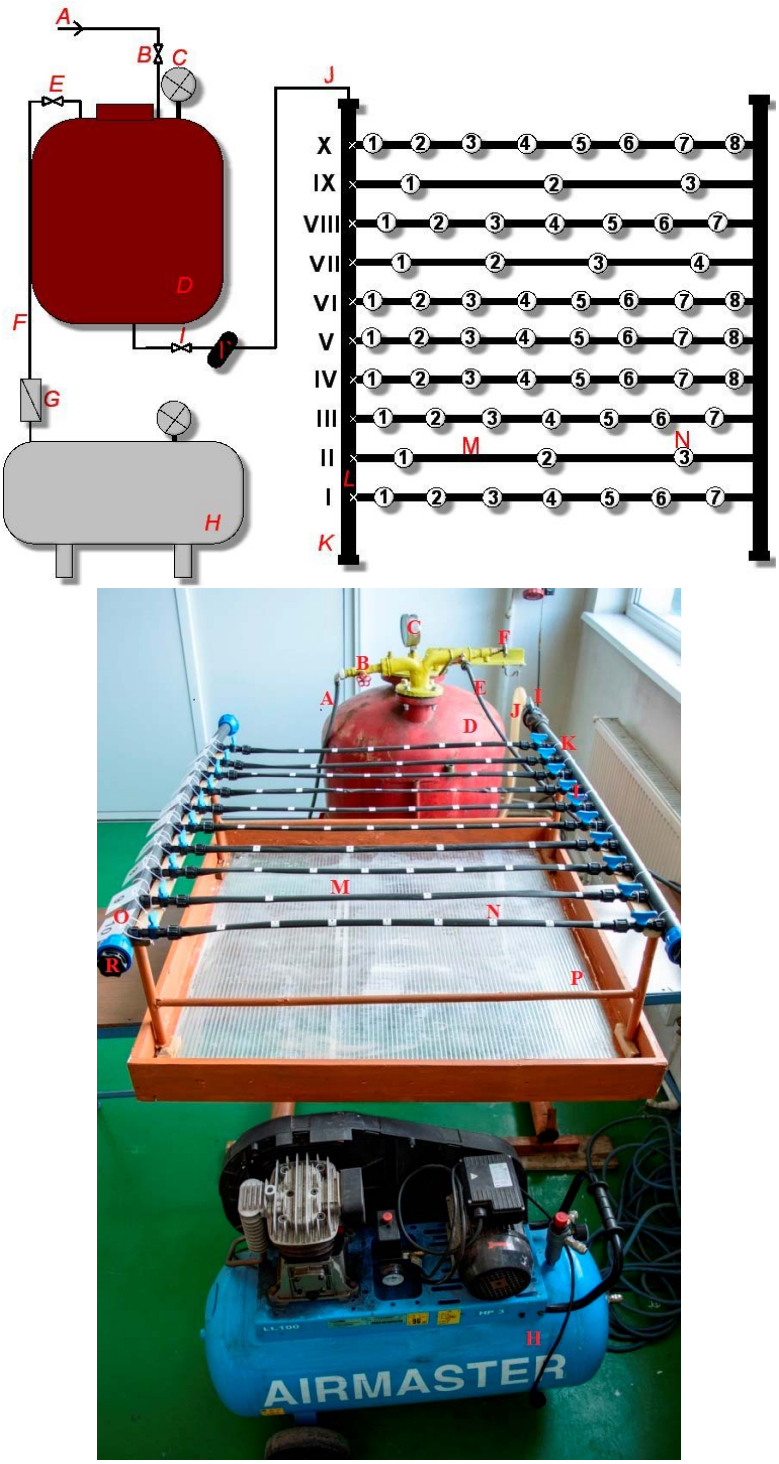


Figure 1 **Experimental stand for testing various drip tubes**

**A** – water supply hose; **B, E, I, L** – valve; **C** – manometer; **D** – water tank; **F** – compressor cable; **G** – backflow; **H** – compressor; **I' –** filter; **J** – supply connection; **K** – main pipeline; **M** – watering tape; **N** – drainer; **P-** ironwork platform; **R –** plugs for the main pipeline; **I...X** – watering tape lines numbering; **1...8** – watering tape drainers numbering.

Table 1

| Features of the watering tapes used provided by the manufacturer | | | | | |
|---|---|---|---|---|---|
| **Watering line** | **Hole type** | **Tape wall thickness (mil.)** | **Distance between drainers (cm)** | **Flow L/h** | **Manufacturing company** |
| 1 | slot | 6 | 10 | 1,5 | Toro (Aqua-Traxx) |
| 2 | pill | 6 | 20 | 2,1 | Plastic Puglia (Aqua Tape) |
| 3 | slot | 6 | 10 | 1,5 | Plastic Puglia |
| 4 | slot | 6 | 10 | 1,5 | - |
| 5 | slot | 8 | 10 | 1,5 | Plastic Puglia |
| 6 | slot | 6 | 10 | 1 | Hidro Tape |
| 7 | pill | 6 | 20 | 2 | Hidro Dryp |
| 8 | slot | 6 | 10 | 1,5 | Irri Tape |
| 9 | pill | 6 | 20 | 1,2 | Green Tape |
| 10 | slot | 6 | 10 | 1,2 | Silver Drip |

*** 1 mil = 1/1000th of an inch**

In order to store the water supplied from the drainers, there were used plastic containers (*figure 2*), located under each drainer. To measure the amount of water in each container corresponding to each drainer, a 1000 ml graduated cylinder was used (*figure 2*).

The experimental research has sought to reproduce, in the laboratory, a drip watering cycle, during 2 hours, using eight working pressures, from 0.025 MPa to 0.2 MPa.

The aim of the experimental research was to monitor throughout the whole process of watering, the watering tapes resistance and the flow on each line, while increasing the pressure. For every pressure used, there were made 3 attempts.

The average amount of water accumulated per line was carried out by calculating the amount of the water supplied after three attempts, corresponding to each of the eight pressures.

Thus, for each attempt, the watering system was opened, adjusting and keeping the pressure constant over two hours. In this time, there were monitored and measured the volumes of water resulted in each container from each line and in each drainer in the line (*figure 2*).

As the drainer related to a container was filled, it was hollowed into a cylinder (*figure 2*), it was measured and its value was recorded, along with the time when the replacement of the filled container with an empty one was made.

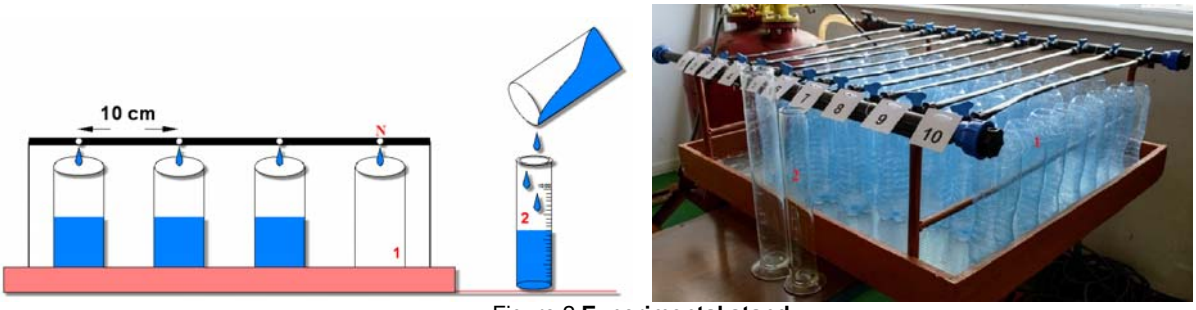


Figure 2 **Experimental stand**
**1 –** plastic container; **2** – cylinder; **N** – drainer

## RESULTS AND DISCUSSIONS

The evolution of the water flow on each line, in all the 8 used pressures (0.025 ... 0,2 MPa) and the resistance of the watering tapes can both be seen in *figure 3*.

The average volume of the water flow during 2 hours varied according to the pressure. At a pressure of 0.025 MPa, the water quantity ranged from a minimum of 3,419 L obtained in the 10$^{th}$ line, to a maximum of 14,042 L obtained in the 4$^{th}$ line, the maximum difference obtained with this pressure being of 10,623L.

Increasing the pressure to 0.05 MPa, the amount of water was minimal in the 10$^{th}$ line, with a value of 5,397 L, while in the 4$^{th}$ line a maximum of 20,490 L was obtained. The maximum difference obtained with this pressure was of 15,093 L.

Reaching a 0,1 MPa pressure, the minimum amount of water recorded was of 8,098L in the 10$^{th}$ line, the maximum being yield in the 4$^{th}$ line, with

a value of 28,827L, resulting in a maximum difference of 20,729L.

The amount of accumulated water at a pressure of 0,125 MPa ranged from 9,542 L in the 10th line to 32,263 L in the 4th line, the difference obtained being of 22,721 L.

The minimum amount of water recorded at a pressure of 0.15 MPa was achieved in the 9th line, with a value of 10,108L, and the maximum, in the 4th line, of 35,201L, resulting in a maximum difference of 25,093L.

At a pressure of 0,175 MPa, the tapes belonging to the 2nd, 4th and 9th lines have failed, being turned off, the amount of water being recorded only for the remaining lines in operation. Thus, the amount of water in the 1st,3rd,5th,6th,7th,8th and 10th lines ranged from a minimum of 11,619 L in the 10th line, to a maximum of 33,343L in the 5th line, and the recorded difference was of 21,724 L.

At the maximum working pressure under study, of 0.2 MPa, the amount of water ranged from 12,157 L in the 10th line, to 34,438L in the 5th line. The difference obtained was of 22,281 L.

The differences observed in the lines that have resisted all the three attempts, up to the maximum pressure under study, of 0.2 MPa, concerning the amount of the accumulated water with increasing the pressure, were attributed to losses.

At a pressure of 0.075 MPa it was obtained an accumulated amount of water, which ranged from a minimum of 6,787 L in the 10th line, to a maximum of 23,713 L, obtained in the 4th line, the maximum difference recorded being of 16,926 L

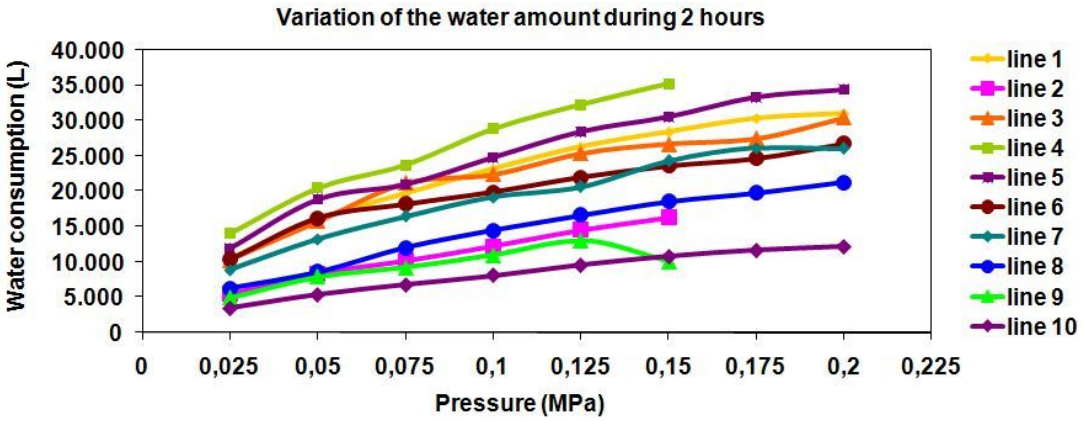


Figure 3 **Variation of the water amount in all the working lines during 2 hours**

## CONCLUSIONS

Following the experimental research, the analysis and the interpretation of the results, conclusions concerning the influence of the pressure on the flow rate and the resistance of the used watering tapes can be shaped as it follows:

With the increase of pressure, the water flow in all the lines tested for two hours increases as well.

The minimum amount of water recorded was of 3,419 L, at a pressure of 0,025 MPa, in the 10th line, and the maximum amount of water was of 35,201 L, at a pressure of 4 0,15 Mpa, in the 4th line.

Out of the 10 lines tested in the experiment, 7 resisted to the maximum pressure of 0,2 MPa bar and 3 lines have succumbed to a pressure greater than 0,15 MPa.

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# STUDIES CONCERNING THE ALLERGENICITY OF DIFFERENT APPLE VARIETIES CULTIVATED IN REPUBLIC OF MOLDOVA

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**Abstract**

The allergenic properties of apple varieties are very different and mechanisms which ensure these difference are not fully elucidated. In this study was estimated transcriptional activity of four allergen genes (Mal d 1.01, Mal d 1.02, Mal d 1.03 and Mal d 1.04) in peel and pulp of seven apple varieties, widely presented in the market in Republic of Moldova. The maximum values of transcript accumulation were attested for Mal d 1.01 cluster. Mal d 1.03 and Mal d 1.02 had intermediate expression levels. Mal d 1.04 clusters had minimal transcriptional activity values, which in most cases were very low or undetectable. In base of obtained results, have been revealed the highly allergenic (Golden delicious, Florina and Mantuaner) and hypoallergenic (Richard (Gloster)) varieties.

