ABSTRACT BOOK

1st International
2nd National

Conference

CHALLENGES AND OPPORTUNITIES TO BOOST AGRICULTURE IN CHANGING CLIMATE

March 26-28, 2018

Editors:
Dr. Mubshar Hussain
Dr. Muhammad Ijaz

College of Agriculture BZU, Bahadur Sub-Campus Layyah, Pakistan

1st INTERNATIONAL AND 2nd NATIONAL CONFERENCE

ON

CHALLENGES AND OPPORTUNITIES TO BOOST AGRICULTURE IN CHANGING CLIMATE

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ABSTRACT BOOK

COLLEGE OF AGRICULTURE,
BAHAUDDIN ZAKARIYA UNIVERSITY, BAHADUR SUB-CAMPUS, LAYYAH, PUNJAB, PAKISTAN

Message

Vice Chancellor

Bahauddin Zakariya University, based in Multan, Pakistan, is one of the nation's leading public research universities. The university is widely known as an institution of strong performance and high ambition as it has continued to make excellent progress towards its goals. It plays a significant role in developing indigenous human resources through its highly productive achievements both in sciences and humanities as it has a variety of disciplines.

To equip the people of remote areas with research and higher studies, Bahadur Sub-Campus of Bahauddin Zakariya University was established at Layyah under the direction of the Chief Minister of Punjab in 2009. In Pakistan, Layyah is one of those areas which is rich in human capital and blessed with one of the highest literacy rates among the districts of the South Punjab. To shape up this potential, a need was felt to cater higher educational and research needs of Layyah and its adjacent areas. Through this campus, the people of Layyah can have their due share and contribution in the national economy.

I am delighted to know about the 1st international and 2nd national conference on "Challenges and opportunities to boost agriculture in changing climate" to be at College of Agriculture, Bahauddin Zakariya University, Bahadur Sub-Campus, Layyah on March 26-28, 2018. As I understand that the climate change is affecting the crop production worldwide. Climate change affects agriculture in a number of ways, including through changes in average temperatures, rainfall, and climate extremes (e.g., heat waves), changes in pests and diseases and changes in the nutritional quality of some foods. To mitigate the effects of climate change on crop production, the agricultural scientists across the globe has developed diverse strategies. To share their findings, it is necessary to organize events of international level in order to provide the opportunites to the agricultural scientists for making interaction with each to solve the problems of crop production under climate change scenarios at international level. I know, College of Agriculture, Layyah has always been remained engaged in organizing such type of national and international creative events on regular basis. I heartily welcome international and national delegates, students and dignities who will participate in this conference, and I assure them a comfortable and joyful stay at Layyah. I, appreciate the contribution of sponsors as well for their generous support toward making it a successful story. I, as patron in chief of this conference, also assure the organizers of this conference for all kinds of support and wish them a complete success for this international event.

Prof. Dr. Tahir Amin
Patron-in-Chief

Preface

Pakistan holds an agro-based economy. The importance of the agriculture sector in the economy of Pakistan can be viewed from the factor that it contributes 21% to the gross domestic product of the country and provides job opportunities for ~55% of the labor force. It also accounts for ~80% of the total export earnings of the country. In Pakistan, agriculture is playing a vital role in ensuring the food security, reducing poverty and improving the economic growth. Indeed, Pakistan has a tremendous potential for agriculture as the weather pattern of the country is suitable for the production of diverse agronomic crops, fruits and vegetables.

The climate of the world is changing including Pakistan. Our country ranks at the top in the list of lands being affected due to drastic climatic changes. Pakistan is basically an arid country as 92% of the area falls under semi-arid to hyper-arid regions. Thus, 74 million hectares (out of 80 million hectares) are under arid environment, including "Thal Region of Pakistan", which is characterized by low precipitation and dry climate. Our country has a population of over ~193 million, and is among the few countries in the world that depends more or less on a single river system for its entire agricultural water requirement. The Indus River and its tributaries supply water to over 16 million hectares of land, located in the arid and semiarid zones of the country. Keeping in mind the increasing population, rapidly changing climate scenarios, and the recent hikes in global food prices, it is prerequisite to adopt judicious measures and develop the novel techniques to optimize the crop production in Pakistan.

In this scenario, various novel techniques have been developed at national and international level to improve the agricultural productivity under changing climate. Researchers are developing new breeds of crops and animals that are well-adopted to the abrupt changes in climatic conditions. Vast experimentation have been carried out to increase the productivity of arid regions on sustainable basis for profit maximization. Nevertheless, we have noticed that independent case studies are not efficient for systematic and adequate generalization. For this, the holistic and integrated approaches comprising of site-specific and collaborative research activities, considering all the aspects of integrated agro-ecosystem management in arid areas might be useful. This approach will definitely identify, quantify, and integrate all the driving forces and interactions that may be useful to manage the diverse natural resources of the arid regions. Furthermore, not only identification, but the dissemination of these techniques can act as a primer for the development of sustainable agriculture approaches under changing climate scenarios. Research and training is essential in providing innovative solutions to these challenges.

In order to analyze the challenges and opportunities to boost agriculture in changing climate, we organized a three days 1st International & 2nd National Conference "Challenges and opportunities to boost agriculture in changing climate'' during 26-28 March, 2018 at the College of Agriculture, Bahauddin Zakariya University, Bahadur Sub-Campus, Layyah. The national and international scientists gathered to share their innovative ideas and technologies to improve the agriculture under changing climatic conditions.

Dr. Mubshar Hussain
Chief Organizer

College of Agriculture,
Bahauddin Zakariya University, Bahadur Sub-Campus, Layyah

The College of Agriculture, Bahauddin Zakariya University, Bahadur Sub-Campus, Layyah was established in 2012 with the aim of enhancing the number of agriculture graduates equipped with modern skills and technologies who are able to solve emerging problems while working for the socio-economic growth of the region and country. The College of Agriculture with its highly motivated and qualified faculty, state of the art research facilities and very conducive learning atmosphere, has been remarkably contributing to upload the standards of higher education in the field of agriculture in remote areas.

The college is equipped with state of art visual aided classrooms, wide range of scientific equipments, functional laboratories and agricultural research farm. Currently, there are 30 young PhD faculty members having international experience and exposure working very hard for the development of this college.

The College of Agriculture is offering different degree programs at graduate and postgraduate levels which are helpful in meeting the professional/skilled manpower for the agriculture sector particularly in the south Punjab. The College of Agriculture is offering B. Sc. (Hons.) Agriculture (Agronomy, Entomology, Plant Breeding and Genetics, Horticulture, Plant Pathology, Soil Science), M. Sc. (Hons.)/M. Phil. Agriculture (Agronomy, Entomology) and Ph.D. Agronomy.

The college of agriculture has rich tradition to organize different events on regular basis like *scientific writing, tunnel farming, citrus production, pulses production in arid regions, profitable wheat production in Thal region, weed eradication in field crops, sustainable agriculture in arid climates, challenges and opportunities to boost agriculture in changing climate* to train the students and provide handout training to the farmers of this zone to boost their crop productivity under changing climate. First time, we are going to organize this three day international conference in order to provide the scientists a forum to share their research findings for addressing the problems of crop production under climate change. On the behalf of the faculty of this college, I warmly welcome all the international and national delegates from China, Turkey, South Africa, Canada and New Zealand, and from all the provinces of Pakistan including Azad Jammu and Kashmir and FATA.

Dr. Muhammad Ijaz
Chief Organizer

Patron-in-Chief

Professor Dr. Tahir Amin (Vice Chancellor, BZU, Multan)

Chief Organizer

Dr. Mubshar Hussain (Associate Professor/Director)
Dr. Muhammad Ijaz (Assistant Professor/Principal)

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INTERNATIONAL AND NATIONAL KEYNOTE SPEAKERS

MAIZE-SOYBEAN STRIP INTERCROPPING: ACHIEVED A BALANCE BETWEEN HIGH PRODUCTIVITY AND SUSTAINABILITY

Wenyu Yang*

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ABSTRACT

Population burst requires increase of grain production which largely relays on over-fertilization in recent years in the world. Environmental problems caused by over-fertilization lead to the rediscovery of intercropping systems in China in recent years. However, the traditional intercropping systems have many disadvantages including illogical field lay-out of crops, low economic value and labor deficiency and in available of mechanization, which cannot balance the crop production and agricultural sustainability. In view of this, we developed a novel soybean strip intercropping model using maize as the partner, the regular maize-soybean strip intercropping mainly popularized in Northern China and maize-soybean relay-strip intercropping principally extended in Southwestern China. Compared to the traditional maize-soybean intercropping systems, the main innovation of field lay-out style in our present intercropping systems is that the distance of two adjacent maize rows are shrunk as a narrow strip, and a strip called wide strip between two adjacent narrow strips is expanded reserving for the growth of two or three rows of soybean plants. The distance between outer rows of maize and soybean strips are expanded enough for light use efficiency improvement and tractors working in the soybean strips. Importantly, optimal cultivar screening and increase of plant density achieved a high yield of both the two crops in the intercropping systems and increased land equivalent ratio as high as 2.2. Accompanied with maize- and soybean-strip alternative rotation annually, maize grain yield, absorption amount of nitrogen, phosphorus and potasium in maize were increased, but no significant changes were detected in soybean. Extra soybean production was obtained without affecting maize yield in our strip intercropping systems, which balanced the high crop production and agricultural sustainability.

Keywords: Sustainable agriculture, Intercropping, Nutrient management

CHICKPEA CROPPING SYSTEMS FOR HIGH AND SUSTAINABLE CROP PRODUCTIVITY IN A CHANGING ENVIRONMENT IN NE-SOUTH AFRICA

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ABSTRACT

The predicted increase in temperature and concomitant decrease in rainfall amount due to climate change, coupled with poor soil fertility is likely to lead to decreased crop productivity in NE South Africa in the foreseeable future. Incorporation of drought tolerant legumes like chickpea (*Cicer arietinum* L.) may increase productivity and minimize crop failure risks of current cropping systems and thus play a significant role in achieving sustainable food security. This paper gives an overview of research endeavours aimed at promoting chickpea-based cropping systems in NE South Africa over the last decade. We have thus far undertaken several studies including evaluation of: germplasm performance; effect of chickpea incorporation on productivity of maize-based cropping systems; biological nitrogen fixation; resource capture and use; effect of water stress in the production environment and seed ageing on seed quality; and the response of chickpea to different moisture regimes as well as calibration, validation and use of Aqua-Crop model to simulate response of chickpea to different planting dates under varying climatic scenarios. The high grain yields and water use efficiency (3.3 t ha^{-1} and 6.4 kg ha^{-1} mm^{-1}, respectively) reported in winter sowings show huge potential of chickpea in the region. However, challenges including root rot, poor nodulation, poor seed quality, and bird and monkey damage have been reported. Some of these challenges are already being addressed in subsequent studies which will be outlined in the presentation. Clearly chickpea may be an important crop to incorporate into the existing cropping systems as part of adaptation strategy to climate change.