**Key words**: apple, allergenicity, gene expression.

Apple (*Malus domestica* L. Borkh) is one of the most consumed fruit in the word. Due to antioxidant capacity and important micro-nutrients content, the apple is included in healthy diet and could contribute to reduction of the risks of lung cancer and cardiovascular diseases (Knekt P. *et al*, 1996, 2000; Le Marchand L. *et al*, 2000). However, apple fruit are reported to be frequently responsible for allergic reactions with wide variety of symptoms: from mild and localized reactions like an oral allergic syndrome (OAS) to severe such as an anaphylactic shock (Hoffmann-Sommergruber K., 2005). Two models of apple allergy were described in Europe. Thus, in the Northern and Central Europe apple allergy occurs mainly due to IgE cross-reactivity to the Bet v 1 major birch pollen allergen, which has a high degree of homology with apple allergen Mal d 1 (Son D.Y. *et al*, 1999). This type of food allergy is found frequently in patients sensitive to birch pollen and causes mild local symptoms. Unlike first type of allergy, in the Mediterranean region apple allergy is often diagnosed in patients who are not sensitive to the pollen (Fernandez-Rivas M. *et al*, 2006). This form of allergy causes more severe symptoms and it is determined mainly by allergen Mal d 3.

In most cases fruit allergies are due to presence of different classes of Pathogenesis-Related proteins, such as class 10 (PR-10), class 14 Lipid Transfer Proteins (LTP, PR-14), class 5 Thaumatine-like proteins (TLP, PR-5), classes 3 and 4 chitinases (PR-3 and PR-4), class 2 β-1,3-glucanases (PR-2) or profilins (Hoffmann-Sommergruber K., 2002).

Four main classes of allergenic proteins are described in apple:

- Mal d 1 (PR-10), the major apple allergen, homologue of Bet v 1 protein from birch pollen with molecular weight 17.5 kD (Botton A. *et al*, 2008, 2009);
- Mal d 2 (PR-5), thaumatine-like protein with molecular weight 23 kD (Gao Z.S. *et al*, 2005a);
- Mal d 3 (PR-14), Lipid Transfer Protein with molecular weight 9 kD (Sancho A.I. *et al*, 2006b);
- Mal d 4 (profilin), homologue of Bet v 2 protein from birch pollen with molecular weight 14 kD (Gao Z.S. *et al*, 2005a).

Each family of proteins is encoded by several genes or gene clusters.

Genetic mapping studies revealed 31 genes encoding Mal d 1 protein isoforms (Pagliarani G. *et al*, 2012), which are classified into four groups: Mal d 1.01, 1.02, 1.03 and 1.04 (Gao Z.S. *et al*, 2005b; Puehringer H.M. *et al*, 2003). The expression level of these genes assessed by qRT-PCR revealed that 11 Mal d 1 genes were not expressed in fruits, thus, demonstrating the tissue-dependent expression. These data were obtained for ten varieties of apples (Florina, Gala, Santana, Elstar, Elise, Golden Delicious, first, Jonathan Cox

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and Ingrid Marie) with different degree of allergenicity (Pagliarani G. *et al*, 2013).

Also, the accumulation of both proteins and gene transcripts of *Mal d 1* in fruits has been associated with various factors such as the genotype, the ripening stage, cultivation and storage conditions (Hsieh L.S. *et al*, 1995; Botton A. *et al*, 2009; Matthes A. *et al*, 2009; Sancho A.I. *et al*, 2006a; Sancho A.I. *et al*, 2006b; Zuidmeer L. *et al*, 2006).

Investigations regarding allelic diversity of *Mal d 1* genes revealed highly conservative (*Mal d 1.01* and *Mal d 1.02*) and variable (*Mal d 1.04*, *Mal d 1.05* and *1.06 A, B* and *C*) allelic variants. Also, it has been shown association between allergenicity and protein variants encoded by the *Mal d 1.04* and *Mal d 1.06* genes (both located in linkage group 16). This association was confirmed for ten apple varieties (Golden Delicious, Priscilla, Ingrid Marie, Cox, Jonathan, Red Delicious, Fuji, Discovery and parental varieties Prima and Fiesta) (Gao Z.S. *et al*, 2008).

The most of studies is focused on determination of the allergenic protein content or genome mapping and there are fewer investigations aimed to establish the allergen gene expression.

Thus, the aim of this study was to reveal allergenicity of different apple varieties, widely presented at the market in Republic of Moldova through estimation of transcriptional activity of some *Mal d 1* allergen genes in peel and pulp.

## MATERIAL AND METHOD

**Biological material.** Samples of pulp and peel from seven varieties widely presented at the market in Republic of Moldova (Richard (Gloster), Idared, Reinette Simirenko, Mantuaner, Jonathan, Golden delicious and Florina) have been studied. Collected samples were frozen in liquid nitrogen and stored at - 80°C until RNA extraction.

**RNA extraction.** Total RNA was extracted using CTAB buffer (2 % CTAB, 20 mM EDTA, 1,4 M NaCl, 100 mM TrisHCl pH 8.0, 2 % PVP K-90, 1 % β-mercaptoethanol) according to Bonghi C. *et al* (1992).

**DNase treatment and cDNA synthesis.** Obtained samples were treated with DNase I (Thermo Scientific) and were used for reverse transcription with RevertAid RT Reverse Transcription Kit (Thermo Scientific) supplied with Oligo(dT)18 primer (Thermo Scientific). Reactions were carried out according to manufacturer instructions. Samples were equalized by the cDNA amount.

**Gene expression analysis.** Gene expression of four allergen gene clusters (*Mal d 1.01, Mal d 1.02, Mal d 1.03* and *Mal d 1.04*) was studied using RT-qPCR in DT-96 termocycler (DNA technology, Russian Federation). Each reaction was performed in 15 µl using the Maxima SYBR Green/ROX qPCR Master Mix (Thermo Scientific) with 0.3 µM of each primer and 360 ng of cDNA. The cluster specific primers and Real-Time conditions were similar with those used by Botton A. *et al* (2008).

Every amplification was performed in three replicates. For normalization of the target gene expression the values of ubiquitin transcription activity were used (DQ438989).

Relative expression was determined according Livak K.J. and Schmittgen T.D. (2001). Specificity of amplification was confirmed by melting curve analysis, followed by 1.2 % agarose gel electrophoresis in TAE buffer.

Statistical analysis was performed according to Dospekhov B. (1985).

## RESULTS AND DISCUSSION

Different values of gene expression were established for Mal d 1 clusters in seven apple varieties used in study.

The maximum values of transcript accumulation were attested for *Mal d 1.01* (from 1.5 to 16 conventional units (c. un.). *Mal d 1.03* and *Mal d 1.02* had intermediate expression levels. *Mal d 1.04* had minimal transcriptional activity values, which in most cases were very low or undetectable.

For *Mal d 1.01* the highest values of expression were detected in pulp and peel of Golden delicious, followed by Mantuaner and Florina (only pulp). In these varietes transcriptional activity of *Mal d 1.01* varied from 16 c.un. (pulp of Golden delicious) to 1.97 c.un. (peel of Florina). Minimal values of *Mal d 1.01* gene cluster expression were established in old German variety Richard (Gloster) – 1.5 and 1.67 c.un. in peel and pulp respectively *(figure 1).*

Values of *Mal d 1.02* gene expression are ranged from 0.0025 c.un. in pulp of Richard (Gloster) variety to 0.0847 c.un. in pulp of Idared variety. High values of transcriptional activity of *Mal d 1.02* were observed in pulp of Florina and Jonathan varieties. The lowest values were detected in old varietes Richard (Gloster), Reinette Smirenko and pulp of Golden delicious *(figure 1b).*

The *Mal d 1.03* cluster in all cases showed higher values of expression in peel of studied apple varieties than in pulp.

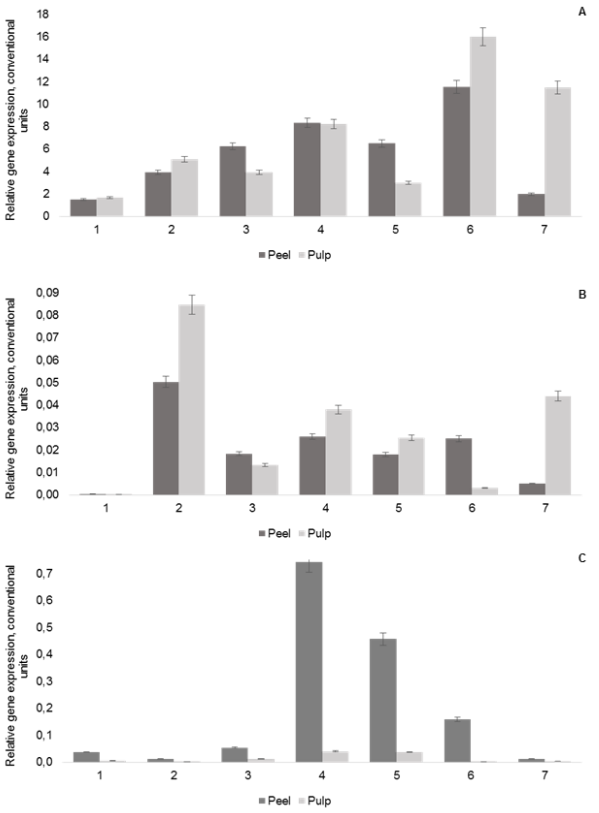


Figure 1 **Expression profile of *Mal d 1.01* (A), *Mal d 1.02* (B) and *Mal d 1.03* (C) gene clusters in the peel and pulp of different apple varieties. 1 – Richard (Gloster), 2 – Idared, 3 – Reinette Simirenko, 4 – Mantuaner, 5 – Jonathan, 6 – Golden delicious, 7 – Florina**

The most abundant presence of this transcript was detected in Mantuaner, Jonathan and Golden delicious peel *(figure 1C)*. Thus, the expression of this gene showed the genotype and tissue specificity.

The *Mal d 1.04* gene cluster mostly showed undetectable level of transcriptional activity. The highest value of expression was detected in peel of Mantuaner variety (0.000183 c.un.). Other varieties, such as Reinette Simirenko, Golden delicious and Florina, showed detectable values mostly in peel (data not shown).

Low transcriptional activity of *Mal d 1.04* gene was ascertained by the Botton A. *et al*, 2008, who analyzed gene expression of 12 genes encoding different isoforms of allergen proteins Mal d 1, Mal d 2, Mal d 3 and Mal d 4 in 15 apple varieties. Except *Mal d 1.04* gene, which expression varied slightly dependent on the genotype, all other genes showed different expression profiles.

The gene expression profiles of *Mal d 1* gene cluster varied considerably between studied genotypes. According to obtained data, there were established highly allergenic and hypoallergenic varieties. Thus, similarly with other studies (Puehringer H.M. *et a*l, 2003; Botton A. *et al*, 2008) Golden delicious was one of the most allergenic cultivars. Other varieties with high values of *Mal d 1* transcript accumulation were Florina and Mantuaner. In contrast to these varieties, old German variety Richard (Gloster) showed the lowest values of transcriptional activity for studied genes.

Also, it could be mentioned that Florina variety showed higher expression values for different allergen genes, including *Mal d 1*, in studies of Pagliarani G. *et al*, 2009, who assessed the level of allergen gene expression in association with genotype, tissue type and stage of fruit ripening.

Reinette Simirenko and Jonathan varieties showed higher values of *Mal d 1* allergen genes expression in peel than in pulp. Thus, it could be recommended to consume these cultivars without peel.

The obtained data and those reported by other authors demonstrate that allergenic properties of apple varieties differ very much and mechanisms which ensure these differences are not clearly understood.

Considering that in apples exist four main classes of allergenic proteins, it is important to extend this study to other genes and encoded proteins, which will be the aim of our further studies.

## CONCLUSIONS

Expression analysis of *Mal d 1.01*, *Mal d 1.02*, *Mal d 1.03* and *Mal d 1.04* genes in apple peel and pulp allowed to establish varieties with high (Golden delicious, Florina and Mantuaner) and low (Richard (Gloster)) transcripts accumulation values and to suggest some recommendations regarding the apple consumption.

In contrast to other three studied genes (*Mal d 1.01*, *Mal d 1.02* and *Mal d 1.04*) the *Mal d 1.03* gene expression was tissue specific with higher values in peel than in pulp of all analyzed varieties.

## ACKNOWLEGMENTS

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allergenic proteins, using genomic and proteomic techniques".