Keywords: Aqua-Crop, Climate change, Cropping system, Seed quality

DROUGHT IN SOUTHWESTERN CHINA

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ABSTRACT

In recent years, with the global warming, extreme weather events have increased in frequency and intensity, which seriously affected the human survival and the sustainable development of social economy. Drought was one of the nature hazards which could lead the biggest scope of influence and the worst damage to human beings. It has been widely attention and become an important subject of research on global change. The study region lies in southwestern China with complex topographical and typical monsoon climate, and it is one of the most important agricultural regions in China. In which the average annual precipitation is 1198mm, average potential evapotranspiration is 3144mm. Studies concentrate on evaluating the performance of various drought indices viz. (videlicet) Pa (Precipitation Anomaly Percentage), MI (Relative Moisture Index), SPI (Standardized Precipitation Index), CI (Comprehensive Index) and Z drought index. The most appropriate drought index was assessed to describe drought propagation in southwest China, which aimed at monitoring drought accurate and providing scientific basis for agriculture production and disaster prevention. At the same time, studying change rule, characteristics and forecasts of drought which could aid decision makers in identifying appropriate mitigation actions for future drought events and minimize its impacts. Besides, we have done some mechanism-based research between drought and geological hazards, such as landslide, debris flow, exploring their statistical relationship.

Keyword: Drought, Asia, Standardized precipitation index, Comprehensive index

DETERMINATION OF YIELD PERFORMANCES OF OLEIC TYPE SUNFLOWER (*Helianthus annuus* L.) HYBRIDS RESISTANT TO BROOMRAPE AND DOWNY MILDEW

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ABSTRACT

Sunflower (*Helianthus annuus* L.) is the most important edible oil crop in Turkey. Downy mildew and broomrape are the most important limiting factors for yield production in sunflower areas both in Turkey and also Eastern Europe and Black Sea countries. High or mid oleic type sunflower have recently started to gain importance year by year in the world because of that high oleic acid sunflower oil is more appropriate for frying as it is more beneficial to health. Therefore, higher oleic varieties will be demanded frequently in the future both in Turkey and also in the world. The study is involved the oleic type sunflower hybrids developed in Hybrid Sunflower Breeding Project conducted by Trakya Agricultural Research Institute, Edirne, Turkey. The measured values were evaluated in oleic type hybrids evaluated in regional yield trials in dry conditions at Edirne and Luleburgaz in the project during 2011 and 2012. Oleic type hybrids resistant to broomrape and downy mildew were tested in yield trials. Some experimental hybrids exhibited higher performance than controls in some locations both for seed yield and seed weight and promising candidate hybrids were selected to promote in registration trials. Based on yield trials in the study, some oleic type candidate hybrids exhibited higher performance in terms of grain yield than other varieties. These hybrids were also resistant to broomrape and downy mildew and their oleic acid contents were measured as over 80% which were characterized as high oleic varieties while some of them were categorized mid oleic acid type as having 60-75% oleic acid content.

Keywords: Sunflower, Oleic acid, Hybrid, Yield, Broomrape, Downy mildew, Resistance

GREAT CHALLENGES TO HERBICIDAL WEED CONTROL: WHAT ARE SOLUTIONS AND ALTERNATIVES?

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ABSTRACT

Weeds are the most important biotic constraints that limit productivity of cereals, fiber crops, pulses, fodder crops, vegetables and orchards. To date, herbicides are the most effective and efficient means that provide sustainable and timely weed control in all kinds of cropping systems. However, recently the use of herbicides as sustainable weed control agent is facing several of great challenges of all times. Most important among these include evolution of herbicide resistance in weeds, changing climate and, environmental and human health damages caused by misuse of herbicides. Currently herbicide resistant weeds have been reported in more than 90 crops from 70 countries, while nearly 100 and 150 narrow- and broadleaved weeds, respectively are known to evolve a resistance against various herbicides. Climate change (particularly global warming and elevated carbon dioxide) are expected to impact both the weed growth and herbicide efficacy on a global scale. Climate change may have a multiple negative impact on sustainability of herbicidal weed control. For example, high carbon dioxide in the atmosphere may cause an increase in the weed growth and hence reduce herbicide effectiveness while warming may increase the tolerance of weeds to herbicides. Another serious concern is the health and environmental impacts of herbicides on humans, insects, animals and ecosystems. A general response to these challenges should be formation of weed science as a discipline of agriculture rather than a technology of weed control. This will help to properly study the rarely addressed topics in weed science discipline such as weed biology and ecology, economic thresholds, critical periods for weed crop competition in relation to climate change, evolution of herbicide resistance and environmental pollution. Herbicide rotation, use of herbicide mixtures and integrated weed control are recommended to manage herbicide resistance in weeds. A combination of classical (cultivars, crop rotation, agronomic management etc.) and modern tools (such as intelligent (robotic) weed control) may help to cope with the challenges of herbicide resistance evolution in weeds and environmental pollution.

Keywords: Weeds, Herbicide resistance, Climate change, Global warming

CLIMATE CHANGE INDUCED SPECIES' RANGE SHIFTS: GETTING READY FOR COMPLEX WEED-CROP INTERACTIONS

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ABSTRACT

Climate change is resulting in massive range shifts and extinction of species at different spatial scales across the world. Ecological niche models or species distribution models are widely used in ecology to predict the distribution of common and rare species under current, past and future climatic conditions. However, these models have not been widely used by agricultural scientists. The expected climate changes will have an obvious effect on the distribution/shifts of suitable areas of field crops as well as associated weed flora. Weed species have higher adaptive abilities, thus, could offer severe competition to field crops under future climatic conditions. Nonetheless, range-shifting weed species could invade the areas owed to successful crop production. Thus, projecting range shifts for both field crops and associated weed flora could help the agricultural scientists to make suitable mitigation strategies for complex weed-crop interactions in the future. We hereby describe the possible options to build and project ecological niche models for field crops and weed species at regional and global scales. The works done to project the potential distribution of noxious weeds of Turkey will be explained in detail. The methods used and their practical implications will be discussed. Besides, possibilities and limitations of the models and data used, and opportunities to improve the predictions will be described in detail. At the end different ideas will be proposed to work on for the fine tuning of these models to get projections useful in the real world. Predicting range shifts of weed flora and field crops could help land managers to devise possible strategies to minimize the complex weed-crop interactions in the future.

Keywords: Climate change, Range shifts, Agriculture, Ecological niche models

USE OF TISSUE CULTURE IN CROP IMPROVEMENT

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ABSTRACT

Plants are the primary source of food for the human race and can feed the present world's exploding population by correct management of plant agriculture. Agriculture is the world's largest single industry and in developed countries, such as the U.S., and contributes over 20% of gross national product. On the other hand, in advanced economies, agriculture relies heavily on technology to achieve higher efficiency in productivity and profitability. Plant tissue culture consists of a several *in vitro* techniques and methods that are part of the group of technologies known as plant biotechnology. The growth or maintenance of cells, tissues, organs, and their components under defined physical and chemical conditions *in vitro* described as plant tissue culture, is an important tool in both basic and applied researches as well as in commercial application. It is also powerful tool for studying basic and applied problems in plant breeding. The applications of various tissue culture approaches to crop improvement through regeneration via both organogenesis and somatic embryogenesis, interspecific hybridization and embryo rescue, haploid production, somaclonal variation, protoplast culture, micropropagation, synthetic seed production, pathogen elimination, screening of cells rather than plants for advantageous characters, secondary metabolites production and germplasm preservation are subjects of the review.

Keywords: Plant tissue culture, Crop improvement, Micropropagation, Protoplast culture

CPR5 REGULATES BALANCE BETWEEN PLANT GROWTH AND DISEASE RESISTANCE

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ABSTRACT

Previous studies suggest that CPR5 is a master regulator of multiple processes however, how CPR5 manages to exert pleiotropic effects is still poorly understood. Extensive *in silico* analyses were carried out and the results showed that CPR5 is predicted to be a membrane protein with 4 or 5 transmembrane (TM) domains. Additionally, CPR5 contains intrinsically disordered regions (IDRs) at its N-terminus. Proteins containing IDRs and TM domains are often difficult to purify for crystallization studies. Therefore, the undesirable regions of CPR5 such as, IDR and TM domains were deleted and a set of 24 constructs were developed in order solve CPR5 atomic structure. In addition to IDR and TM domains, *in silico* results also predicted three NLS-encoding clusters, casein kinase phosphorylation sites, multiple start codons, coiled-coil domains and glycine motifs. To find out the roles of these putative structural elements on CPR5 functions, firstly a *CPR5* cDNA was synthesised and termed as *SynCPR5*. Subsequently, predicted sites or motifs were mutated in *SynCPR5* through site-directed mutagenesis and a set of 25 mutated *CPR5* transgenes (cDNA constructs) were developed. The results show that the complementation of *cpr5-2* plants with *SynCPR5*, fully restored HR-like lesions, wildtype-like trichomes and leaves on *SynCPR5* plants. Further physiological characterization such as, transcript abundance of *SynCPR5*, *PR1*, *PR5* and *PDF1.2*, leaf area measurements and ploidy levels showed that *CPR5* regulates some of its functions and phenotypes quantitatively as well as qualitatively. When compared with the wildtype, better growth (larger leaves) but enhanced disease susceptibility was found in *metCPR5* transgenic lines, indicating that CPR5 regulates a balance between growth and resistance. Moreover, these results uncover a novel role of CPR5 in the regulation of balance between plant growth and resistance. Furthermore, this study, for the first time, reports evidence of the requirement of NLS clusters for CPR5 functions.

Keywords: CPR5, Disease resistance, Plant growth, Hypersesitive

LINKAGE MAPPING AND GWAS FOR TOLERANCE AND RECOVERY TRAITS ASSOCIATED WITH DROUGHT TOLERANCE IN SEEDLING WINTER WHEAT

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ABSTRACT

Drought stress is one of the most sever abiotic stresses that limit wheat growth and its development. Breeding for drought tolerance at seedling stage is very important for the wheat plant to continue its life cycle especially if the drought occurs at this stage. To improve drought tolerance and select the most promising drought tolerant genotypes, we developed a new protocol for breeding drought tolerance in seedling winter wheat. Two different genetic backgrounds were used in this study; biparental population (BPP, N=147) and diverse population (DP = 160). The genotypes in both populations were evaluated in a greenhouse under controlled conditions. Each population was evaluated in three replications with a randomized complete block design. Two types of traits were scored namely (1) tolerance traits includes days to wilting, leaf wilting, and stay green and (2) recovery traits which included days to regrowth, shoot regrowth, drought survival rate, and leaf recovery. Three selection indices were calculated; (1) tolerance index (TI), recovery index (RI) and drought tolerance index (DTI) including TI and RI. A high genetic variation was found among genotypes in both populations for all traits. The heritability estimates were higher in GP (0. 77 – 0.95) than in BPP (0. 53 – 0.90). In both populations, no or very weak correlation was found between tolerance and recovery traits. The TI and RI had the same trend of correlation in BPP (r = 0.03) and GP (r = 0.04). Drought tolerance index had high significant phenotypic and genotypic correlations with all traits in both populations. Both populations were genotyped using genotyping-by-sequencing. Linkage mapping was performed on BPP, while, GWAS was performed on GP to detect genomic regions and alleles associated with tolerance and recovery traits. In both populations, no common QTL was shared in both types of traits. In conclusion, recovery and tolerance traits are controlled by different genetic mechanisms. Drought selection index (including RI and TI) facilitated selecting the most promising genotypes in both populations.