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# CORRELATION BETWEEN ANTIOXIDANT ACTIVITY AND TOTAL POLYPHENOLS CONTENT OF AUTOCHTHONOUS WINE VARIETY - FETEASCĂ NEAGRĂ

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**Abstract**

Autochthonous wine variety Fetească Neagră is a red wine known for high quality rich flavor, pleasant and complex associated with black currant flavor and balanced taste, consistent and vigorous. Red wines produced in four different wine growing regions of Romania were analysed for total polyphenols content and antioxidant activity. The total polyphenols content was determined by Folin - Ciocalteu method and antioxidant activity was measured DPPH method. Determined values of antioxidant activity in observed wines were within the interval 56.74 – 94.08% inhibition of DPPH (average value was 70.92% inhibition of DPPH) and total polyphenol content ranged from 1776 to 2935 mg gallic acid/liter (average content was 2218 mg gallic acid/L). Our results showed that the antioxidant activity of tested wines were directly influenced by the total phenolic contents. As a result, we mention that wines with a higher total phenolic contents showed the highest values of antioxidant activity. Particularly, autochthonous wine variety Fetească Neagră had the highest total polyphenols content, the highest concentration of important antioxidants and significantly higher antioxidant activity. There was a very high correlation between antioxidant activity and total polyphenols content in all of the tested wines.

**Key words**: red wine, Fetească Neagră, antioxidant activity, polyphenols, spectrophotometry

The polyphenols, such as flavanols ((+)-catechin, (-)-epicatechin etc.), flavonols (quercetin, rutin, myricetin, etc.), anthocyanins (malvidin-3-O-glucoside), oligomeric and polymeric proanthocyanidins, phenolic acids (gallic acid, *p*-coumaric acid, caffeic acid, ferulic acid, syringic acid, vannilic acid, *trans*-cinnamic acid, etc.), stilbenes (*trans*-resveratrol) found in large quantities, especially in red wine.

From the point of view of the quality of the wine, the phenolic compounds that form in the grapes define the color, flavor and taste. Their evolution should be seen as a result of the relationship between speed biosynthesis and the transformation that takes place during grape maturation under the influence internal factors (genetic) and external stakeholders biotope (climate, soil, terrain).

During the winemaking process from grape skins only a small fraction of phenolic compounds (30 - 50%) is extracted.

The color, smell and taste of the future wine are due to enzymatic transformations of polyphenols from crushed grapes - compounds that suffer from contact of must with oxygen - but also of transformations polymerization during storage and aging of wine - polyphenols in wine are not identical to those extracted from grapes that are originally contained in the must (Pomohaci N. *et al*, 2000). The total content of phenolic compounds in red wines is very variable ranging (Zou H.L. *et al*, 2002).

In terms of biological properties, polyphenols have multiple health benefits and disease prevention (so called French paradox), such as cardioprotective, vasodilatory actions, anti-inflammatory, anti-mutagenic, anti-carcinogenic, antiviral, antibacterial properties, neuroprotective, antiatherogenic and hepatoprotective activities. (Estruch R., 2000, Santos - Buelga C., Scalbert A., 2000, Minussi, R.C. *et al*, 2003, King R. E. *et al*, 2006, Geana E.I. *et al*, 2011, Georgiev V. *et al*, 2014). These biological properties are attributed mainly to their powerful antioxidant and antiradical activity.

The autochthonous grape variety Fetească Neagră is famous for their rich flavour profile that contributes in resulting superior quality red wines (Banc R. *et al*, 2014, Hosu A. *et al*, 2014). Feteasca Neagră is one of the oldest grapes varieties found nowadays in Romania. The aroma of this wine variety is pleasant and complex,

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associated to the aroma of black currants. The taste is generally balanced, consistent and vigorous. Acidity is an appropriate characteristic of the variety, leaving a pleasant and persistent flavour. The high alcoholic potential, dry extract, dyes, as well as acidity, are in perfect harmony, which gives the Feteasca Neagra red wine finesse and smoothness unique, standing out as a quality wine (Coldea T.E. *et al*, 2015).

The purpose of this study was to determine, evaluate and correlate the content of total polyphenols and antioxidant activity of red wine samples - *Fetească Neagră*, originating from different Romanian vineyard areas.

## MATERIAL AND METHOD

*Wine samples*. We analyzed five samples of Fetească Neagră wine from different regions of Romania, purchased on the local market, harvest year 2012 (table 1). All samples were analyzed in 2015 shortly after opening glass packaging containers.

Table 1

**The wine samples of Fetească Neagră from different Romania wine regions**

| Sample | Wine region | Vineyard | Quality | Alcohol content [%] |
|---|---|---|---|---|
| P1 | Dobrogea | Murfatlar | DOC – CMD | 13.5 |
| P2 | Muntenia | Tohani (Dealu Mare) | DOC - CMD | 11.5 |
| P3 | Moldova | Cotești | DOC - CMD | 12.5 |
| P4 | Banat | Recaș | DOC - CMD | 14.5 |
| P5 | Muntenia | Valea Călugărească (Dealu Mare) | DOC - CMD | 11.5 |
| DOC – CMD - quality designation for grapes harvested at full maturity. | | | | |

*Chemicals and equipment*. 2,2-diphenyl-1-picrylhydrazil radical (DPPH), methanol, carbonat de sodiu, gallic acid, Folin - Ciocalteu's reagent were prepared in a mixture of phosphotungstic acid ($H_3PW_{12}O_{40}$) and phosphomolybdic acid ($H_3PMo_{12}O_{40}$),. All other reagents used were of analytical grade purity from Sigma-Aldrich (Germany).

Absorbance measurements were recorded on a UV-VIS-NIR spectrophotometer (UV-3600, Shimadzu, Japan). All samples were analysed in 10 mm quartz cells at room temperature.

*DPPH radical-scavenging assay*. The method DPPH•, based on the reaction with electron donating or hydrogen radicals (H•) producing compounds/antioxidants according to the following reaction were used:

DPPH• + A*ox*-H → DPPH-H + A*ox*•

purple colourless

where: A*ox*-H = Ph-OH,

Ph – polyphenolic compound.

The DPPH radical-scavenging effect was analysed using the procedure described by Menković N. *et al,* 2014. Fractions diluted in appropriate solvents (10–100 µL) were dispensed into a set of test tubes and the final volume was adjusted to 5 mL. Finally, 0.5 mL of a 0.004% methanolic DPPH solution was transferred into each test tube. The absorbances were recorded at 518 nm after 5 min incubation at room temperature in the dark, against methanol as the blank. The percent inhibition (antioxidant effectiveness) was calculated against the control solution, containing methanol instead of a test solution. The $IC_{50}$ (concentration providing 50% inhibition) values were calculated use the dose inhibition curve in linear range by plotting the volume (µL) of wine needed to reduce the initial concentration of DPPH radical by 50 %.

*Total phenolic content*. Total polyphenolic content of the samples was determined by Folin-Ciocalteu method proposed in 1965 by Singleton V.L. and Rossi J. A. This method is based on the reduction of a phosphotungsten- phophomolybdate complex by phenolics to blue reaction products. Absorbance was measured at 765 nm. The content of total polyphenols in wines was calculated as amount of gallic acid equivalent (GAE) in mg per 1 litre of wine.

*Statistical analysis*. The samples were analyzed in three replicated and the results were expressed as mean ± standard deviation using Microsoft Excel 2013 software.

## RESULTS AND DISCUSSIONS

Antioxidant activity in analysed wine samples was in range 56.74 – 94.08% inhibition of DPPH, *Figure 1*. Average value of antioxidant activity was 70.92% inhibition of DPPH. The strongest antiradical activity was found in red wine Fetească Neagră (Valea Călugărească - Dealu Mare) P5 sample, which had the highest content of phenolic compounds and the lowest activity was obtained for red wine Fetească Neagră (Recaş) sample P4 who had the lowest phenolic content. The high content of phenolic compounds in red wines contribute to their increased antioxidant activity.

Antioxidant activity expressed as $IC_{50}$ ranged from 1.885 to 7.51 µL of wine. These $IC_{50}$

values follow the same order of antioxidant activity as the $IC_{50}$ values similar to those have been reported for some Hungarian red wines (average value of 7.58 µL of wine, Lugasi A. and Hovari J., 2003) and for some Italian red wines (average value of 8.39 µL of wine, Giovanelli G., 2005)

Total polyphenol content in analysed wine samples was in the range from 1776 to 2935 mg galic acid/L, *Figure 2*. Average content of total polyphenol content was 2218 mg galic acid/L. The results obtained in determining the total polyphenol content in Romanian wines analyzed by Folin - Ciocalteu recorded variations between samples of red wine. The total polyphenol content varied between different samples of wine, depending on environmental factors in the vineyard, wine processing techniques, soil and atmospheric conditions during the ripening and aging processes grains. Total polyphenol content of red wine is high due to better extraction of phenolic compounds through a longer contact time with the skins and seeds of grapes, fermentation conditions and temperature processing. The literature has shown that total phenolic content of red wine Fetească Neagră was 1.09 mg galic acid/mL (Coldea T.E. *et al,* 2015). Also among red wines, Banc R., 2013 has obtained significant differences between the values of total polyphenol content, for example phenolic content of Fetească Neagră wine - Tohani 2010 (2359 mg galic acid/L) was three times higher than Băbească Neagră wine - Panciu 2011 (801 mg galic acid/L).

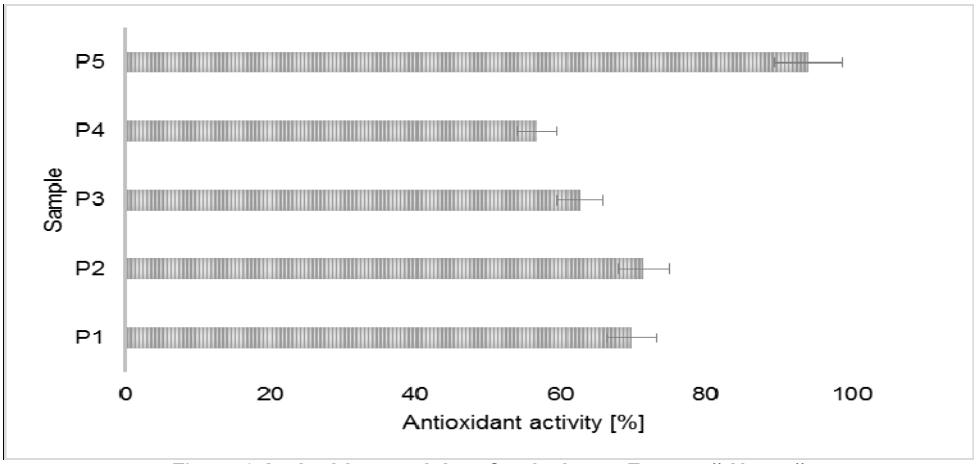


Figure 1 **Antioxidant activity of red wines - Fetească Neagră**

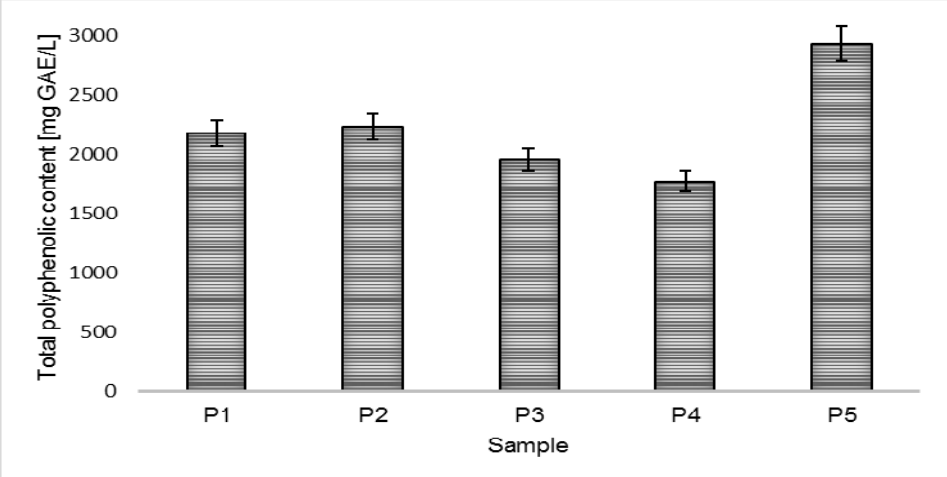


Figure 2 **Contents of polyphenolic compounds of red wines - Fetească Neagră**

The total content of phenolic compounds and antioxidant activity, measured as radical scavenging capacity were comparable to wines produced from international varieties of grapes. The total phenolic contents determined by the Folin-Ciocalteu method and the total antioxidant capacity determined by the DPPH for red wines from other countries are as follow in table 2. Such large differences in total phenolic content between the investigated red wines from different countries are likely to result from grape varieties, vineyard location, climate, soil type, different wine processing techniques and ageing.