Keywords: Drought, Heritability, Recovery index, Tolerance index

CONSEQUENCES OF INDUS WATER TREATY ON WATER AVAILABILITY IN PAKISTAN AND POTENTIAL MEASURES TO COMBAT WATER SCARCITY

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ABSTRACT

Soon after partition in 1948 India asserted its geographic advantage in controlling the water for the first time. This led to a series of water sharing negotiations that ultimately culminated into the Indus Water Treaty (IWT) brokered by the World Bank on September 19, 1960. The treaty gave India exclusive rights to the three eastern rivers and Pakistan was left with only Indus Jhelum and Chenab. As a result, Pakistan lost 21% of the total available river water which reduced from 158 MAF to 125 MAF. India was also given right to use 20% of water from western rivers for irrigation, power generation and transport purposes. By taking the advantage of this clause India started building dams on these rivers and can control the water flow to Pakistan. India has started building Pakal Dul, Kiru, Karwar, Bagliar, Sawalkot, Salal, Sewa II and Burser hydropower projects. After the completion of Tarbaila and Mangal no serious efforts are made to preserve our continuously decreasing water sources. As a results water availability kept on deteriorating and now Pakistan is included in top 5 water scarce countries. Recently PCRWR delivered a grave warning that "if Government does not take serious action, Pakistan will run out of water by 2025. To combat water scarcity in Pakistan we must act quickly. A 5-tier approach is suggested which includes i) Federal Government should immediately build water reservoirs like Tarbaila and Mangla Dams, ii) Provincial Governments must build small reservoirs to store rainy season flood water, iii) Local Governments must build small rain water reservoirs at farm level, iv) adaptation of efficient irrigation water use technologies, and v) Treatment of wastewater at village level and its use for irrigation.

Keywords: Water scarcity, Indus water treaty, Sub-continent

INFESTATION ASSESSMENT OF ROOT-KNOT NEMATODES (*Meloidogyne* Spp.) ASSOCIATED WITH CUCUMBER IN THE POTHOWAR REGION OF PAKISTAN

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ABSTRACT

Studies to estimate root-knot nematode infestations on cucumber were conducted during mid to late season at 378 randomly selected sites in 126 villages of the four districts across the Pothowar zone of the country. The overall mean infestation of root-knot nematodes in the region was found to be 16%. The studies revealed variations in the incidence and severity of root-knot nematodes in the four districts. The incidence of root-knot nematodes was the highest in Rawalpindi district (22%), followed by 14% in Attock. Of the four districts, the minimum incidence of 11% was recorded in Jhelum district. The maximum mean severity (3.8), measured in terms of the galling index, was found in Rawalpindi district, while the minimum (1.9) was observed in Jhelum district. The mean severities of root-knot nematodes in the districts of Attock and Chakwal were 2.7 and 2.2 respectively. Variations in incidence and severity were also observed among subdivisions of the districts. Of all the associated species of root-knot nematodes, *Meloidogyne incognita* constituted 79%, *Meloidogyne javanica* 19%, *Meloidogyne arenaria* 2% and *Meloidogyne hapla* 1%. *M. incognita* and *M. javanica* were recorded in all of the districts, with *M. incognita* predominating. *M. incognita* as a pure population was recorded in 30% of the villages, while the other three species were found as mixtures. The most common mixed population was *M. incognita* and *M. javanica*, observed in 70% of villages in the region. *M. arenaria* and *M. hapla* were not found together in any of the population mixtures. The results indicate that cucumber is severely attacked by root-knot nematodes, warranting adoption of strict control measures for its management.

Keywords: Root-knot nematodes, Cucumber, Rainfed areas

CLIMATE CHANGE AND ROLE OF POLLINATORS TO MITIGATE THE IMPLICATIONS IN AGRICULTURE

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ABSTRACT

Along with providing an essential service to human populations, pollinators also have a key role in maintaining other ecosystem services including ensuring biodiversity and helping Nature to adjust to external threats such as climate change. Pollinators such as birds, bees, butterflies, moths, flies, wasps, beetles bats and even mosquitoes are essential for food production because they transfer pollen between seed plants-impacting 75% of our food crops and nearly 90% of wild flowering plants depend at least to some extent on animal pollination. The yield of different crops and fruits may be increased up to 100% by the activity of pollinators during flowering. Pollinators can perform their activity in a better way before noon by early pollinating the flowers of crop plants when temperatures are mild ≤ 35oC. At the flowering time when temperature rises ≥ 35oC then there are chances of pollen mortality. So effective pollination will occur at morning and or evening time when temperature will be mild. In nature pollinators especially bees prefer to come out from their nests for pollination of available flowers and collection of pollen and nectar for their brood. If we enhance the pollinators activity in our agricultural fields then this will reduce the flower abortion and there will be more fruit setting and more yield. This will improve the livelihood of farmers of Pakistan. At high temperatures pollinators will not be active and pollen will also be not viable, resulting in less fruit setting and yield loss. There is dire need to work on identification and conservation of different native pollinators activity for pollination for different crops and fruit trees at different agro-ecological locations to mitigate the climate change implications in agriculture.

Keywords: Climate change, Pollinators, Agriculture, Yield enhancement

CHALLENGES AND OPPORTUNITIES TO BOOST AGRICULTURE UNDER CHANGING CLIMATE

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ABSTRACT

Agriculture, being the source of basic necessities of life, is regarded as a highly important sector in the world. The sector is facing several threats; among which, climate change is the key issue. It is related with various factors like solar radiations and volcanic eruptions. However, certain human activities like combustion of fossil fuel, deforestation, urbanization and altering amount of greenhouse gases and aerosols have been identified as primary cause of ongoing climate change. This climatic change is not only affecting the global economic development, but the food security too. Pakistan is listed among the most vulnerable countries to climate change. Alteration in monsoon pattern, recession in Hindu Kush-Karakoram-Himalayan glaciers and rise in temperature (warming) are the prominent tangible effects of the climatic change. The drastic effects of climate change related to agriculture sector include the damage of crop and livestock sector by floods in particular areas, increased siltation in major dams and seasonal shifting, Resultantly, various biotic (e.g. diseases, insect-pest and weeds) and abiotic (drought, salinity, frost and waterlogging) stresses have developed, which significantly reduce the yield, quality and value of agriculture produce. The situation demands for research and development based solutions and policies particularly focusing on assessing impact of climate change on production system in different regions; developing varieties tolerant to drought, salinity and heat stress, less vulnerable to heavy spells of rain, reliable forecasts on river flows and weather, and restrictions on carbon emissions.

Keywords: Global warming, Climatic variation, Agro-industry, Environment, Food security

INTROGRESSIVE BREEDING OF COTTON FOR TOLERANCE TO HIGH TEMPERATURE AND WATER AND STRESS CONDITIONS

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ABSTRACT

Cotton is a moderate heat loving crop buts its yield is highly influenced by severe heat and water stress. Genetic mechanism of heat and water stress tolerance is complex and controlled by many genes. Some wild relatives of cotton are tolerant to both water and heat stress but introgression of gene is intricate due to crossing barriers. A breeding program was established to introgress the heat and water stress genes from wild relatives to cultivated cotton. Introgress genotypes (BC6) were evaluated along with true to type cotton cultivars for he abiotic stress tolerance at department of Plant Breeding and Genetics, The Islamia University of Bahawalpur. Water and heat stress were evaluated in separate experiments with a common control. Heat stress was applied by altering sowing dates and water stress was applied by withholding alternate irrigation. Analyses of variance depicted highly significant ($P \leq 0.01$) effect of genotypes and both stresses on all studied traits. Results also showed significant interaction ($P \leq 0.01$) of genotypes with water and heat stress treatment. Genotypes derived from interspecific crosses performed consistently and comparatively better in stress conditions for yield and yield related traits which confirmed introgression of genes from wild relatives to cultivated genotypes.

Keywords: Abiotic stress, Introgressive breeding, Yield related traits

ROLE OF *Camelina sativa* TO MITIGATE CLIMATE CHANGE

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ABSTRACT

Climate change referred as variation of statistical weather distribution for extended time period. Uncertainty in climatic events such as temperature and rainfall has potential positive and negative impacts on agriculture productivity. Cool-season annual crops such as *Camelina sativa*, that can be produced during times of year with lower evapotranspiration demand, and can make direct use of winter rainfall, provide less water-intensive cropping alternatives to maintain economic returns when water for irrigation is limited. *Camelina sativa* commonly known as false flax belongs to family Brassicaceae is an oilseed with potential for use as a raw material in second- generation biofuels and agronomic low-input features. Camelina is one of the most cost-effective oilseed crops to produce due to search for the new sources of essential fatty acids, particularly n-3(omega-3) fatty acids and multiple use values Camelina has a seed yield of up to 2380 kg ha^{-1} and contains around 45% fatty acids. Selection of a suitable site is critical for production optimization. Climate and soil requirements and geographical restraints were evaluated for camelina considering the climatological characteristics of its regions of origin. The variables considered included factors (temperatures, rainfall, soil & degree days) and limitations (altitude, geomorphology, and current land use), which permitted the evaluation of the national territory for a certain level of suitability. It was determined that Pothwar plateau of the national territory has enormous degree of suitability for its adoption. Moreover, increasing crop diversity can improve the viability of agricultural systems over time and provide agro-ecological benefits to the farming system.

Keywords: Camelina, Climate Change, Oil deficit, Pakistan

PERFORMANCE OF WHEAT CULTIVARS FROM DIFFERENT ECOLOGIES OF PAKISTAN UNDER AGRO CLIMATE OF DERA ISMAIL KHAN

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ABSTRACT

Every cultivar of wheat has its own production climate. An experiment was carried out in which different cultivars were selected to grown under the agro climatic conditions of Dera Ismail khan and also to compare the yield potential of old wheat cultivars against latest wheat cultivars. The study was laid out in Randomized Complete Block Design with three replications. There were 9 varieties under study which were Ujala-16, Millet-11, Dharabi-11, Galexy-13, Barani 70, Maxi Pak, Sonilika, Bahawalpur-79 and Blue silver. The data was collected regarding the parameters plant height, number of tillers per plant, number of spikelet per spike, spike length, grain weight per spike, grain weight per plant, number of grains per spike, 1000-grain weight, grain yield and analyzed statistically. Maximum plant height was shown by Bahawalpur-79 and it gained early maturity. Galexy-13 performed well according to yield (5227 kg ha) and yield attributes in agro climatic conditions of Dera Ismail Khan. Results also showed that the three latest cultivars have maximum yield potential than the old cultivars which showed minimum yield and yield attributes. These cultivars have a descending order of decreasing yield and yield attributes as Galexy-13 > Ujala-16 > Millet-11 > Blue Silver > Dharabi-11 > Bahawalpur > Maxi Pak > Barani-70 > Sonilika. Therefore, Galexy-13 and Ujala-16 is recommended in the agro-climate of Dera Ismail Khan to obtain maximum production of Wheat crop.

Keywords: Wheat cultivars, Yield components, Grain yield

VARIATIONS IN ESTERASES AND PHOSPHATASES OF STORED GRAINS INSECT SPECIES EXPOSED TO MEDICINAL PLANT EXTRACTS

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ABSTRACT

Natural extracts of two medicinal plants *Nicotiana tabacum* and *Eucalyptus globulus* were tested for their toxic and enzyme inhibition effects against three insects species of stored grains *Tribolium castaneum, Trogoderma granarium* and *Sitophilus granarius*. Responses of insects varied with exposure periods and dilution levels of acetone extracts of plants. Both plant extracts were lethal to insects but the crude leaf extract of *N. tabacum* evidenced strong toxic action against three tested insect species. Maximum mortality 36.30% in *S. granarius,* 25.96% in *T. castaneum,* and 21.88% in *T. granarium* were found at 20% dilution level, after 10 days exposure to botanical extract of *N. tabacum*. The impact of *N. tabacum* and *E. globulus* on the activity of esterases; acetylcholinesterase (AChE), α-carboxylesterase (α-CE), β-carboxylesterase (β-CE) and phosphatses; acid phosphatase (AcP), alkaline phosphatase (AlP) of three stored grain insect species were also studied in the survivors of toxicity assay. Whole body homogenates of insects were used for enzyme determination and consumption of high dose rate *N. tabacum* extract containing diet resulted in maximum 55.33% inhibition of AChE and 26.17% AlP inhibition in *T. castaneum*, while 44.17% of α-CE and 31.67% inhibition of β-CE activity were noted in *S. granarius*. Maximum inhibition 23.44% of AcP activity was found in *T. granarium* exposed to diet treated with extract of *E. globulus*. The findings indicate that acetone extracts of *N. tabacum* and *E. globulus* are naturally occurring pesticide and facts of the enzyme inhibition relations specify that their effect changes with the insect species.

Keywords: Natural extract, Medicinal plant, Toxic effects, Enzyme inhibition, Acetone extract

STRATEGIES TO COPE WITH CLIMATE CHANGE FOR SUSTAINABLE CITRUS INDUSTRY

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ABSTRACT

The production and quality of horticultural crops like fruit and vegetables may be severely affected due to climate changes in Pakistan. The variability in temperature, uneven rains and climate shift will definitely affect time of flowering, increase of fruit drop, insect pest and diseases attack severity/ pattern etc. Citrus is one of the main fruits of Pakistan and Punjab, grown on 465,000 acres with the production of over 2 million tons, thus contributing 94% and 97% to Pakistan's citrus area and production respectively. Average yield of citrus is far less than potential yield and compared to other main citrus producing countries of the world. Like other horticultural crops citrus is also prone to many insects pests and diseases. The climate change or shift may increase temperature, extended warm season and decreasing winters which ultimately will deteriorate quality and production of fruits. Over the last few years, a dramatic increase in fungal infection has already been observed causing poor cosmetic quality and reducing grower's income. In this paper different positive and negative impacts of climate change on citrus crop along with strategies to be adopted for sustainable production are discussed. . The information collected here will invite the academia, researchers to work on different aspects of citrus production with special reference to climate change.

Keywords: Climate change, Citrus, Pakistan

STATUS AND PERSPECTIVES OF POTASH USE IN PAKISTAN

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ABSTRACT

Pakistan is located in the sub-tropical zone and soils are deficient in a number of plant nutrients especially nitrogen (N) and phosphorus (P), and a clear NP fertilizer response has been observed in most Pakistani soils. High potassium (K) content is apparent in Pakistani soils developed from mica minerals, but the occurrence of soil K in copious amounts does not represent plant-available K for optimum plant growth. In such soils, K is bound within minerals which do not release K at the rate required for crop production. On the other hand, some soils with low plant available K, maintain levels of solution K that are optimal for plant growth, leading to no response to K fertilization. Release and fixation of K depends on the type and content of soil minerals, whose distribution and retention properties are therefore needed to develop K fertilizer recommendations for sustainable nutrient management. Soil mineral composition and potassium chemistry differ with development age and source of soil parent material. Use of K fertilizers in Pakistan is still under debate, due to diverse crop responses to K fertilizer. General K fertilizer recommendations, which are based on exchangeable K content in the soil and which ignore the soil mineralogy and K dynamics, may lead to non-responsive K applications. Nevertheless, K deficiency has been observed in many crops in different areas of the country. Recently farmers have shown interest in K fertilization, as their expertise and technologies have improved. Being a key macronutrient for plant growth and yield development, K is taken up in higher amounts by all crops. Application of K fertilizers is therefore vital for sustainable agriculture in Pakistan and it is therefore the time for comprehensive studies to endorse potassium fertilization by presenting a clearer picture of crop response to K application. Soil mineralogy and K dynamics-based recommendations may be an effective tool to fill a wide crop yield gap in the country where population is increasing at the rate of ~2.0% per year. Application of K fertilizers to extensively used soils is critical for sustainable agriculture, and K fertilization can be emphasized, based on soil mineralogy and K dynamics in soil.

Keywords: K dynamic in soil, Recommendations, Soil mineralogy

IDENTIFICATION OF DROUGHT TOLERANT RICE GENOTYPES BY ANALYZING PHYSIOLOGICAL PARAMETERS AT EARLY SEEDLING STAGE

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ABSTRACT

The present research was conducted at Plant Physiology Division, Nuclear Institute of Agriculture, Tandojam, during 2016. Seeds of ten rice genotypes (KANGNI- 27, IR-6, IR-50, DR-92, IR-72, IRRI-29, IRRI-15, IRRI-14, IRRI-38 and IRRI-8) along with drought tolerance check (IR-04L191) were grown at different concentrations of PEG-6000 (10%, 15%, and 20%) in Yoshida culture solution having three replications. The characters studied were seed germination, root length, shoot length, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight, root shoot ratio, K^+, relative water content, proline content, sugar contents, chlorophyll content and electrolytic leakage. Concerning mean squares of genotypes, the traits such as germination percentage, shoot length, root length, shoot fresh weight, root fresh weight, root dry weight, cell membrane stability, relative water content, proline content, chlorophyll content, potassium content and sugar content were significantly different ($P \leq 0.05$), except shoot dry weight and root shoot ratio. It states that genotypes tended to have genetic variability for various seedling and physiological parameters; therefore these rice genotypes may prove ideal for further breeding experiments. On the basis of mean performance at various PEG treatments including control, the rice genotype IR-50 performed outstandingly for seed germination, shoot length, root length, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight and relative water content; whereas next top ranker was IR-6 for the characters electrolytic leakage, chlorophyll content, sugar content and root shoot ratio. Results revealed that these both rice genotypes may be preferred for various breeding programs. Regarding correlation results, the seed germination, shoot length, root length, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight and root shoot ratio were significantly and positively correlated among them, therefore selection of anyone of these traits would enhance the performance of other traits.

Keywords: Rice, PEG, Seedling characters, Correlation

ASSESSMENT OF GENETIC DIVERSITY IN BREAD WHEAT GENOTYPES BASED ON PHYSIOLOGICAL, GROWTH, YIELD AND ITS RELATED TRAITS

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ABSTRACT

The present research was carried-out to analysis the genetic diversity in twelve commercial bread wheat genotypes for physiological, growth, yield and its related traits. The experiment was conducted in a randomized complete block design with three repeats at the experimental field, Department of Plant Breeding & Genetics, Sindh Agriculture University, Tandojam during the growing season of 2016-2017. The mean squares from analysis of variance revealed significant differences ($P \leq 0.01$) for majority of the traits among the tested genotypes, indicating that used materials can be evaluated for further experiments. Based on mean performance, the commercial wheat variety Tatara displayed desirable performance for number of traits, including grain yield per plant than rest of the genotypes, exhibiting its importance in wheat breeding programs. Talking about PCA, the first, second and third components explained 48.7, 17.7, and 10.7% of total variation, respectively. The cumulative percent of variance was 77.1% in all three components, demonstrating a significantly high variability, which may be exploited for further wheat breeding program. With regard to genetic to genetic distance, out of the 66 pairs of comparisons, a great number of pairs exposed greater genetic distance, while some pairs also revealed very narrow genetic distance; consequently, these pairs can further be utilized in heterosis and backcross breeding program in wheat crop, respectively. Considering cluster analysis, dissimilar parents have also been recognized, representing their importance for upcoming hybridization programs in wheat crop.

Keywords: Genetic distance, Yield, Bread wheat, Cluster analysis

EVALUATION OF BREAD WHEAT (*Triticum aestivum* L.) GENOTYPES FOR HIGHER GRAIN YIELD UNDER SALT STRESS

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ABSTRACT

The present study was designed to assess the bread wheat genotypes for salinity tolerance. For this purpose, a total of 13 bread wheat genotypes alongwith two check varieties (LU-26 and Bhittai) were grown in randomized complete block design with three replications under saline field conditions during the growing season, 2016-2017 at Nuclear Agriculture Institute, Tandojam. Fourteen agronomically important traits were recorded including, day to 75% heading, day to 75% maturity, plant height, tillers per plant, peduncle length, flag leaf area, spike length, spikelets per spike, grains per spike, grain weight per spike, biological yield per plot, grain yield per plot, 1000-grains weight and harvest index. Results from analysis of variance showed that strains and check genotypes performed significantly different ($P<0.01$) for all studied traits. This indicates that there is significant variations are existed for agro-morphological traits; therefore these lines may be preferred for further breeding programs, such as selection and hybridization program to improve bread wheat genotypes in respect to salinity stress. Regarding mean performance of genotypes under saline field conditions, different genotypes expressed promising performance for different traits, including C7-98-11 for early maturity and tallness; C7-98-11 for flag leaf area; C7-98-03 for tillers per plant and grain weight per spike; C3-98-6 for spike length; CIM-03-6 for spikelets per spike and peduncle length; CIM-4-14 for grains per spike and grain yield per plot, while genotypes CIM-03-9 and CIM-04-16 demonstrated desirable results for biological yield per plot and 1000-grain weight, respectively. It is suggested that these above mentioned bread wheat genotypes may be given due chances in breeding programs to improve different traits of bread wheat in regard to salinity stress. In current study, the traits namely peduncle length, spike length and biological yield plot^{-1} showed positive and significant associations with grain yield. It reveals that these yield contributing parameters play an important role to enhance yield in wheat crop, therefore selection may be conducted on these characters especially in saline conditions.