Table 2

**The total phenolic contents and the total antioxidant capacity for red wines in literature**

| Total phenolic [mg GAE/L] | Countries | References | Total antioxidant capacity by DPPH assay [mmol Trolox equivalents per litre of wine] | Countries | References |
|---|---|---|---|---|---|
| 1019–2446<br>1313 - 2389 | Spanish | Sánchez-Moreno C. *et al,* 1999<br>Fernández-Pachón M.S. *et al*, 2004 | 4.65 - 17.41 | Spanish | Fernández-Pachón M.S., *et al*, 2004 |
| 621.7 - 3200.3 | Greek | Kallithraka S. *et al*, 2006 | 9.51 - 12.39 | South African | De Beer D. *et al*, 2003 |
| 2340 – 3730<br>1794 - 4614 | Sicilian | Di Majo D. *et al*, 2008<br>Dugo G. *et al*, 2006 | - | - | - |
| 2220 - 2390 | California | Jewell W.T. and Ebeler S.E., 2001 | - | - | - |
| 1390–1600 | Finland | Heinonen M. *et al*, 1998 | - | - | - |
| 1365–3326<br>3314 - 4177<br>1921–3659 | Italian | Simonetti P. *et al,* 1997<br>Minussi R.C. *et al*, 2003<br>Stevanato R. *et al,* 2004 | - | - | - |
| 938–1820<br>1724 - 1936<br>1788 - 3070 | Portuguese | Schoonen J.W. and Sales M.G.F., 2002<br>Paixao N. *et al*, 2007<br>Jordao A.M. *et al*, 2010 | - | - | - |
| 1460 – 3380<br>1218 - 3444 | Slovakian | Stasko A. *et al*,2008<br>Bajčan D. *et al*, 2016 | 13.22 - 17.74<br>69.0 – 84.2 % inhibition of DPPH | Slovakian | Stasko A. *et al*,2008<br>Bajčan D. *et al*, 2016 |
| 1012 - 3264<br>554 - 2669 | Croatian | Seruga M. *et al*, 2011<br>Vrcek I.V. *et al*, 2011 | 9.2 - 37.8<br>4.94 - 20.64 | Croatian | Seruga M. *et al*, 2011<br>Vrcek I.V. *et al*, 2011 |
| 3.2 - 5.9 | Brazilian | Lucena A.P.S. *et al*, 2010 | 2.6 - 6.3 | Brazilian | Nixdorf S.L. and Hermosin-Gutierrez I., 2010 |
| 1402 - 3130<br>860 - 2710 | China | Li H. *et al*, 2009<br>Jiang B. and Zhang Z.W. 2012 | 4.19 - 17.17<br>3.86 - 6.18 3.64 - 8.06<br>4.73 - 31.05 | China | Li H. *et al*, 2009<br>Xi Z.M., *et al*, 2013 |
| 963 - 2262 | Czech Republic | Stratil P., *et al*, 2008 | 2.91 - 8.62 | Czech Republic | Stratil P., *et al*, 2008 |
| 1460 – 3380<br>1181 – 3589 | Australian | Stasko A. *et al*,2008<br>Yoo Y.J., *et al*, 2011 | 13.22 - 17.74<br>8.51 - 18.85 | Australian | Stasko A. *et al*,2008<br>Yoo Y.J., *et al*, 2011 |
| 1602 - 1968 | Serbian | Radovanovic A.N. *et al*, 2012 | 3.64 - 8.06 | Serbian | Radovanovic A.N. *et al*, 2012 |
| 1837 – 3467<br>2491.28 – 3845.19 | Turkish | Porgali E. and Buyuktuncel E., 2012<br>Cavuldak Ö. A., et al, 2013 | 60,68 – 87,58 % inhibition of DPPH | Turkish | Cavuldak Ö. A., et al, 2013 |

The correlation between total polyphenolic content and antioxidant activity of red wine samples we tested is shown in Figure 3. Our results show that the antioxidant activity of wines tested were directly influenced by the total phenolic contents, the wines with a higher total phenolic contents presented the highest values of antioxidant activity. The same high correlation between total polyphenolic content and antioxidant activity was shown by many other researchers in their studies (Büyüktuncel E. *et al*, 2014, Leahu A. *et al*, 2014, Paixao N. *et al*, 2007, Vrcek I.V. *et al,* 2011).

Some studies have shown that the antioxidant activity of wine seems to be related more to the type of individual phenolic compounds than the total content of polyphenols (Geana E.I. *et al*, 2011, Ma T.-T. *et al*, 2014, Tudorache A. *et al*, 2014).

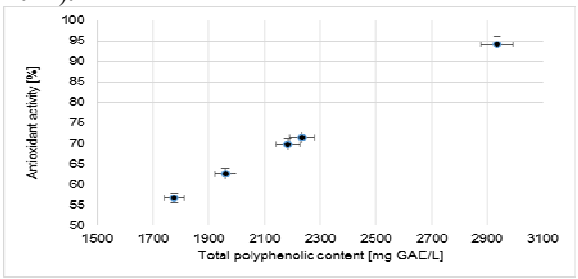


Figure 3 **Correlation between antioxidant activity and total polyphenols content of red wines - Fetească Neagră**

Our study confirms that tested autochthonous wine variety Fetească Neagră is a good source of antioxidants and hence a moderate consumption may have a beneficial effects on human health.

In spite of such differences between the results obtained by different authors, practically all published papers on this subject suggests that the predominant source of the antioxidant activity of red wines derives from different polyphenolic compounds presented in the wines and depends strongly on their total polyphenol content.

## CONCLUSIONS

Red wines Fetească Neagră produced in four different wine growing regions of Romania were analysed for total polyphenols content and antioxidant activity. The total polyphenols content was determined by Folin-Ciocalteau method and antioxidant activity was measured DPPH method. Determined values of antioxidant activity in observed wines were within the interval 56.74 – 94.08% inhibition of DPPH (average value was 70.92% inhibition of DPPH) and total polyphenol content ranged from 1776 to 2935 mg gallic acid/liter (average content was 2218 mg gallic acid/L). The results presented in this study showed that the antioxidant activity of wines tested were directly influenced by the total phenolic contents, becuse as wines with a total phenolic contents greater had the highest values of antioxidant activity.

In conclusion, autochthonous wine variety Fetească Neagră had the highest total polyphenols content, the highest concentration of important antioxidants and significantly higher antioxidant activity. There was a very high correlation between antioxidant activity and total polyphenols content in all of the wines tested. The determinations of total phenolic compounds and the total antioxidant activity of wine tell more about the health effect of a particular wine and can be used as criteria of quality and beneficial health effect.

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# FOOD SAFETY – A CHALLENGE IN THE EUROPEAN CONTEXT

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**Abstract**

In this paper studied the objectives and importance of food safety along the food chain, from producer to consumer, as well and the implications on human health and a guarantee high level of consumer protection.
Food safety is a multiple and complex process are based the conceptions that on advanced management system on the prevention, analysis and risk management microbiological, chemical and physical food found on the entire flow from raw materials to consumer food on the consumer table. This process of food safety is conditioned by existing gaps in legally, mismanagement and insufficient and inaccurate information. Food safety should be based on tracking, coordination, analysis and design of food technology, the initiation of management and marketing strategy along the food chain and on the design, implementation and monitoring of quality management systems.
European Union law contains a general approach related to the wide range of food, but also a special approach on food safety and correct information about food and animal welfare supplying raw materials for food industry. Thus, it can sustain and ensure the traceability of all food and feed produced and distributed in the European Union.
Protection of human health, animal and plants, for each operation of technological flow, represents a key- element priority of the economic strategies and public health of all citizens are assured that their access to healthy and safe food, from plants and animals healthy and, also, ensure the smooth and developer food industry, an industry which is the largest employer and manufacturing sector in Europe. European Union policy ensures the health every stage of production, from the farm to the consumer's table, prevents food contamination, promote food hygiene and provide consumers with accurate and transparent information about food..

**Key words**: food safety, consumer, trade, European Union

Providing superior food quality and quantity consistent with the increasing needs of the people, is one of the key themes and debate worldwide. A healthy diet involves both ensuring rational and nutritional requirements and ensuring healthy food and quality.

The demographic boom of recent decades has resulted in an imbalance between growing source of world population food needs and possibilities of obtaining it. This imbalance has caused the invasion of global market counterfeit food, unsafe, of poor quality, but at a price below the market at a price much diminished food than authentic.

Nowadays, consumers are becoming more and more concerned, more aware and informed of issues hygienic life and their diet and from this point of view, has become crucial for producers and processors in the food industry to meet both the requirements and parameters on food technology and sanitary requirements on the technological flow. Food safety is one of the most important factors that converge to health, to decrease sick people, and hence the cost of health structures, as well as to optimize the quality of people's lives.

The terms "food safety" and "quality food" can sometimes be mistaken. The first is a concept that shows that food can not harm the consumer when prepared and/or eaten according to its intended use (Cecilia Răbonţu, 2010).

Food safety concerns the hazards and acute or chronic disease which may make food dangerous to consumer health. Therefore, food safety cannot be negotiated. The difference between safety and quality has implications for policies in the field and influence the essence and content control system, which must meet predetermined national objectives (Opopol N., 2014).

## MATERIAL AND METHOD

This paper studied the topic was conceived on the basis of bibliographical studies of European Union policies and strategies on food safety. Bibliographic material was analyzed and structured based on new concepts and approaches relevant to the food chain.

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## RESULTS AND DISCUSSIONS

Current lifestyles, modern and fast people XXI century, substantial changes have occurred globally, conceptually, in terms of addressing food style and practical, in terms of preparation and consumption of food. A consequence of the positive effects of these changes has been the rapid advancement and modernization of food technology flows.

Rapid advancement in food technology can determine the risk of food contamination through natural contaminants through the accidentally introduced through improper food handling or unfair trade practices. Most reported cases of acute illnesses are caused by food microbiological origin. The presence of chemical and physical factors in determining a limited number of foods acute health disorders, however morbid condition multiple chronic standings and premature deaths, negatively affecting quality of life and life expectancy (Opopol N., 2014).

The importance of the food chain is vital because the quality of the raw materials used in the subsequent technological flows, has a major impact on the quality and safety of the finished product.

Political strategies of the European Union regarding food safety ensure human health along the food chain, following every stage of food production, from farm - producer (raw materials) to the consumer's table.

Food policy of the European Union (”Să înţelegem politicile Uniunii Europene. Siguranţa alimentară”, 2014) suggested:

• guarantee of food and animal feed safe and nutritious food;

• ensuring a high level of health and welfare and plant protection;

• guarantee that adequate and transparency information about the origin, content, labeling and use of food.

Thanks to EU rules, european citizens benefit from some of the highest international standards in food safety. Along the food and agricultural chain were performed mandatory controls are in place designed to ensure that plants and animals are healthy and that food and feed are safe, high quality, properly labeled and conform to strict standards set at european level („Să înţelegem politicile Uniunii Europene. Siguranţa alimentară”, 2014).

In 1993, the Codex Alimentarius commission, and then World Health Organization (WHO) have established theoretical control through HACCP (Savu C., 2009).

According to the European Union and the World Health Organisation, food safety is everyone's responsibility, from their origin until they arrive on the table. To maintain the quality and safety of food throughout the chain recalled, it takes so procedures to ensure that foods are intact and monitoring procedures to ensure the outworking of operations in good conditions. The consumer is the end point of the food chain (Cara Daniela, 2014).

Food safety policy in the European Union is considering regulations and rules enlarged highlights the responsibility of producers and suppliers regarding their participation in providing a quality food supply. From this point of view, European Union regulations are among the strictest in the world.

Food quality and safety is based on the efforts of all those involved in the complex chain that includes agricultural production, processing, transportation and consumption. Most reported cases of food-borne illnesses are of microbiological origin. The germs are present everywhere and can enter the food chain at any point (Bondoc, I., 2002).

Quality assurance systems are designed to minimize the risk of microbiological contamination. However, since most foods are not sterile, if not handled properly, there is a risk of contamination. Food safety is an intrinsic quality of the food and the consumer's right to use products safe for consumption (Bondoc, I., 2002).

International law and that in Romania the food industry provides for all units involved in the food chain from primary producers to the distribution of food (production, transport, storage and trade of food), the principles of a management system of food safety (Răbonţu Cecilia, 2010).

The three main systems that apply more broadly, are:

• Good Manufacturing Practices (GMP). This requires conditions and procedures processing, which have been shown to provide consistent quality and food safety sustainable.

• Risk Analysis in Critical Control Points (HACCP). HACCP is the latest technique, proactive, focusing on identifying potential risks and their control during the production process and ask implemented at all manufacturing enterprises.

• Standards for Quality Assurance. Adherence to the standards set by the International Organization for Standardization and the European Standards contribute to enhancing food safety, the fact that the processes of food processing, catering and other food-related industries conform to prescribed procedures priori. These quality management system used by food processors,

although in its infancy, include relationships with suppliers (farmers and wholesalers of raw materials), transport agencies, sellers of goods wholesale and retail to ensure quality high on every level (Cara Daniela, 2014).

ISO 22000 is the new international standard developed to ensure food security. Developed with the participation of specialists from domain food, ISO 22000 contains the principles HACCP and integrates requirements key standards developed worldwide (Popescu D.V., 2005).

Food sector is the second largest economic sector in the European Union, with a total of 48 million employees and an annual contribution of 750 billion euros to the European Union economy

(”Să înţelegem politicile Uniunii Europene. Siguranţa alimentară”, 2014).

Starting from this premise, guarantee consumer access to clear information about the contents and origin of food is paramount and necessary.

It must thus ensure food security globally, giving citizens access to sufficient and quality food, as it is expected that by 2030, we will have to feed a world population consists of 8 billion people, whose needs nutrition will lead to increased consumption of meat products. To meet these needs, global food production will be 40% higher than today, and 80% of this growth will have to come from intensive agricultural production (”Să înţelegem politicile Uniunii Europene. Siguranţa alimentară”, 2014).