Keywords: Bread wheat, Salinity, Yield traits, Correlation

A. CROP PRODUCTION

CLIMATE SMART STRATEGIES FOR IMPROVING THE CROP PRODUCTIVITY IN DRY REGIONS

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ABSTRACT

Feeding the increasing global population is one of the major challenges being faced by the researchers in the field of agriculture. The drylands, covering more than 40% of the world's landmass, may be ideal sites to achieve this targeted growth in food production. However, aridity, water scarcity and heat waves are the major issues in crop production systems of dry regions. This necessitates developing novel and innovative climate smart strategies for improving the crop productivity. Use of primed seeds of stress resilient crop genotypes together with super absorbent biopolymers, developed from crop wastes, under conservation agriculture system (with minimum soil disturbance and soil cover) can help harvest better crop yields in dry regions on sustainable basis. In addition to improvement in the sustainability, productivity and profitability, this suit of technology helps in improving the soil water holding capacity and soil health in dry regions.

Keywords: Dryland agriculture, Crop productvity, Seed priming, Conservation agriculture

PLANT PHENOTYPING, ASSESSMENT FOR PLANT PRODUCTIVITY UNDER DIVERSE ENVIRONMENTAL SCENARIOS

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ABSTRACT

Non-invasive, cost effective and often image-based technologies have been developed to quantify the plant functions on leaf and whole plant basis. These innovative plant phenotyping methods are used in complementary to conventional and molecular breeding for genetic dissection of complex traits. These help to explore physiological traits among genetic resources for strong relationship with plant productivity and translate them to elite lines through genetic approaches. Some important examples are leaf Na^+ for NHX_1 dissection for salinity tolerance in wheat, canopy temperature and chlorophyll fluorescence for heat adaptation in wheat, normalized difference vegetation index (NDVI) for stay green and N management in rice and wheat. The overall aim is to harness the relationship between genotype and environment, the expression of responsible genes not only to improve plant production and yield and crop efficiency to improve stress resistance including increasing plant biomass for renewable energy sources and applications. In this research, the relationship of stay green trait, canopy temperature and water soluble carbohydrate for heat tolerance in wheat, NDVI for in season yield estimation and SPAD based chlorophyll for their relationship with grain yield in rice and wheat will be discussed. The overall objective is not only to quantify the structure, function and quality of plants interacting with the environment for improving phenotypic processes and also for testing existing or virtual combinations of populations in a variety of climatic scenarios and management practices.

Keywords: Phenotyping, Productvity, Climate Change, NDVI

MODELING THE POTENTIAL IMPACTS OF CLIMATE EXTREMES ON RAINFED CEREAL-BASED CROPPING SYSTEMS

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ABSTRACT

Rainfed agriculture, which constitutes 80% of global agriculture, is under severe threat due to the frequency and severity of extreme weather events. Increased temperature and water scarcity are major challenge for CEREAL-based cropping systems (CBCS) productivity and ultimately region food security. Since socio-economic conditions of rainfed farmers have been significantly influenced by CBCS. Therefore, reducing vulnerability to climate extremes is essential for adapting to climate change. This will ultimately help the small scale farmers to come back to agriculture sector as dropout rate in this sector is very high due to multiple factors. Meanwhile, yield sustainability of different crops under CBCS could also be achieved by quantifying impact of climate extremes and designing adaptation strategies which have not been studied yet for rainfed region of Pakistan. The cropping patterns adapted by farmers under present scenario includes wheat-maize and wheat-fallow under lepara lands (Land close to village) while two crops in two years are obtained under maira lands (Land away from village). This exploitive cropping systems as well as climate change resulted to the deterioration of crop yield, soil C and N dynamics. Farmers of the region have limited knowledge about climate change therefore, climate extremes impact on cropping systems are in progress by using APSIM, CropSyst & DSSAT model with special emphasis on food security. After calibration and evaluation, model will be run to determine the impacts of climate change on wheat crop growth and productivity alone and in the proposed cropping systems using different general circulation models (GCM) under two Representative Concentration Pathways (RCP): RCP4.5 and 8.5. The desired outcomes of the project will be optimization of wheat adaptive traits, designing of new cereal-based cropping system, and utilization of models as ICT based agro-advisory tool for improved management of climatic risks.

Keywords: CEREAL-based systems, Climate extremes, APSIM, CropSyst, DSSAT

RESPONSE OF ORGANIC PEANUT (*Arachis hypogea* L.) TO VARIOUS SOWING DATES UNDER AN ARID AND A SEMI-ARID ENVIRONMENT

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ABSTRACT

In Pakistan, groundnut is cultivated mainly in rainfed areas of Punjab, Khyber Pakhtunkhwa, and Sindh. Peanut (*Arachis hypogea* L.) crop performs well on sandy to sandy loam texture soil due to easiness in pegging process. The soil of Layyah are sandy to sandy loam in nature and they might be a good option to grow the peanut crop provided that irrigation facilities are available. As, peanut is oilseed crop which performs well on sandy soil, its expansion to thal area might be a viable option to boost oil yield in country. However, it's sowing time need to be optimized for thal area. This study was conducted to evaluate the performance of two peanut varieties under different sowing dates under an arid (Layyah) and semi-arid climate (Chakwal) without using the synthetic fertilizer. The experiment consisted of five sowing dates viz., i) April 10, 2017, ii) May 01, 2017, iii) May 20, 2017, iv) June 10 2017 and iv) June 30, 2017, and two peanut varieties viz., i) No. 334 (spreading type) and ii) BARI -2016 (bunchy type). Pod yield was highest when peanut was sown on April 10, 2017; and there was declining trend in pod yield in the late sowing dates at Layyah site. At Chakwal, the pods yield was statistically similar when peanut was sown on April 20, May 01, and May 20, 2017. The pod formation did not occur in the peanut crop sown at 30 June at both experimental sites. Both peanut varieties produced the similar yield at both experimental sites. In conclusion, the expanding of peanut production to thal area equipped with irrigation facilities might be a viable option to boost the peanut yield in the country.

Keywords: Organic peanut, Thal area, Oilseed deficient, Sowing dates, Peanut varieties

LEAF OXIDATIVE STATUS AND ANTIOXIDANT RESPONSES IN PRIMED AND NON-PRIMED RICE SEEDLINGS UNDER LIMITED MOISTURE AND NUTRIENT SUPPLY

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ABSTRACT

With increasing frequency and episodes of extreme climatic events, the crop plants are sometimes exposed to multiple abiotic stress factors at the same growth stage. The present study investigated the behavior of growth, reactive oxygen species and antioxidant defense system in primed (60 µM selenium or 100 mg L^{-1} salicylic acid priming) and non-primed rice seedlings to the combinations of drought stress and N-, P- or K-deprivation. Results indicated that drought stress as well as deprivation of any mineral nutrient severely hampered the seedling growth of rice. The N-deprivation alone or in combination with drought stress caused the maximum reduction in shoot length and biomass accumulation, although the N-deprived roots were longer. The beneficial effects of seed priming on shoot and root growth of rice were well indicated under drought stress and different nutrient management regimes. Drought as well as nutrient deprivation caused pronounced changes in the oxidative metabolism of rice leaves. The marked increase in the accumulation of ROS ($O_2^{\bullet-}$, OH^{-}, H_2O_2) and activities of ROS-producing enzymes under the individual as well as interactive effect of drought and N-, P-, or K-deprivation, led to higher lipid peroxidation. The interaction of drought stress and N-deprivation caused the maximum oxidative damage, and recorded poor antioxidant activity, suggesting that N-supply is more crucial under drought stress. The N-deprivation also significantly decreased the levels of non-enzymatic antioxidants (GSH, Vc, Ve), which are crucial for the drought tolerance of plants. The oxidative stress evoked by drought or/and nutrient deprivation, was effectively alleviated after seed priming. The leaves of rice seedlings emerged from primed seeds, recorded significantly lower accumulation of ROS and MDA, and lower activities of MAO and XOD. These attributes were well linked to priming-induced enhancements in the activities/levels of SOD, POD, GR, GPX, GSH and Vc in the rice leaves.

Keywords: Rice, Nutrient stress, Water stress, Seed priming, Physiology

ADAPTABILITY EVALUATION AND SIMULATION OF SAFFLOWER (*Carthamus tinctorius* L.) PRODUCTIVITY UNDER RAINFED CONDITIONS

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ABSTRACT

Acute edible oilseed deficiency in Pakistan is due to many problems such as low acreage and climatic extremes. Safflower is hardy crop with deep taproot system, hence capable to withstand harsh climatic conditions. Present study was executed under different climatic conditions of Pothwar region to check the adaptability of spineless safflower accessions aided with simulation modeling. Adaptability evaluation trials were conducted at Islamabad (High), University Research Farm, Chakwal Road (medium) and Talagang (low) rainfall zones of Pothwar. During course of study, growth/development parameters such as days to flowering days to maturity, leaf area index (cm^3), biological yield (t ha^{-1}) and seed yield (t ha^{-1}) were recorded. Collected data was analyzed statistically to sort out the best performing accession under different climatic conditions of Pothwar region. Maximum and minimum days to flowering (148,118) were recoded for genotype 26748 at Islamabad and Attock respectively. However, highest (186) and lowest (147) days taken to maturity were recorded for 26748 at Islamabad and Attock. Genotype 16315 produced highest (5.08 m^2) LAI at Islamabad and lowest was recorded at for (2.41 m^2) by 26748 in Attock. Maximum biomass (12.61 t ha^{-1}) was produced by the genotype (16315) and lowest biological yield (9.52 t ha^{-1}) was computed for 16309 in Attock. Gain yield was maximum (3.58 t ha^{-1}) for 16315 in Islamabad and lowest (1.64 t ha^{-1}) by 26744 at Attock was recorded. First year data was calibrated and model results for studied parameters were in closed agreement with observed values. Moreover, DSSAT_CROPGRO model is in progress to be used to simulate growth and yield of safflower under rainfed conditions of Pothwar. The evaluation of model over multiple locations will enhance our knowledge to predict/forecast safflower yield variability with various rainfall and temperature regimes.