Manufacturers must put on the market products which comply with the general safety requirement. In addition, they must:

- To provide the consumer with useful information to evaluate the risks inherent in a product when they are not directly obvious;

- Take appropriate measures to avoid these risks (eg, withdrawal of products from the market, warning consumers, recall from consumers products already supplied etc.) (Standardul SR EN ISO 22000:2005 Sisteme de management a siguranţei alimentelor).

In the market economy, characterized by a complex mix of food, there is a fierce competition between manufacturers and retailers in terms of meeting at the highest level of requirements, which are in constant change, but without the achievement of economic efficiency and, ultimately, profit is unlikely. Therefore, in a competitive market with such a scale, consumers seek not only general and particular characteristics

of the existing product range, but also the possibilities they have in relation to choice of quality food and goods that is safe for consumption

(Manole, V., 2003; Mirela Stoian, 2005).

Should be implemented in each plant food processing, various procedures and control mechanisms, to ensure that products arriving on the table consumers are qualitative, with a risk contamination reduced to zero, so that population to be healthier ago benefits of safe food healthy.

It can be said that a trade niche which aims to clear harmlessness and quality of food is represented by bio or premium products for which the because of the difficult economic situation, consumers are less willing to spend given that they have prices higher (Popescu, D.V., 2005).

Even though food products quality, have a safety guaranteed by the very composition ecological, footprint defining the development of trade in such products rather only, has the purchasing power of end consumers (Răbonţu Cecilia, 2010).

## CONCLUSIONS

There are four major components that make up the food safety strategy:

1. regulations on food and feed safety;
2. assurance available and independent scientific information to consumers;
3. the verification process control mechanisms;

4. recognition of the rights of consumers to make decisions based on sources and comprehensive information regarding the origin of the food and its content.

Food safety approach as prominently in European Union directives and standards.

Through the system of food safety management, food suppliers declare their compliance with legal regulations, requirements competent control authorities, professional associations, industry-specific food chain and orientation communication problems the food safety of existing or potential in order to prevent illness and consumer fraud in the food.

Whatever constraints, food safety must remain the primary objective of a civilized society.

Promotion management performance and increase product quality food makes you grow competitiveness on the national and international.

In conclusion, food safety should be a responsibility of all those involved in food, from professionals to consumers.

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***** Standardul SR EN ISO 22000:2005 Sisteme de management a siguranței alimentelor**.

# THE INFLUENCE OF MATURITY STAGE AND EXTRACTION SOLVENTS ON PHENOLIC CONTENT AND ANTIOXIDANT ACTIVITY OF THREE SWEET CHERRY CULTIVARS

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**Abstract**

The effects of two extracting solvents (70% acetone and 70% ethanol) and maturity stage (semi ripe and ripe) on the phenolic content and antioxidant activity of fruits of three sweet cherry cultivars (Burlat, New Star and Peter) were investigated. Results showed that extraction solvent did not have significant effects on total phenolics (TP), tannins (TT) and flavonoids (TF) content and antioxidant activity (1,2-diphenyl-2-picryl-hydrazyl (DPPH) assay, ferric-reducing antioxidant power (FRAP) assay, 2,2'-azinobis-(3-ethylbenzothiazoline-6-sulphonic acid (ABTS) assay, total antioxidant activity (TAA) by phosphomolybedenum complex formation method and reducing power (RP) assay) in dried fruits of sweet cherry. The results did not showed significant changes in phenolic content and antioxidant capacity of fruits during the ripening**.** Among the investigated sweet cherry fruits, Peter cultivar contained the highest amounts of all groups of phenolics, followed by Burlat and New Star. TP in fruits ranged from 10.90 (ripe New Star, ethanol extract) to 28.92 (semi ripe Peter, acetone extract) mg gallic acid equivalents (GAE)/g dry weight (DW). The highest amount of TF in fruits was detected in ethanol extract of semi ripe Peter cultivar (12.97 mg quercetin equivalents (QE)/g DW), while the lowest content was found in ethanol extracts of semi ripe New Star cultivar (7.80 mg QE/g DW). The examined cultivars possess a high antioxidant capacity, and all measured phenolic groups were highly correlated with performed antioxidant assays. The antioxidant activity values obtained with DPPH in the dry fruits (ranging from 7.68 to 13.29 mg trolox equivalents (TE)/ g DW) were comparable to those obtained with FRAP 3.69 to 13.28 mg TE/g DW).

**Key words**: antioxidant capacity, phenolics, sweet cherry

Reactive oxygen species (ROS), including free radicals and other reactive oxygen molecules, are normally formed during metabolic processes, and are considered to have very important roles in cell signaling and homeostasis. ROS are in more reactive state than molecular oxygen. The formation of superoxide radicals ($O_2^{\cdot -}$) is a well-known example of ROS generation during normal respiration. Further reactions may lead to formation of hydroxyl radicals ($OH^{\cdot}$), most reactive species in chemistry, especially in the presence of metal ions. The formation of ROS is seen at high rates in many diseases, including diabetes, cancer, cardiovascular diseases, and other neurodegenerative disorders (Gill S.S. and Tuteja N., 2010; Karuppanapandian T. et al, 2011; Jajic, I. *et al*, 2015).

The high antioxidant capacity of polyphenol components could contribute to health benefits by acting to ameliorate the detrimental effects of ROS generated through oxygen metabolism in the human body. Polyphenols could act as chain-breaking agents preventing the ROS from instigating free radical cascades that could damage cell components like membranes and DNA (Grassmann J. *et al*, 2002). However, this simple and attractive precept is not generally tenable and high antioxidant capacity *in vitro* does not automatically translate into *in vivo* effectiveness. Different polyphenols have different stabilities, bioavailability and therefore potential effectiveness (Ozcan T. *et al*, 2014).

Cherries are among the coloured fruits that are a very popular and important part of food consumed in Europe and other parts of the world. Sweet cherry fruits have been collected and consumed simply because of their sweetness and taste aspects (Crisosto C.H. *et al*, 2003). Recently, the awareness of the fruit health compounds has directed consumer preferences more to the nutritional, antioxidant and physiological qualities of sweet cherry fruits, based on the level and composition of various bioactive substances such

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as minerals, vitamins and phenolic compounds (Ferretti G. *et al*, 2010; Delgado J. *et al*, 2012).

Many aspects such as genetics, environmental factors and agricultural practices affect the pre-harvest quality of sweet cherries. Total polyphenol content can vary hugely between varieties and under different growing conditions (Faniadis D. *et al*, 2010). Maturity stage is also an important factor that influences the compositional quality of fruit cultivars. Several structural, biochemical and physiological modifications take place at different maturity stages and these changes determine the final composition and quality during ripening (Gonçalves B. *et al* 2007; Kállay E. *et al* 2008). For extraction of phenolic compounds from plant material different solvent systems have been used and their efficiency varies (Melicháčová S. *et al* 2010).

The aim of this study was to determine the content of phenolic compounds and antioxidant activity in fruits and stalks of three sweet cherry cultivars extracted at different maturity stages with two different extraction solvents (70% acetone and 70% ethanol).

## MATERIAL AND METHOD

**Plant material.** Fruits of sweet cherry cultivars were collected in 2015 from the productive orchard "Sloga" Kać in vicinity of Novi Sad, Serbia. Fruits of three red-coloured sweet cherry cultivars (Burlat, New Star and Peter) were included in this study. Cherry fruits were picked at two maturity stages: seven days before commercial maturity and at commercial maturity, on the basis of fruit colour. Approximately 2 kg of fruits per cultivar was harvested from the trees. The fruits were selected according to uniformity of size, shape and colour and then transported to the laboratory for analysis.

**Extraction of bioactive compounds.** Edible parts of fresh fruits were dried in an vacuum oven (50°C) to the constant weight. Dry fruit material (1 g per sample) was ground to a fine powder and extracted with 70% aqueous ethanol or acetone solution (50 mL) by sonication for 20 minutes in an ultrasonic bath at ambient temperature. The extracts were rapidly vacuum-filtered through a sintered glass funnel and kept refrigerated until assayed.

**Determination of phenolic compounds.** The total phenolic (TP) content was determined using a Folin-Ciocalteu colorimetric method (Nagavani and Raghava Rao, 2010) and the results were expressed as milligrams of gallic acid equivalents per 1 g dry fruit weight (mg GAE/g DW). Total tannins (TT) content was determined by the Folin-Ciocalteu procedure, after removal of tannins by their adsorption on insoluble matrix PVPP (polyvinylpolypyrrolidone). Calculated values were subtracted from total phenolics content, and total tannin contents were expressed as milligrams of quercetin equivalents (QE) per 1 gram of dry fruit weight (FW). The total flavonoid (TF) content was determined spectrophotometrically with 3 mL of 2% $AlCl_3$ solution (Saha *et al,* 2013). The amount of flavonoids was calculated as a quercetin equivalent (QE) from the calibration curve of quercetin standard solutions and expressed as milligrams of quercetin per 1 gram of FW.

**Measurement of antioxidant activity.** Scavenging of free radicals was tested in a DPPH (2,2-diphenyl-1-picrylhydrazyl) acetone solution (Lai and Lim, 2011). The degree of decoloration of solution indicates the scavenging efficiency of the substance added. Ferric-reducing antioxidant power (FRAP) assay was carried out according to the procedure described in the literature (Valentão *et al,* 2002). The ABTS (2,2'-azinobis-(3-ethylbenzothiazoline-6-sulphonic acid) assay was based on a method developed by Re *et al* (1999). Acetone solution of known trolox concentrations were used for calibration and the results were expressed as mg trolox equivalents per g of dry fruit weight (mg TE/g DW) for all three assays. The total antioxidant activity of plant extracts were evaluated by phosphomolybdenum method as reported by Kalaskar and Surana (2014) and results were expressed as mg of butylated hydroxytoluene equivalents per gram of dry fruit weight (mg BHTE/g DW). A reducing power assay (total reduction capacity) was performed by method of Saha *et al* (2013). The standard curve was constructed using different concentrations of trolox, and the results were expressed as mg trolox equivalents per gram of dry fruit weight (mg TE/g DW).The superoxide free radical scavenging activity was carried out by NBT (nitroblue tetrazolium) test (Kalaskar and Surana, 2014). The percent inhibition of superoxide anion generated was calculated using the following formula:

Scavenging activity (%) = (1 - absorbance of sample/absorbance of control) x 100

**Statistical analysis.** Results were expressed as mean of determinations of 3 independent samples made in triplicates. Statistical significance was tested by analysis of variance followed by comparison of means by Duncan's multiple range test ($P<0.05$) calculated using STATISTICA for Windows version 12.0 (StatSoft, Tulsa, OK, USA). Stepwise multiple regression analyses were used to determine correlation among variables.

Table 1

**Content of total phenolics, tannins and flavonoids in extracts of sweet cherry fruits**

| | | | Phenolic compounds | | |
|---|---|---|---|---|---|
| Cultivar | Maturity stage | Extraction solvent | Total phenolics[1] | Total tannins[1] | Total flavoinids[1] |
| Burlat | Semi ripe | 70% ethanol | $22.51^{a} \pm 1.98$ | $4.34^{a} \pm 0.48$ | $0.983^{a} \pm 0.054$ |
| | | 70% acetone | $22.51^{a} \pm 1.04$ | $4.02^{a} \pm 0.11$ | $0.968^{a} \pm 0.071$ |
| | Ripe | 70% ethanol | $16.58^{c} \pm 0.51$ | $2.96^{b} \pm 0.09$ | $0.857^{a} \pm 0.055$ |
| | | 70% acetone | $18.01^{c} \pm 1.54$ | $2.87^{b} \pm 0.36$ | $1.011^{b} \pm 0.027$ |
| New Star | Semi ripe | 70% ethanol | $11.92^{d} \pm 0.34$ | $1.88^{c} \pm 0.12$ | $0.780^{c} \pm 0.025$ |
| | | 70% acetone | $12.28^{d} \pm 0.40$ | $1.70^{c} \pm 0.26$ | $1.037^{a,d} \pm 0.036$ |
| | Ripe | 70% ethanol | $10.90^{d} \pm 0.42$ | $1.92^{c} \pm 0.14$ | $1.047^{d} \pm 0.036$ |
| | | 70% acetone | $10.95^{d} \pm 1.07$ | $2.04^{c} \pm 0.31$ | $1.018^{a,d} \pm 0.042$ |
| Peter | Semi ripe | 70% ethanol | $25.35^{a,b} \pm 0.57$ | $4.93^{d} \pm 0.51$ | $1.297^{e} \pm 0.085$ |
| | | 70% acetone | $28.92^{b} \pm 0.38$ | $5.08^{d} \pm 0.22$ | $1.131^{d,e} \pm 0.061$ |
| | Ripe | 70% ethanol | $23.62^{a} \pm 1.03$ | $4.58^{a,d} \pm 0.56$ | $1.070^{d} \pm 0.083$ |
| | | 70% acetone | $25.92^{a,b} \pm 1.50$ | $4.60^{a,d} \pm 0.40$ | $0.846^{a} \pm 0.098$ |

[1]mg quercetin equivalents (QE)/g dry weight
[a-e] values without the same superscript within each row differ significantly ($P< 0.05$)

## RESULTS AND DISCUSSIONS

The present study was conducted to determine the phenolic compounds and antioxidant activity in fruit of three different sweet cherry cultivars at different maturity stages. Basically, phenolic content and antioxidant activity in all three cultivars varies irregularly when maturity progressed.

Table 2

**Antioxidant activity (DPPH, ABTS and FRAP assays) in extracts of sweet cherry fruits**

| | | | Antioxidant test | | |
|---|---|---|---|---|---|
| Cultivar | Maturity stage | Extraction solvent | DPPH[1] | ABTS[1] | FRAP[1] |
| Burlat | Semi ripe | 70% ethanol | $9.14^{a,b} \pm 0.63$ | $8.29^{a} \pm 0.94$ | $6.98^{a} \pm 0.26$ |
| | | 70% acetone | $8.58^{a,f} \pm 0.21$ | $8.78^{a} \pm 0.40$ | $7.36^{a} \pm 0.24$ |
| | Ripe | 70% ethanol | $9.42^{a,b} \pm 0.64$ | $5.95^{b} \pm 0.44$ | $5.21^{b} \pm 0.08$ |
| | | 70% acetone | $9.85^{b} \pm 0.46$ | $5.69^{b,c} \pm 0.16$ | $7.23^{a} \pm 1.14$ |
| New Star | Semi ripe | 70% ethanol | $7.72^{c} \pm 0.28$ | $4.78^{c,d} \pm 0.48$ | $5.19^{b} \pm 0.18$ |
| | | 70% acetone | $7.68^{c} \pm 0.41$ | $4.08^{d} \pm 0.16$ | $5.59^{b} \pm 0.22$ |
| | Ripe | 70% ethanol | $10.16^{b,d} \pm 0.43$ | $5.64^{b,c} \pm 0.37$ | $3.69^{c} \pm 0.42$ |
| | | 70% acetone | $10.70^{d} \pm 0.30$ | $5.13^{b,c} \pm 0.20$ | $3.78^{c} \pm 0.28$ |
| Peter | Semi ripe | 70% ethanol | $12.82^{e} \pm 0.28$ | $8.96^{a} \pm 0.27$ | $11.20^{d,e} \pm 0.83$ |
| | | 70% acetone | $13.29^{e} \pm 0.49$ | $9.09^{a} \pm 1.46$ | 13.29e ± 0.47 |
| | Ripe | 70% ethanol | $7.49^{f} \pm 0.49$ | $8.46^{a} \pm 0.73$ | $10.61^{d} \pm 0.63$ |
| | | 70% acetone | $7.23^{f} \pm 1.09$ | $8.21^{a} \pm 0.79$ | $11.71^{d,e} \pm 0.43$ |

[1]mg trolox equivalents (TE)/g dry weight
[a-f] values without the same superscript within each row differ significantly ($P< 0.05$)

In sweet cherry fruits the ripening process is related to a change from the initial green colour into red, with degradation of chlorophyll and accumulation of different phenolic compounds. The typical colour of sweet cherry fruits is due to the presence of water-soluble phenolic compounds (Ferretti G. *et al*, 2010). Content of total phenolics, tannins and flavonoids of the fruit extracts from

selected sweet cherry cultivars are presented in table 1. In this study, the Peter sweet cherry cultivar had the highest content of total phenolics and tannins in fruits, followed by Burlat cultivar. Fruits of New Star cultivar had a 50% less of this biomolecules in fruits than other two. The tested sweet cherry fruits had a TP range of 10.90 (cv. New Star, ripe, ethanol extract) up to 28.92 (cv. Peter, semi ripe, acetone extract) mg QE/g DW. The TP content values were significantly different among different sweet cherry genotypes. Our results are in according with results of other researcher (Pérez-Sánchez R. *et al*, 2010, 2013; Mahmood T. *et al*, 2013).

Significant variability exists among the examinated sweet cherry genotypes, regarding their content in TT, ranging from 1.70 (cv. New Star, semi ripe, acetone extract) up to 5.08 (cv. Peter, semi ripe, acetone extract) mg QE/g DW. Fruits from the cultivars that are abundant in TP content also contained more TT. Tannins are widely distributed in the plant kingdom. The biochemical activities of tannins range from beneficial antioxidants to damaging prooxidants and toxins.The concentration of tannins depend on environmental condition, maturity stage and plant genotype (Barbehenn R.V. and Constabel C.P., 2011). Tannins markedly affect the flavor and the astrigancy of fruits (Bernalte M.J. *et al,* 2003). Solvent used for extraction had no effect on quantity of extracted TP or TT.

Flavonoids are a wide group of plant secondary metabolites, occurring in all parts of the plants. They have a variety of functions in plant biochemistry and physiology, acting as antimicrobials, antioxidants, UV protectors, photoreceptors, and also play a important role in nitrogen fixation. Flavonoids have been described as health-promoting agents as well (Karabin *et al*, 2015). The range of TF in all tested sweet cherry fruits ranged between 0.780 (cv. New Star, semi ripe, ethanol extract) and 1.297 (cv. Peter, semi ripe, ethanol extract) mg QE/g DW. Although there is statistically significant difference in TF content among different samples we did not find any obvious pattern in it. Genotype, maturity stage and extraction solvent did not have any influence on TF content in sweet cherry dry fruits of selected cultivars.

The antioxidant activity of plant extracts may vary with assay performed. Therefore, a single assay could be inadequate (Yen, G.C. *et al*, 2005). For this reason, we checked antioxidant activities of different extracts of sweet cherry fruits with six different assays. Antioxidant activities measured in three different extracts obtained using DPPH, ABTS and FRAP assays are presented in table 2. The antioxidant activity of extracts from sweet cherry fruits as measured by DPPH assay

Table 3

**Total antioxidant activity (TAA), total reduction capacity (TRC) and scavenger activity of $O_2^{\cdot -}$ radicals (NBT test) of sweet cherry fruit extracts**

| | | | Antioxidant test | | |
|---|---|---|---|---|---|
| Cultivar | Maturity stage | Extraction solvent | NBT[1] | TRC[2] | TAA[3] |
| Burlat | Semi ripe | 70% ethanol | 52.3$^{a}$ ± 4.0 | 14.75$^{a,e}$ ± 0.24 | 35.86$^{a}$ ± 0.90 |
| | | 70% acetone | 43.1$^{b}$ ± 2.9 | 14.54$^{a}$ ± 0.28 | 38.99$^{a}$ ± 2.27 |
| | Ripe | 70% ethanol | 43.8$^{b}$ ± 2.1 | 11.40$^{b,c}$ ± 0.59 | 37.31$^{a}$ ± 0.79 |
| | | 70% acetone | 39.3$^{b,d}$ ± 4.8 | 12.49$^{b}$ ± 0.61 | 48.01$^{b}$ ± 2.85 |
| New Star | Semi ripe | 70% ethanol | 29.7$^{c}$ ± 5.7 | 11.49$^{b,c}$ ± 0.39 | 29.94$^{c}$ ± 1.47 |
| | | 70% acetone | 32.4$^{c,d}$ ± 2.6 | 10.41$^{c,d}$ ± 0.07 | 32.78$^{c}$ ± 1.58 |
| | Ripe | 70% ethanol | 37.8$^{c,d}$ ± 2.6 | 10.78$^{c,d}$ ± 0.48 | 28.78$^{c}$ ± 1.01 |
| | | 70% acetone | 41.6$^{b}$ ± 3.8 | 10.11$^{d}$ ± 0.03 | 31.63$^{c}$ ± 0.35 |
| Peter | Semi ripe | 70% ethanol | 53.5$^{a}$ ± 1.5 | 14.44$^{a}$ ± 0.26 | 36.13$^{a}$ ± 0.89 |
| | | 70% acetone | 52.5$^{a}$ ± 1.7 | 17.69$^{e,f}$ ± 0.61 | 43.34$^{d}$ ± 0.96 |
| | Ripe | 70% ethanol | 51.8$^{a}$ ± 2.2 | 16.45$^{e}$ ± 0.57 | 36.90$^{a}$ ± 0.50 |
| | | 70% acetone | 48.3$^{a}$ ± 4.0 | 18.36$^{f}$ ± 0.74 | 43.26$^{d}$ ± 0.95 |

[1]% of inhibition of superoxide anion generated

[2]mg trolox equivalents (TE)/g dry weight

[3]mg butylated hydroxytoluene equivalents (BHTE)/g dry weight

[a-f] values without the same superscript within each row differ significantly ($P< 0.05$)

ranged from 7.23 mg TE/g DW (cv. Peter, ripe, acetone extract) to 13.29 mg TE/g DW (cv. Peter, semi ripe, acetone extract). Differences for the ABTS radical cation scavenging capacities of each sample was recorded in this study. Among various samples acetone extract of cv. Peter (semi ripe, acetone extract) possessed the highest ABTS radical scavenging activity (9.09 mg TE/g DW), while acetone extract of cv. New Star (semi ripe) showed the lowest ABTS radical scavenging activity (4.08 mg TE/g DW). FRAP test has shown that fruits of sweet cherry have the significant reduction potential. Extracts of semi ripe sweet cherry fruits demonstrated higher scavenging activities then ripe samples. Our investigation shows that the FRAP method is independent of the extraction solvent polarity.

Results of total antioxidant activity, total reduction capacity, inhibition of superoxide anion ($O_2 \cdot^-$) radical scavenging activity are shown in table 3. The phosphomolybdenum assay is quantitative method to evlauate fat and water soluble antioxidant activity (total antioxidant activity), in which transforming of Mo(VI) into more stable Mo(V) non-reactive products occurs (Kalaskar and Surana, 2014). Transformation of $Fe^{3+}$ to $Fe^{2+}$ in the presence of sweet cherry fruits extracts was performed to measure the total reductive capability. The total antioxidant activity and total reduction capacity in all tested genotypes has been similar. The lowest bioactivity was measured in extracts of New Star cultivar, while the total antioxidant activity of extracts of Burlat and Peter cultivars found to be highest. Acetone and ethanol extracts of fruits of Peter cultivar expressed the highest scavenging activity for superoxide radicals, while New Star extracts possessed the lowest scavenging activity for these radicals.

There were statistically significant correlation between TP content and TT content ($r$=0.914), as well as, between TP content and antioxidant capacity measured with some, but not all, assays (DPPH: $r$=0.534; ABTS: $r$=0.811; FRAP: $r$=0.928; NBT: $r$=0.860; total antioxidant activity: $r$=0.517; total reduction capacity: $r$=0.409). In this study, no statistically significant correlation was observed between antioxidant activity and TF content in sweet cherry fruits. Positive correlation between amount of phenolic compounds in samples of different plant origin and antioxidant capacity is supported by work of other researchers (Medić-Pap S. *et al,* 2014, 2015).

This comprehensive study clearly demonstrates the variability among cherry cultivars for total phenolics, flavonoid and tannins content, which is also reflected in their antioxidant activities. The results of this study were in good agreement with previous reports of various scientists (Faniadis D. *et al,* 2010; Ferretti G. *et al,* 2010; Prvulović D., *et al* 2012; Ognjanov V. *et al,* 2016). In general, this study suggests those sweet cherries are an excellent source of antioxidants as health-improving compounds in human diet.

## CONCLUSIONS

The results of the present investigation revealed that phenolic compound contents and antioxidant capacity of extracts of sweet cherry fruits are significantly affected by genotype and maturity stage, but not by the solvent system used for the extraction process. Data on phenolic compounds investigated in this study, as well as the antioxidant capacity of extracts of sweet cherry fruits of different cultivars could be valuable to the food industry for selection of genotypes rich in nutriceuticals and could be also valuable for sweet cherry producers in order to increase the biological value of the commercial products.

## ACKNOWLEGMENTS

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# THE COMPARATIVE STUDY ON THE QUALITY CHARACTERISTICS OF DOMESTIC PORK MEAT AND WILD BOAR MEAT

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**Abstract**

Meat and meat products represent a valuable source of protein with high biological value, due their content in all essential amino acids which are found in an optimum ratio. The wild boar meat and the products processed by its have a high quality. In this paper we present the results of a study aimed to assess by comparison the physical, chemical and microbiological characteristics of the wild and domestic meat. The experimental results obtained for moisture was 78.3% for domestic pork meat and 70.9% for wild boar meat respectively. The pH of wild boar meat was nearly one neutral (6.8) while the pH of the domestic pork meat was more acidic (5.8). Regarding the fat content the wild boar meat it was found to be twice lower as fat than the domestic pork meat. Also, the registered values of protein content was in the range of 19.2% (for domestic pork meat) – 20.5% (for wild boar meat). In terms of number of coagulase-positive staphylococcus and of the total number of coliforms it was noticed that the domestic pork meat had a lower number of germs than the one in wild boar meat. The obtained results are according to literature data and lead to conclusion that the meat of the wild boar is more valuable in terms of nutritive properties than that of domestic pork.