Keywords: Safflower, Adaptability, Rainfed, DSSAT

MODELING OF GROUNDNUT UNDER VARIABLE CLIMATIC CONDITIONS, WATER AND NITROGEN REGIMES

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ABSTRACT

Climate is one of the main determinants of agricultural production system. Globally, there is significant concern about the effects of climate change and its variability on agricultural productivity. The changes in climatic factor (CO_2, temperature, vapor pressure deficit and rainfall) alter plant growth and development processes and most likely have negative impact on productivity of groundnut, especially in the semi-arid region. Current study was planned to assess the impact of climate change on growth and yield of groundnut using PNUTGRO-DSSAT model. Field experiments were laid out in Randomize Complete Block Design (RCBD) using groundnut cultivar (Pothwar) with three replications at URF (University Research Farm) Koont Chakwal and Islamabad. Crop growth parameters such as plant height, crop phenological development, biological yield, grain yield and harvest index were recorded. Collected data was analyzed using Fisher's analysis of variance techniques and significant of treatment while means were tested using least significance difference (LSD) test at 5% probability level. Maximum days to branching, days to flowering, day to maturity, plant height, biological yield, grain yield and number of plants were recorded under higher nitrogen treatments. Model performance was accurate in predicting crop phenology, growth and yield as evaluated by statistical indexes such as, Root Mean Square Error (RRMSE), Residual Error (ER) and Relative Root Mean Square Error (RMSE). In conclusion, PNUTGRO-DSSAT model could be used to design management strategies for peanut productions under rainfed agriculture.

Keywords: Peanut, Climate, Nitrogen, Crop modeling, Rainfed

ZINC APPLICATION THROUGH SEED TREATMENT IMPROVES THE STAND ESTABLISHMENT AND EARLY SEEDLING GROWTH OF CHICKPEA

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ABSTRACT

Zinc (Zn) deficiency is a major reason causing substantial loss to chickpea production. Chickpea is very sensitive to Zn deficiency and toxicity due to their negative impact on the chickpea growth and productivity. Zinc is being applied by several techniques including seed treatment (seed priming and seed coating). Therefore, two independent studies were conducted to optimize Zn seed priming and seed coating concentration in *desi* and *kabuli* chickpea types at Allelopathy Laboratory, Department of Agronomy, University of Agriculture, Faisalabad, Pakistan. The experiments were laid out in completely randomized design with factorial arrangement. Zinc was applied as seed priming at (0.01, 0.001, and 0.0001 *M* Zn) and seed coating at (05, 20, 35 and 50 mg Zn kg^{-1} seed). Results indicates that, seed priming with 0.001 *M* Zn decreased mean germination time; in contrary improve root and shoot length, number of secondary roots, seedling dry weight and seedling Zn contents in both chickpea types. While, seed coating with 5 mg Zn kg^{-1} seed increased the germination/emergence rate, emergence index, root and shoot length, number of secondary roots and seedling dry weight in both chickpea types. However, Zn seed priming above (0.001 *M*) and seed coating (5 mg Zn kg^{-1} seed) suppressed the seedling germination/emergence, and seedling growth of both chickpea types indicating the Zn toxicity. In conclusion, Zn seed priming at 0.001 *M* and Zn seed coating at 5 mg Zn kg^{-1} seed improves the stand establishment and early seedling growth of both chickpea types.

Keywords: Chickpea, Zinc priming, Biofortification

EFFECT OF ZINC BIOFORTIFICATION FOR IMPROVING THE PERFORMANCE OF MUNG BEAN

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ABSTRACT

Various regions of Pakistan are facing zinc deficiency in soils. It is the main hindrance in attaining high mung bean yield. This problem can be solved by proper zinc application either through soil dressing or basal application method. This experiment was carried out to evaluate the impact of different zinc levels by various application methods on mung bean. The research was conducted at Agronomic Research Area, Bahauddin Zakariya University, Multan in 2017. In this study, zinc was applied at the rate 0, 5, 10, 15 kg ha^{-1} as basal, soil dressing or in combination (50% basal + 50% side dressing). The trial was laid out in randomized complete block design with factorial arrangement having three replications. Crop cultivar AZRI-2006 was used as test crop. All the zinc levels performed well as compared to control, nonetheless, maximum plant height, number of pods bearing branches, pods per plant, number of grains per pod, 1000-grains weight, chlorophyll contents, biological yield and grain yield was observed where 15 kg ha^{-1} of Zn was applied. It is concluded from the experiment that higher mung bean grain yield was obtained when zinc was applied as basal dose at the rate of 15 kg ha^{-1}.

Keywords: Mung bean, Zinc, Basal dose, Soil dressing

APPLICATION OF SPERMIDINE TO MANAGE WATER STRESS FOR IMPROVED FINE RICE YIELD AND QUALITY

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ABSTRACT

Water shortage is the big concern for the rice producers worldwide. Water stress induces abnormalities in rice plant and leads to reduce crop yield or quality. Various approaches are under study to manage water stress in rice production. Foliar application of spermidine was done in different rice cultivation systems of Pakistan to estimate its role in sufficient and scarce water condition. Spermidine was foliarly applied at seedling, tillering, panicle initiation, seedling + panicle initiation, tillering + panicle initiation, seedling + tillering + panicle initiation in flooded and aerobic rice cultivation systems. The results revealed that all treatments of spermidine improved rice crop yield in term of panicle length, number of grains per panicle and crop yield. But the most economical and improved results were obtained from a single application of spermidine at panicle initiation. Furthermore, spermidine application also resulted in improved quality parameters in term of filled grains and cooking quality. The results showed that application of spermidine might be further investigated for its positive role in aerobic rice or under water stress condition for sustainable rice cultivation system.

Keywords: Spermidine, Drought, Rice

EXOGENOUS APPLICATION OF POTASSIUM IMPROVES THE DROUGHT TOLERANCE IN CHICKPEA

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ABSTRACT

Drought is one of the major agricultural problems which cause the losses to crop productivity. It is a worldwide problem and prevails in many parts of the world as a major threat to agriculture. Potassium (K) is considered to be an essential nutrient that plays an important role in growth, development and defense response in plant under stressful conditions. This work investigated the effects of K in drought tolerance of chickpea seedlings by examining the growth, photosynthetic performance, total osmo-regulation substance contents and antioxidative enzymes subjected to drought stress. The drought stress impaired the growth (root and shoot dry weight, root: shoot ratio, seedlings biomass), water relations, photosynthetic attributes, transpiration rate, chlorophyll contents and anti-oxidants activity of the chickpea seedlings. Nonetheless, the foliar application of K improved the growth, water relations, photosynthetic attributes, transpiration rate, chlorophyll contents and anti-oxidative activity of chickpea under drought conditions. Moreover, an increase in antioxidant enzyme activity and accumulation of osmo-protectants (proline, soluble protein and soluble sugar) was noted under stressed conditions, which was more pronounced in chickpea which received the K nutrition. To conclude, foliar application of K mitigated the adverse effect of drought on chickpea.

Keywords: Antioxidant, Water relation, Potassium, Water deficit

GROWTH AND PRODUCTIVITY OF ADVANCED COTTON CULTIVARS AS INFLUENCED BY SOWING TIME UNDER THE AGRO-CLIMATIC CONDITIONS OF SOUTHERN PUNJAB

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ABSTRACT

Cotton is an important fiber crop and is considered as the back bone of Pakistan economy. There are several yield limiting factors that create obstacles to achieve the potential yield. Among these, sowing time has got key position because of climatic changes in the country. Nitrogen deficiency along with delayed sowing has made this situation more worsen. To overcome this situation, three studies was conducted at Central Cotton Research Institute Multan. The experiment was laid out in randomized complete block design with split-plot arrangement using three replications. The first experiment comprised of five sowing dates in main plots *viz* S_1 (15 April), S_2 (01 May), S_3 (15 May), S_4 (01 June) and S_5 (15 June) and three different cultivars *viz* G_1 (CIM-620), G_2 (Cyto-120) and G_3 (CIM-608) in sub plots. Seed cotton yield was significantly ($P \leq 0.05$) influenced by sowing date. Delay in sowing date reduced significantly the seed cotton yield, and the highest yield was produced when crop was sown early on April 15 and the lowest yield was produced with late sown crop (June 15) during both years of experimentation. Cultivar CIM-620 produced significantly more seed cotton yield (2456 kg ha^{-1} & 2257 kg ha^{-1}) than CIM-608 that gave lower yield of 1971 kg ha^{-1} & 1773 kg ha^{-1} ($P \leq 0.05$) during 2016 and 2017 respectively. The maximum net income of Rs. 155725 in 2016 and Rs. 142365 in 2017 were achieved with combination of S_1G_1 treatment (sowing of cotton at 15th May). It is directed to the cotton growers that the crop sowing should not be delayed with any cultivar. Furthermore, the sowing of CIM-620 genotype of cotton along with sowing at optimum time at 15th May is fairly a good suggestion to improve cotton yield.

Keywords: Cotton, Genotype, Sowing time, Yield, Growth

TRACING THE IMPACT OF CLIMATE CHANGE ON RICE CROP OF PAKISTAN: AN EMPIRICAL INVESTIGATION

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ABSTRACT

Global climate change has started affecting virtually all forms of life. It is now a well acceptable phenomenon all over the world. South Asian Region (SAR) is under threat of these changes, especially the Himalayas, providing water to a large population, for drinking and allied purposes. This paper empirically investigates effect of climate change on rice crop of Pakistan in rice/wheat zone of the country. Study used Ricardian approach to delineate the impact of temperature, precipitation and humidity on net farm revenues (NFR). In addition, some socio-economic variables were also introduced into the model to have a broader look of the said impacts. The results ascertained that warming is going to be beneficial for rice crop in Pakistan. Temperature showed positive significant impacts, while precipitation showed some slim negative impact on NFR. The positive impacts of temperature were greater than negative impacts of precipitation. Humidity showed insignificant impacts on rice production. Results also emphasized on adapting effective strategies, to combat any harmful impacts of climate.

Keywords: Climate Change, Ricardian, Pakistan, Rice, Net farm revenue

IMPROVING THE OIL AND MEAL QUALITY IN *Brassica napus* L. AND *Brassica campestris* L.

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ABSTRACT

Breeding in *Brassica napus* and *Brassica campestris* is strongly directed towards better oil and meal excellence. For consumption as a food , oil containing low amount of erucic and eicosenoic acid, with high linoleic and low linolenic acid content material is suited, whereas for technical functions i.e. as a lubricants and raw substances for the manufacture of plastic and fragrance, oil with high concentration of erucic acid content is demanded. The half-seed and the backcross strategies are more effective and suited in the breeding work in contrast to inbreeding technique. Feedstuff value increases appreciably with the decrease in the content of glucosinolates from the both the brassica species i.e. napus and campestris. It is estimated that in yellow seeded material, the amounts of glucosinolates are low and their meal serve as a protein source for human beings. In both these species, promising lines with low erucic acid and glucosinolates contents are released. The first ever twofold varieties viz. tower and polish, with excessive yielding quality and low contents of erucic acid and glucosinolates were advanced and released in Canada.

Keywords: Erucic acid, Glucosinolates, Eicosenoic acid, Linolenic acid, Linoleic acid

BIOFORTIFICATION OF MUNG BEAN BY USING IRON SULPHATE (FeSO4) TO IMPROVE CROP PRODUCTIVITY AND REDUCE MALNUTRITION

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ABSTRACT

Malnutrition is biggest threat now a day throughout worldwide. Moreover, Pakistani pulses also lack micronutrients contents in their grains. The mung bean is a highly nutritive crop and contain large amount of protein which fulfill the protein needs of great population. To solve the problem of malnutrition, the agronomic biofortification of iron was practiced in mung bean. The study was conducted at Research Farm, Department of Agronomy, Bahauddin Zakariya University, Multan during 2017. For this purpose, Azri-2006 variety was selected for experimental material. Iron sulphate ($FeSO_4$) was applied at three different levels (5, 10 and 15 kg ha^{-1}) and through three application methods viz., i) basal, ii) side dressing, and iii) basal + side dressing. The results of study indicated that iron application has significant effect on chlorophyll content, leaf area index, number of branches, number of pods per plant, number of seeds per pod and grain yield of mung bean. Iron application at rate of 15 kg ha^{-1} with basal + side dressing application produced the maximum chlorophyll content, leaf area index, number of branches, number of pods per plant, number of seeds per pod, grain iron content and grain yield. In conclusion, $FeSO_4$ at 15 kg/ha with basal + side dressing application improved the mung bean productivity and enhanced the mung bean iron content which can resolve the issue of malnutrition.

Keywords: Mung bean, Biofortication, $FeSO_4$, Allometry, Grain yield

IMPACT OF SOIL APPLIED BORON ON GERMINATION AND GROWTH OF COTTON (*Gossypium hirsutum* L.)

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ABSTRACT

Deficiency of boron (B) is a serious issue of lower crop growth and yield. This problem can be resolved by B application through proper method. Deficiency of B impose deleterious effects on cotton growth and yield. A pot trial was conducted to investigate the impact of soil applied B on germination, growth and yield of cotton. The experiment was carried out at Central Cotton Research Institute, Multan during kharif 2017. Growth and yield response of two cotton (CIM-632 and CIM-616) cultivars to five B levels (0, 2.6 mg, 5.52 mg, 7.78 mg and 10.04 mg per pot) were tested in soil filled pots. The experiment was laid out in completely randomized design with factorial arrangement having five replications. All the B levels performed well as compared to control, however, B application at 10.04 mg pot^{-1} remained superior to others. Maximum percentage of germinated seeds, number of leaves per plant, plant height (cm), leaf area index per plant, chlorophyll contents, number of sympodial and monopodial branches, number of bolls per plant, boll weight, total biomass, seed cotton yield and harvest index was observed where 10.04 mg pot^{-1} of B was applied. It is concluded from the experiment that higher cotton seed yield was obtained when B was applied in soil at the rate of 10.04 mg per pot.

Keywords: Cotton, Boron, Chlorophyll, Monopodial, Sympodial, Soil application

IMPROVING THE YIELD AND QUALITY OF SAFFLOWER (*Carthamus tinctorius* L.) THROUGH FOLIAR APPLICATION OF SELENIUM

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ABSTRACT

Safflower (*Carthamus tinctorius* L.) is an important medicinal oilseed crop. Selenium in trace amounts is one of the beneficial micronutrient. Selenium is an essential element for thirty selenoenzymes and selenoprotein and it is an important component of enzymes. This study was conducted to evaluate the impact of foliage applied selenium on the performance of four safflower genotypes viz. 16427, 16493, 26733 and 26748. Selenium was foliage applied to all genotypes at 50, 100, 150 and 200 ppm; no selenium application being taken as control. Results indicated that foliar application of selenium significantly improved the crop growth rate, stay green, plant height, number of branches, pods per plant, number of seed per pod, 1000-seed weight, biological and seed yield and oil quality of all safflower genotypes. Among the various concentrations of thiourea, foliar application at 75 mg L^{-1} was most effective for improvement in crop growth rate, morphological and yield related parameters and the oil quality. Among different safflower genotypes, the highest seed yield was recorded in 16493 genotype. In crux, foliar application of selenium at 75 mg L^{-1} might be opted to improve the performance (yield and quality) of safflower.

Keywords: Safflower, Selenium, Oil yield

IMPROVING GROWTH AND YIELD OF MUNG BEAN (*Vigna radiata* L.) THROUGH FOLIAR APPLICATION OF SILVER AND ZINC NANO-PARTICLES UNDER ARID CONDITIONS

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ABSTRACT

Nano-materials are being used in every aspect of modern life and its application is rapidly expanding even in agriculture. Silver and Zinc nano-particles are hypothesized to enhance growth and productivity of crop plants. Present study was carried out to evaluate the effect of foliarly applied Ag and Zn nano-particles on growth and yield of mung bean. The experiment was comprised of sixteen treatments and three replications. Three concentrations of silver nano-particles (10, 20 and 30 ppm) and zinc nano-particles (2, 4 and 6 ppm) were used as separate treatments, as well as in combinations and were compared with the control treatment (without nano-particles). Foliar application of nano-particles had significant effect on growth, yield and yield related traits. Branches per plant, number of pods per plant, chlorophyll contents and seed yield was improved in treatment where Ag and Zn nanoparticles were applied in combination i.e. 20 ppm + 6 ppm concentration respectively, while nodules per plant were improved in treatment where silver and zinc nanoparticles were applied in combination i.e. 20 ppm + 4 ppm concentration, respectively. However, reduction in branches per plant, number of pods per plant, chlorophyll contents and seed yield was observed where only water was sprayed and was at par with higher concentration of silver and zinc nanoparticles i.e. 30 ppm + 6 ppm respectively. The higher concentration of both nano-particles resulted in decreased leaf chlorophyll content, biological yield and nodule formation. The results of the current study might be helpful for the farmers of arid area to improve the mung bean production.

Keywords: Mung bean, Nano-particles, Foliar spray, Nodule formation, Seed yield

INFLUENCE OF WATER DEFICIT IRRIGATION ON GROWTH AND PRODUCTIVITY OF WHEAT (*Triticum aestivum* L.)

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ABSTRACT

Wheat is of prime importance after rice and major grain source of masses of Pakistan. Wheat flour is significant product that has a prominent share of daily caloric consumption with per capita intake. Multiple factors contribute to reduce the yield of wheat in Pakistan chiefly water stress during growth period and late sowing. A field trail was conducted to evaluate the influence of water deficit irrigation on growth and productivity of normal and late sown wheat (*Triticum aestivum* L.). Split plot design was used for field trail. Results revealed that irrigation at 45mm potential soil moisture deficit (PSMD) produced highest number of productive tillers m^{-2} (326), maximum grain yield (3881 kg ha^{-1}) and highest spike length (14 cm). Application of irrigation at 60 mm PSMD ensured maximum water use efficiency regarding total dry matter production (6.40 g m^{-2} mm^{-1}) and grain yield (1.97 g m^{-2} mm^{-1}), while highest crop growth rate (9.98 g m^{-2} d^{-1}) was observed in case of 45mm PSMD. Present results depicted that the effect of water is more distinct regarding the growth and productivity of wheat. Application of irrigation at 45 mm PSMD ensured higher economical yield.

Keywords: Water deficit, Wheat, PSMD

MITIGATING THE CHALLENGE OF CLIMATIC CHANGE: CROPS ADAPTATION STRATEGIES FOR FARMING COMMUNITY IN PAKISTAN

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ABSTRACT

Pakistani agriculture is highly vulnerable to climatic change due to diverse climatic conditions in the country. The major factors which effect agriculture output includes shift in rainfall pattern, rise in temperature, increase in carbon dioxide concentration, longer growing season in summer, increase in drought spell, high risk of floods, high erodibility and vulnerability of crop to insect pest attack. To cope with the current alarming situation in the country, different crop adaptation strategies may be adopted like introduction of drought tolerance species, late sowing cultivars, early maturity crops and development of mid-season Zaid-e-Rabi cropping pattern. Besides these breeding programs for development of existing crops varieties is required to make it adoptable to the current climatic change. Introduction of innovative and substitute species of crops, fruits and vegetable which can replace the existing crops species and can adjust in the existing cropping pattern of the country. By adopting these technologies in the country, the farmer will be able to get maximum output from their fields. Besides these practices, awareness and capacity building in the subject area may also play a major role in the current situation.

Keywords: Climate change, Rabi crops, Breeding strategies

IMPROVING YIELD AND DROUGHT TOLERANCE INDEX THROUGH WHEAT VARIETIES AND DROUGHT STRESS

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ABSTRACT

Drought stress is a major abiotic factor, and one of major production limiting factor in cereal crops all over the world. Therefore this study was conducted at agro-climatic conditions of Agricultural Research Farm University of Haripur to assess different wheat varieties under irrigated and rainfed conditions of Haripur. The experiment was laid out in randomized complete block design with three replications. Eight wheat varieties i-e PIRSABAK-08, PIRSABAK-13, FAKHR-E-SARHAD-97, BARSAT-10, ATTA-HABBIB-10, HASHIM-08, SIRAN-07, and LALMA-12 were tested. Wheat varieties differed significantly for plant height, spike density (spike length, spikelet's per spike), 1000-grains weight, grain yield, stress tolerance index (STI), tolerance and mean productivity (MP). Wheat variety Hashim-2008 performed best under irrigated and rainfed conditions regarding yield and yield related traits. Highest STI and MP values were also observed in Hashim-2008 whereas, highest TOL was recorded in Pirsabak-2013. Hashim-2008 performance under irrigated and rainfed conditions is best under agro-climatic conditions of Haripur, KPK.

Keywords: Wheat, Varieties, Rainfed, Haripur

EXPLORING THE POTENTIAL OF VARIOUS PLANT GROWTH REGULATORS FOR MITIGATING HEAT STRESS IN SPRING MAIZE

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ABSTRACT

Maize is recognized as one of vital cereal after rice and wheat, and is extensively cultivated all over the world. Numerous factors which decline the yield of maize include late sowing, weed infestation, and inaccessibility of value seeds, water logging and accumulation of salts and lethal heat stress especially at reproductive phase of crop. Delayed sowing of crop and numerous abiotic stresses especially heat stress are declining the productivity of maize. Various plant growth regulators are reported by many scientists to mitigate heat stress. Current experiment was conducted to evaluate the effect of various plant growth regulators like salicylic acid, humic acid and methyl jasmonate at various sowing dates of spring maize. The experiment was laid down in randomized complete block design with split plot arrangement having three replications. The net plot size was 6 m × 2.25 m. The results showed that salicylic acid application in recommended sowing (20-02-2017) produced maximum height and number of grains per cob of maize.