**Key words**: meat, pork, wild boar, fat, protein

It is known that the consumers want to introduce in their diet, meat coming from other than domestic animal species. One of the arguments for consuming venison is due to consumer desire to diversify their daily menu by introducing special dishes in it consisting of foods rich in nutrients and not least with superior sensory properties (Rywotycki R., 2003; Soriano A. *et al*, 2006; Vergara H. *et a*l, 2003). The main attributes of wild animal meat that make it superior to that of domestic animal include their livelihood in welfare, having unlimited access to natural pastures away from human settlements pollution. The mentioned living conditions induce the chemical composition of venison, which is distinguished by its high content of macro- and microelements, optimal ratio between polyunsaturated and saturated fatty acids, lower caloric value, and also by a specific smell and taste (Szczepański J. et al, 2007a,b). There are informations which indicate that the domestic pig has taken its rise in ~9000 years ago from Eurasian wild boar independent from wild boar subspecies in Europe (*Sus scrofa scrofa*) and Asia (*Sus scrofa vittatus*) (Giuffra E. *et al*, 2000). Differences in physiochemical characteristics between meat from wild boars and domestic pigs consist in a higher pH, dark colour and lower conductivity of the wild boar meat as against to the pig (Kasprzyk A. *et al,* 2010). The fatty acids composition is influenced by the animal diet. Thus palmitic (16:0), stearic (18:0), oleic (18:1 cis–9) and linoleic (18:2 n−6) acids were the most abundant fatty acids in wild boar meat (Razmaitė V. et al, 2012). Several studies has reported that the moisture and fat content were lower and protein higher in meat from hunted wild boars compared to domestic pigs (Żmijewski T., 2001). Meat from wild boars presents a significantly lower content of sodium, and higher contents of iron, manganese, phosphorus and zinc compared to pork (Sales J., 2013). Microbiological characteristics of venison meat depend on: types of microorganisms on the digestive tract and muscles of animals; the way in which animals are killed; and the grooming of carcase conditions. Also, the bacteriological charge could be influenced by the storage conditions and biochemical properties of the meat (Gill C. O., 2007). European legislation does not established specific microbiological criteria for venison meat and microbiological quality of wild boars is generally considered as to be similar to that of domestic pigs. The possible differences among species could be atributed to differences in hunting

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and/or handling methods, being independent of the time periods between killing, evisceration and sampling (Membré J., 2011). Taking into consideration the aforesaid, we present in this work some physical and chemical characteristics of meat from wild boar and pork.

## MATERIAL AND METHOD

The samples were collected from quadriceps femoris muscle both in case of wild boar and pork, in the winter hunting season, right after the hunting and immediately after slaughter, respectively. 500g from each of sample was taken of after the evisceration of animals. The samples were kept for 24 hours on 4ºC, and then they were frozen and were stored in refrigerator until the carrying out laboratory tests. Moisture, protein and fat contents were measured in accordance with the methods reported by AOAC (1990, 1995). The humidity was determined by drying oven method by drying of 5g samples at 105ºC, until a constant mass. pH was determined using a pH-meter Mettler Toledo™ FiveEasy™ Plus FP20 pH/mV Meters. Determination of raw protein content was performed using the Kjeldahl-method, using 1g of minced sample which was mineralized in 20mL sulfuric acid, 98%. The obtained mineralization was distilled in the presence of boric acid 01.N and sodium hidroxid 30%. The distillate was titrated with sulfuric acid 0.1N. Determination of fat content was performed by Soxhlet extraction method using petroleum ether as solvent. In terms of microbiological characteristics we determined the colonies number of coagulase-positive staphylococci and total coliforms, respectively. In order to determine the colonies number of coagulase-positive staphyloccocs we proceeded to inoculate 1 ml sample on a selective Chapman medium which were incubated at 37ºC for 48 hours. The total coliforms were determined by inoculation of 1 $cm^3$ sample on a Levine medium which were incubated at $37^0$C for 48 hours in order to distinguish *Escherichia coli* and *Enterobacter* bacteria and to identify the *Candida albicans*.

## RESULTS AND DISCUTIONS

In order to compare the physical and chemical characteristics of wild boar meat and pork meat we assessed the pH, moisture, total proteins and fat content of these (*table 1*).

Table 1

**Physical and chemical characteristics for wild boar meat and pork meat**

| Physical and chemical characteristic | Meat from pork | Meat from wild boar |
|---|---|---|
| pH | 5.8±0.29 | 6.8±0.29 |
| Moisture (%) | 78.3±1.52 | 70.9±1.25 |
| Protein (%) | 19.2±0.85 | 20.5±1.05 |
| Fat (%) | 4.0±0.18 | 2.0±0.11 |

According to previously performed study the pH value registred experimental for wild boar meat was 6.8 while the pH value determined for pork meat was 5.8 (Marchiori A. F., 2003). The meat sample taken from wild boars shown a higher pH value than of the meat sample excised prom pork meat.

It was noticed that the meat sample from pork was slightly higher in comparison to meat sample from wild boar.

The results obtained in this study, presented in *table 1*, are according with previously obtained data for moisture content in pork meat, which had almost 5% higher content of humidity than wild boar meat (Szczepański *et al*, 2007).

As it was reported in several other studies, wild boars shown a higher fat level in meat than pork meat.

Our experimental results highlighted that the wild boar meat was twice lower as fat than the domestic pork meat (*table 1*). It is known that usually venison meat is considered as more dietetic, mostly due its fewer amounts of lipids than domestic animals. But this tendency is not observed during autumn-winter season, when meat is fattier, because of the fact that animals consume more fodder in order to gain weight for winter (Szmańko T. *et al*, 2007). A similar fat content in meat from pork was reported by Szczepański et al (2007). The special sensory properties of wild boar meat can be atributed the total lack of marbling, bacause the fat was not visible in the microstructure of muscle tissue. This observation can be explained by the fact that fat was limited to a very narrow clusters or a very small cells. This leads to the conclusion that the venison meat has higher tenderness and juiciness (Szmańko T. *et al*, 2007).

The experimental values determined for crude protein (*table 1*) content reveal that the

protein content of wild boar meat is 7% higher than the pork. Our study results were according with the data published by Szczepański et al [2007] for protein content in pork meat. Other authors noticed that wild animals were able to produce meat with higher protein content (23.91%), which confirmed that meat from wild animals contains more protein.

Microbiological contamination of meat represent maybe the most important quality characteristic of food, including culinary meat. The main goal of this study was to compare the quality of meat from traditional hunting with meat from domestic animals which is obtained in accordance with the industry slaughter procedure, respecting the rules of very high hygienic standards, including HACCP system. The experimental results obtained for coagulase-positive staphyloccocs and total coliforms are presented in *figure 1*.

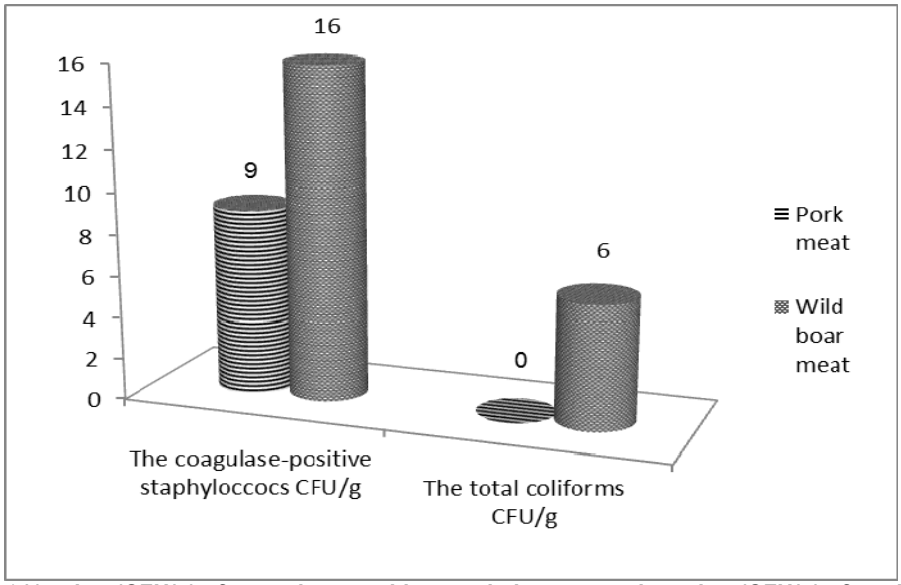


Figure 1 N**umber (CFU/g) of coagulase-positive staphyloccocs and number (CFU/g) of total coliforms of the meat from wild boar and pork**

As is shown in *figure 1*, in the venison meat was determined a higher microbiological contamination than in the pork meat, both in terms of coagulase-positive staphyloccocs and total coliforms. It must be mentioned that in case of meat from pork, we did not find any coliforms bacteria. Nevertheless, the level of contamination with both bacteria, coagulase-positive staphyloccocs and total coliforms, was not danger and is reach and are within the limits of legislation regarding the meat from pork. European legislation does not yet established specific limits for microbiological parameters in venison meat. According to Decastelli *et al* (1995) microbiological contamination of wild boar carcasses is dependent on slaughter conditions, and it ranges from $10^5$ to $10^8$ cfu/g or from $10^3$ to $10^6$ cfu/g.

## CONCLUSIONS

Result recorded in the study show, that meat from wild boars, in terms of physico-chemical parameters as moisture, protein in fat content, has a higher quality in comparison to meat from domestic pigs. The most valuable quality characteristics of wild boar meat were high protein content, low quantity of fat and the resistance to microbiological contaminations which might confer an optimal nutritional profile of the finished products.

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# SOME ASPECTS OF WINTER RAPE PESTS COMBATING

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**Abstract**

During crop vegetation the winter rape may be challenged by a complex of pests. Integrated protection of winter rape requires the use of complex measures. Chemical control of polyphagous pests to different cultures is provided by a large number of insecticides and winter rape culture require a much larger study. In complex integrated pest winter rape in Moldova are admitted about 10 to 12 insecticides. But plant protection practice in recent decades has shown that the composition of plant protection products must be constantly renewed. Proceeding from the above, the purpose of research is studying the biological effectiveness of insecticide Kaliber 200 SC in combating pests rapeseed complex.

**Key words**: *rape, pests, testing, insecticides*

Winter rape crop during the period of vegetation can be attacked by a complex of polyphagous pests, rarely - pests with a narrower nutrition specialization. In the autumn the sowing rape can be attacked by the turnip moths, 2nd generation of caterpillars (*Agrotis segetum* L.), rapeseed wasp (*Athalia colibri* Christ.). Early spring the rapeseed plants are attacked by the hibernate adults of corn leaf weevil (*Tanymecus dilaticollis* Gyll.), darkling beetle (*Opatrum sabulosum* L.), cabbage stem weevil (*Ceuthorhynchus quadridens* Panz.), pollen beetle (*Meligethes aeneus* F .) and the flea beetles (*Phyllotreta atra* F., *Ph. nigripes* F., *Ph. nemorum*). In the same period, but later, leaves, flowers and inflorescences buttons are attacked by various aphid species, of which the most common is the cabbage aphid (*Brevicoryne brasicae* L.). From the defoliating pests damage can be caused by the caterpillars of the cabbage butterfly (*Pieris brassicae* L.), the cabbage moth (*Mamestra brassicae* L.), the rapeseed wasp (*Athalia colibri* Christ.), the rapeseed weevil larvae and adults (*Ceuthorhynchus* spp.), the red turnip beetle (*Entomoscelis adonidis* Pall.), the mustard beetle (*Colaphellus sophiae* Schall.). During the summer, from the sucking group pests can be met the cabbage aphid (*Brevicoryne brasicae* L.) and cruciferous bugs (*Eurydema oleracea* L., *E. adorned* L., *Dolycoris baccarum* L.).

Integrated protection of rape requires the use of complex agro-technical measures. However, these measures do not provide total protection from pests. Chemical control of pests is provided by a large number of insecticides and for rapeseed crop this problem requires a much larger study. In the integrated complex of rape pests combating in Moldova are admitted about 10 to 12 insecticides. Proceeding from the above, the purpose of research is studying the biological effectiveness of insecticide Kaliber 200 SC in combating the complex of rapeseed pests.

## MATERIAL AND METHOD

The experiments to determine the biological effectiveness of product Kaliber 200 SC were met in 2015. The experimental group was installed in winter rape field of agricultural company SRL "VALENAGRO COM" Ciutuleşti village, Floreşti district, which lies in theNorthern area of the Republic Moldova. Winter rape was sown in the first decade of September, 2014, with seeding scheme 20 X 15 cm, Ascona variety. The experiments were installed in four repetitions. The size of 10x10 m plots and the area - 100 square meters.

The location of plots in the experimental group was compact, randomized. As the strip of insulation between the plots were left gang with1 m width. The surface of all plots constituted 1600 square meters and the total area was 1720 square meters. The soil is clayey - sandy black earth with a high content of carbonates. In experiment were included four variants: untreated control; standard, FASTAC 100 EC, 0.15 l/ha; Kaliber 200 SC 0.08 l/ha; Kaliber 200 SC, 0.1 l/ha.

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For detection of cabbage aphid and flea beetles were examinated 20 plants in each plot. The evidence of the cabbage butterfly and the cabbage moth was achieved by calculating the numebr of caterpillars on a plant, and for cabagge moth additionally have been taken into account the caterpillars from around the plant. The records were achieved by the treatment and the 3rd, 7th and 14th day after the treatment. For record of pollen beetle and cabbage stem weevil in each plot were marked 20 plants pattern. It was calculated the number of buttons and flowers at each plant pattern, and number of adults and larvae.

The darkling beetle and the corn leaf weevil density was calculated by record pests per plot 4 survey on the soil surface with dimensions of 0.25 square meters. The determination of the biological efficiency of insecticides was done according to the requirements of the method for testing and plant protection products (Chisinau, 2002).

## RESULTS AND DISCUSSIONS

In order to select the most appropriate field to install the experiment, and to determine the biological effectiveness of Kaliber 200 SC insecticide, in mid-April were done a series of records. Thus, at the stage of bud - early flowering on the winter rape plants and on the soil surface were found 12 species of insect pests, of which - four species are polyphagous and 8 species olygofagous. Among the polyphagous pests were encountered more often *Tanymechus dilaticolis* and *Opatrum sabulosum*, whose density was 0.6 and 0.7 specimens/square meter. Cabbage aphid (*Brevicorine brassicae* L.) was found only as unique specimens of adults and larvae, and the cruciferous bugs (*Eurydema* sp.) density no exceeded 0.27 specimens per plant. Among entomophages deserves attention seven-spot ladybird (*Coccinella septempunctata* L.), which has the numerical value of 5.6 specimens per plant and syrphid flies (*Syrphus* sp., *Episirphus* sp.), which reached a density of 3.8 specimens per plant.

From the wide complex of polyfagous and olygofagous pests, in 2015, only the pollen beetle and the cabbage stem weevil exceeded PED. The record of April 16 the pollen beetle density was 8.54 - 9.14 specimens on plant, and the numerical value of the cabbage strain weevil reached the maximum of 2.84 - 3.41 specimens on plant. Therefore, the chemical treatment was done on 16 April. From the data presented in Table 1, it is noted that before treatment the numerical density of pollen beetle was uniform and was from 8.54 specimens per plant - in the third variant, up to 9.14 - in the fourth variant.

Research conducted at specific intervals (3, 7 and 14 days) after treatment, showed a essential reduction of hibernate adults in all treated variants. This index was 9.36 - 12.27 times lower than in control variant. Comparing the pests data density in relation to the initial, is observed that on the third day after treatment in all variants of experiment remained no more than 0.45 to 12.30% from baseline. In control this index made up 104.474%. Comparing after this index the experimental variants each other, it is noted that on the first record, the essential differences were recorded in the 4th variant- on the one hand, and the 3rd variant - on the other hand. The same regularity, but in a more pronounced form was observed in the following two records.

Analyzing the data of reducing the pest density compared to the control is observed that at the third day after treatment, only at the fourth variant and at the standard variant this index was 100.0 and 98.64%, respectively, but these differences are not essential . At the 3rd variant the number density reduction was 87.19%, which is lower than the standard variant and 4th. The deviation between experimental variants was increased in the following two records. Results records made at the 7th day after treatment, confirmed that only the standard variant and the fourth variant, the reduction of the numerical density of pollen beetle was above 90% and amounted to 91.89 and 92.31% accordingly. In the third variant this index was 80.97%, which is 10.92 to 11.34% lower than in the previous variant. The records made at the 14th day after treatment showed an overall decrease in the efficiency of the product, but during this period there were essential differences between standard and fourth variant - on one hand, and the third variant, on the other part.

Given that the adults and larvae of pollen beetle attack flowers and floral buttons, we conducted also the evidence of generative organs. From Table 2, it is seen that the attack frequency of flowers and flower buttons before treatment was fairly uniform and ranged from 3.51% - the 3rd variant, to 3.82% - 4th variant. The records made at the 3rd day after treatment showed that in all experimental variants flowers and flower buttons attack frequency was significantly reduced and constituted 1.09% in standard variant, 1.07 - variant 4th and 3.82 - 3rd variant. In March the index has risen by 1.92 times. The next two records degree of attack of flowers continued to decline and accounted for properly 0.57 to 0.41% - the standard 0.52 - 0.33% - in the 4th variant.

In the 3rd version also was labeled a reduction of flower attacked by the pollen beetle compared with the control, but this index essential gives both variant 4th and standard. In the control, the degree of attack of flowers to the 14th day after treatment constituted 14.00%, which is 4.01 times higher than the index to treatment. Comparing experimental variations to the control shown that plants processing with insecticide make the reducing of the flower attack

The analysis of attack degree of flowers, compared to the original, has given us the opportunity to see that, as in the standard variant and also in the 4th was noted a reduction of the index, respectively from 29.54 to 11 11% and from 28.01% to 8.64%. By comparing these variants with each other it can be seen that the deviation is not essential. Variant 3th essential gives for both the standard and the 4th variant. Calculation of reduction of the flowers attack compared to the control revealed that the highest reduction was achieved in the 4th variant, where the index has made up to the 14th day after treatment 96.17%, which is with 2.15% higher than the standard, but these deviations are not essential. The 3rd variant was much less marked reduction which gives essential standard. Generalizing the results it can be concluded that both consumption norms insecticide Kaliber 200 SC differ essentially as effectively, both among themselves and against the standard. The most effective insecticide has proved Kaliber 200 SC-consumption norm of 0.1 l/ha, which ensures a reduction of pollen beetle 100.0 to 92.31%, during the 10-12 days, what is at the standard level. The same product, with the consumption norm 0.08 l/ha, ensure a reduction of 87.19% only in the first days after treatment, and later its effectiveness decreases as essential to the standard so in relation to variant 4th .

Simultaneously with research on determining the biological effectiveness of two consumption norms insecticide Kaliber 200 SC in pollen beetle combating, were made records and the cabbage stem weevil, the numerical value of which also exceeded the threshold of economic damage.

Results of the biological effectiveness records and calculation formulas are given in Table 3. The data table can see that the adult density until the treatment ranged from 2.84 specimen/plant – the 3rd version, to 3.41 specimen/plant - the 4th variant. On the 3rd day after treatment only in variant 4th the pest have not been found. In other experimental variants of adult density ranged from 0.11 specimen/plant - in the standard, up to 0.38 specimen/plant 3rd variant. In control after this time, the pest density reached 4.21 specimen/plant, so increased by 1.09 specimen/plant.

The results received in evidence at the 7th day after treatment demonstrates that the pest was detected in all experimental variants, but the reduced density of adults was marked in the 4th variant and in standard respectively constituted 0.20 0.23 specimen/plant, deviations not being essential. The 3rd variant this index made up 0.92 specimen /plant and essentially gives both to the 4th variant and standard, but it is less than control by 4.90 times.

Results records made at the 14th day after treatment confess that the product efficiency feels afterwards. Thus, most reduced indices were mark at the 4th version (0.87 specimen/plant) and at standards (0.94 specimen/plant), the minimum essential deviation of 0.41 specimen/plant. At the 3rd variant, the weevil density was 2.04 specimen/plant and this index gives so essential as standard and variant 4th. Comparing the variant 3th of the control it is seen that in this variant weevil density is 0.57 times lower.

Another criterion in determining the effectiveness of prroduct is the density of the pest in relation to the original. Comparing experimental results after this index is seen that the lower indices over the three records were labeled variant 4th (0.00; 5.87; 25.51) and these indices are at the standard level (3.43; 7.17; 29.28), the deviations not being essential.

It is well known that the most convincing criterion in determining the biological effectiveness of the product is to reduce pest density compared to the control, expressed in%. Comparing this index after experimental variants is seen that on the 3rd day after treatment, the highest value was reached in the 4th variant and in the standard, deviation is not essential. In these variants reduction above 90% was marked also in the 7th day after treatment. Regarding variant 3rd the reduction of pest density above 90% was marked only in the first record, and later this figure was significantly reduced.

Based on research conducted during the vegetation period of 2015, it was found that the most effective in combating the cabbage stem weevil is insecticide Kaliber 200 SC-consumption norm 0.1 l/ha, which provided a reduction pest to 100 to 94.55% over a period of 10-12 days after treatment. Same product with the norm of consumption 0.08 l/ha gives essential as the previous variant and also to the standard.

Table 1

**The biological efficiency of Kaliber 200 SC insecticide, for combating the pollen beetle adults (2015)**

| Variant | Consumption norm of the productl/ha | Numerical density of bugs per a pattern plant | | | | The pest density, in %, compared with the iitial, at ... day after treatment | | | The reducing of pest density compared with control, in % at ..... day after treatment | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | until the treatment | after ... days after treatment | | | | | | | | |
| | | | 3 | 7 | 14 | 3 | 7 | 14 | 3 | 7 | 14 |
| Control | untreated | 8.79 | 9.18 | 11.29 | 12.92 | 104.47 | 128.44 | 146.99 | 0.0 | 0.0 | 0.0 |
| Standard, FASTAC 100 EC | 0.15 | 8.94 | 0.04 | 0.91 | 1.61 | 0.45 | 10.18 | 18.01 | 98.64 | 91.89 | 84.17 |
| Kaliber 200 SC | 0.08 | 8.54 | 1.05 | 1.97 | 2.91 | 12.30 | 23.07 | 34.07 | 87.19 | 80.97 | 70.86 |
| Kaliber 200 SC | 0.1 | 9.14 | 0.0 | 0.92 | 1.38 | 0.0 | 10.07 | 15.10 | 100.0 | 92.31 | 85.72 |
| DEM. p. 5% | | | 1.21 | | | 4.53 | | | 4.2 | | |

Table 2

**The results of attack degree of generative organs of winter rape. by the adults and larvae of the pollen beetle (2015)**

| Variant | Consumption norm of the productl/ha | The attack frequency of floral elements. % | | | | The attack degree of floral buttons and flowers %. compared with the initial. at ... day after the treatment | | | The reducing of attack degree of floral buttons and flowers |%. compared with control. at ...day after treatment | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | until the treatment | At ... day after treatment | | | | | | | | |
| | | | 3 | 7 | 14 | 3 | 7 | 14 | 3 | 7 | 14 |
| Control | untreated | 3.49 | 6.71 | 8.89 | 14.00 | 192.26 | 254.79 | 401.15 | 0.0 | 0.0 | 0.0 |
| Standard. FASTAC 100 EC | 0.15 | 3.69 | 1.09 | 0.57 | 0.41 | 29.54 | 15.45 | 11.11 | 85.04 | 90.13 | 94.02 |
| Kaliber 200 SC | 0.08 | 3.51 | 3.82 | 4.09 | 4.19 | 108.89 | 116.52 | 119.37 | 42.07 | 11.84 | 22.15 |
| Kaliber 200 SC | 0.1 | 3.82 | 1.07 | 0.52 | 0.33 | 28.01 | 13.61 | 8.64 | 84.98 | 92.26 | 96.17 |
| DEM. p. 5% | | | 3.76 | | | 4.18 | | | 4.05 | | |

Table 3

**The biological efficiency of Kaliber 200 SC insecticide for cabbage stem weevil combating (2015)**

| Variant | Consumption norm of product. l/ha | The density of adults at a pattern plant | | | | The pest density in % compared with the initial | | | The reducing of pest density in %. compared with control | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | until the treatment | At ... day after treatment | | | | | | | | |
| | | | 3 | 7 | 14 | 3 | 7 | 14 | 3 | 7 | 14 |
| Control | untreated | 3.12 | 4.21 | 4.51 | 5.24 | 134.94 | 144.55 | 167.95 | 0.00 | 0.00 | 0.00 |
| Standard. FASTAC 100 EC | 0.15 | 3.21 | 0.11 | 0.23 | 0.94 | 3.43 | 7.17 | 29.28 | 89.12 | 92.77 | 78.24 |
| Kaliber 200 SC | 0.08 | 2.84 | 0.38 | 0.92 | 2.04 | 13.38 | 32.39 | 71.83 | 91.13 | 72.34 | 46.19 |
| Kaliber 200 SC | 0.1 | 3.41 | 0.0 | 0.20 | 0.87 | 0.0 | 5.87 | 25.51 | 100.0 | 94.55 | 81.23 |
| DEM. p. 5% | | | | | | | | | | | |

## CONCLUSIONS

In 2015 have created favorable conditions for both growth and development of winter rape and also the spread and development of the main pest species.

During the research period PED had overcome by the pollen beetle and cabagge stem weevil.

The product Kaliber 200 SC- consumption norm 0.08 l/ha, ensure an essential reduction of winter rape pest only in the first days after treatment.

Chemical treatment of winter rape plants with insecticide Kaliber 200 SC- consumption norm 0.1 l/ha, ensure a reduction of the cabbage stem weevil from 100 to 94.55% and the pollen beetle 100-92.31% over a period of 10-12 days.

Based on the results obtained Kaliber 200 SC insecticide is recommended to be included in the integrated protection of winter rape to combat the pollen beetle, cabbage stem weevil and other pests with the norm of consumption 0.1 l/ha, by performing 1-2 treatments in the bud stage.

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