Keywords: Heat stress, Sowing dates, Plant growth regulators, Humic acid, Salicylic acid

BROWN MANURING FOR WEEDS SUPPRESSION IN WHEAT (*Triticum aestivum*)

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ABSTRACT

Weeds are one of major threats in attaining higher yields of agronomic crops. Brown manuring is recognized as one method to suppress weeds in which some fast-growing crop preferably legume is grown with main crop followed by killing with the help of herbicides. Brown manuring increase nutrient status and organic matter of soil, and cause weed suppression. Different crops like linseed, lentil, chick pea, lucern, Egyptian clover, canola, fennel, and mung bean were intercropped in wheat and were killed 60 days after sowing at Agronomic Research Farm, Department of Agronomy, University of Agriculture Faisalabad. Experiment was carried out under randomized complete block design having three replications. Data regarding weed population, weed biomass, cover crop biomass, wheat biomass before and after herbicides spray, spike length, number of grain per spike and grain yield of wheat was recorded following standard procedures. Our results show that brown manuring caused weed suppression compared to control. Highest weed suppression was noted in Egyptian clover brown manuring followed by lucern and linseed. Highest grain yield was recorded in Egyptian clover brown manuring among all brown manuring treatments. Our study exhibited potential of brown manuring for weed control in wheat.

Keywords: Brown manuring, Weed suppression, Wheat

ANALYSIS AND DESIGNS OF ORGANIC FARMING SYSTEMS IN PAKISTAN

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ABSTRACT

Conventional farming is costly and may be hazards to soil, environment as well as living organisms on planet earth. Therefore, organic farming is getting attention among farmers. However, there is lack of institutional and scientific support for organic farming in Pakistan. Therefore, the aim of the research was to (i) study the design of existing organic farming systems in Pakistan, farmers satisfaction levels and factors influencing adoption of organic farming systems, (ii) evaluate the economic performance of organic farming in terms of productivity cost and net farm income (iii) measure soil organic matter contents and relates it with time after transition to organic production systems from conventional system. The study was conducted in six districts of Pakistan, i.e. Bagh, Poonch, Mansehra, Swabi, Attock and Rawalpindi with organic and conventional farmers. From each district 10 organic and 5 conventional farmers were selected based on their land holding areas. The farmers were interviewed through a structured questionnaire. Soil samples from each farm at depth 0-30 cm and 30-60 cm were collected and analyzed for organic matter content. Results showed that most of organic as well as conventional farmers were practicing mixed farming (37% vs. 53%, respectively). About 82% farmers were satisfied over organic farming system and liked to practice organic farming as well as wished to continue organic farming in future. Correlation analysis of the data revealed that the characteristics viz age, family size, farming experience and net farm income were found positively and significantly related with the extent of adoption of organic practices by the organic farmers whereas farm size and market availability were negatively and significantly related. Net return per rupee invested was 3 times greater in organic as compared to conventional farming. A positive relationship between soil organic matter content and duration of farming was found under organic farming while it was negative under conventional farming system. The research data might be helpful for policy making of organic farming systems in Pakistan.

Keywords: Organic farming, Organic matter, Farmer satisfaction, Farm income

INTEGRATION OF BENEFICIAL MICROBES WITH ORGANIC AND INORGANIC NITROGEN RATIOS AND LEVELS FOR THE IMPROVEMENT IN BIOMASS, GRAIN YIELD AND QUALITY OF SPRING MAIZE

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ABSTRACT

In arid and semi-arid ecosystems, low organic matter is an important threat to soil fertility, crop productivity and economic returns. Sustainable approaches are required to build organic matter in such soils to improve nutrients use efficiencies and food security. This study was designed to observe the spring maize biomass, yield and quality effects with integration of beneficial microorganisms, organic and inorganic N fertilizer and N rates. For this purpose, field experiments were conducted in randomized complete block design using three replications during 2014 and 2015 at Agronomy Research Farm, the University of Agriculture Peshawar-Pakistan. Application of beneficial microbes significantly enhanced biological yield (BY), grain yield (GY), stover N content (SNC), grain N content (GN) and protein content (PC) of maize. Application of 50:50 organic and inorganic N also enhanced the BY, GY, SNC, GN and PC. Higher GY, GN and PC were observed with application of 150 kg N ha^{-1} however, BY and SNC were observed with 200 kg N ha^{-1}. It was concluded that beneficial microbes and 50:50 ratio of organic and inorganic N and 150 kg ha^{-1} N gave better performance in terms of biomass, yield and quality analysis of maize which is recommended for agro-climatic condition of Peshawar.

Keywords: Beneficial microbes, Organic and inorganic sources, Nitrogen, Spring maize

INTEGRATIONS OF MICROBES WITH NITROGEN SOURCES FOR IMPROVING YIELD AND YIELD COMPONENTS OF SPRING MAIZE

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ABSTRACT

Deficiencies of micronutrients and low soil organic carbons are main drivers of low yield in arid and semi-arid regions of the world. Thus, novel approaches are required to build organic matter in such soils to improve nutrients use efficiencies and food security. Therefore, we conducted an experiment on spring maize to test with and without beneficial microbes (BM) (Azotobacter and Azospirillum) and nitrogen (N) management on crop productivity. Field experiments were conducted at Agronomy Research Farm, University of Agriculture Peshawar, Pakistan during 2014 and 2015. Beneficial microorganism, 50:50 ratio of organic and inorganic N and 150 kg N ha^{-1} seem better in term of improving number of ear per unit area, grains per ear, 1000-grains weight and grain yield of spring maize. So, application of microorganism, 50:50 ratio of organic and inorganic N and 150 kg N ha^{-1} are recommended for enhancing crop productivity in agro-climatic condition of Peshawar Pakistan.

Keywords: Beneficial microbes, Organic and inorganic, Nitrogen, Yield and yield components

IMPACT OF DIFFERENT PLANTING DATES ON SEED COTTON YIELD AND OTHER ATTRIBUTES OF DIFFERENT COTTON GENOTYPES

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ABSTRACT

It is essential to provide the experimental evidence and reliable prediction to estimate the effects of the planting dates on the enhancement of yield and other attributes of selected cotton varieties. A two year experiment was conducted at Cotton Research station Sahiwal to assess the impact of planting dates on cotton productivity attributes of five genotypes during 2016-17 and 2017-18. The experiment was designed in split plot design with three replications. Main plots were six sowing dates (1st March, 16th March, 1st April, 16th April, 1st May and 16th May) and subplots were genotypes (SLH-6, SLH-19, SLH-33, FH-142, CIM-602). Results revealed that varieties and planting dates had significant effect on cotton performance during both years; early plantation produced more vegetative growth than lint production. The results further indicated that the strain SLH-33 produced significantly higher number of bolls, boll weight, seed cotton yield per plant, ginning turn out and staple length when planted on April 01. Earlier plantation produced higher plant height. Late plantation also gradually reduced the number of bolls per plant, boll weight, ginning turn out and staple length. Thus, it is concluded that 1st to 30th April is an ideal plantation window for cotton sowing in Sahiwal area.

Keywords: Cotton attributes, Planting dates, Central Punjab

PRODUCTION EFFICIENCY OF PROMISING MUNG BEAN GENOTYPES AFFECTED BY DIFFERENT SOWING DATES UNDER RAINFED CONDITIONS

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ABSTRACT

Determination of optimum sowing time for mung bean is inevitable which may vary from variety to variety due to variation in agroecological conditions. Therefore a field trial was conducted at pulses research field NARC, Islamabad, to establish the optimum sowing time and suitable genotype for rainfed conditions of the area. The treatments were five sowing dates (15 June, 25 June, 05 July, 15 July and 25 July) and two promising genotypes (NM-11, NCM-2013). Experiment was laid out in randomized complete block design with split plot arrangement by using three replications. Data regarding growth, yield attributes and yield were collected and analyzed. Considering the individual effect, results depicted that among varieties, NCM-13 exhibited significantly better performance as compared to NM-11 for most of the studied traits including yield. In case of planting times, delayed sowing delayed maturity but July 05 reported best results especially for yield attributes like number of clusters per plant, pods per plant, biological yield, grain yield and harvest index; however it was statistically similar with planting time of July 15 for all these traits. The interaction also exhibited significant results and V2S3 recorded highest yield than all other treatments. So it can be concluded that genotype NCM-13 should be grown from 05 July to 15 July for maximizing the mung bean yield under rainfed conditions of the area.

Keywords: Genotypes, Sowing date, Growth, Yield, Mung bean

MITIGATING CLIMATE EFFECT ON RAINFED WHEAT THROUGH TILLAGE AND FORAGES

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ABSTRACT

Summer fallowing is the most common practice in the rainfed areas of Potohar to conserve soil moisture for the wheat establishment as winter rains are not enough to establish and mature the crop. Farmers plough their land to conserve the moisture and control weeds. In the changing climate scenario, no rain is received during the wheat sowing season (September to November), thus badly affecting the wheat establishment. To utilize the summer fallowing and rains, two year field experiment was carried out to compare the conventional tillage (moldboard plow + 8 cultivations) with modified conservation tillage (chisel plow + 4 cultivations with common cultivators) and summer forage (maize + soybean mixture) with 50:50 ratio was sown with the initiation of monsoon as fodder and green manure crop. Conventional summer fallow was kept as control. After almost a period of two months, summer forage was harvested and incorporated in the soil as per treatment. Soil parameters such as soil moisture content, soil organic matter and soil N (NO_3^-), tonnage of summer forage crop and subsequent wheat sown growth and yield parameters i.e. root length, shoot length, shoot biomass, plant height, spike length, spikelets per spike, grains per spike, 1000-grain weight, biological and grain yield were recorded. The results of the experiment clearly demonstrated that summer forages had significant effect on soil and wheat productivity while tillage systems failed to produce any significant effect between conventional versus modified conservation tillage. Forage green manure produce significant effects in terms of soil moisture percentage and SOM than fallow and fodder treatment. The residual effect of summer forages clearly showed that wheat growth such as root length, shoot length, shoot biomass, plant height and yield parameters such as spike length, spikelets per spike, grains per spike, 1000-grain weight and final biomass and grain yield were statistically at par in fallow and green manuring treatment, while they were significantly lower in fodder mixture treatment. Modified conservation tillage (chisel plow + 4 cultivations with common cultivator) and incorporation of forage mixture (soybean + maize) may therefore be a better option to mitigate the climate effect and to obtain sustainable crop production in rainfed areas.

Keywords: Tillage, Cropping system, Cereal-legume mixture, Rainfed

ALLEVIATION OF WATER DEFICIT STRESS EFFECTS BY FOLIAR APPLICATION OF ASCORBIC ACID ON MAIZE

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ABSTRACT

Salinity is one of the major abiotic stresses affecting the plant growth and biomass production. Maize being a salt sensitive crop faces serious issues of yield production. Keeping in view the economic utilization of salt affected areas, research work was carried out to counteract salt-sensitivity in maize by pre-soaking of seeds with ascorbic acid. In this regard, various seed priming concentrations of ascorbic acid (0, 0.5 and 1.0 mM) were applied before sowing and seeds were sown in different concentrations of salt stress (0, 60, 120 mM). The experiment was laid out in completely randomized design with factorial arrangement. Plant responses were determined on the basis of several morphological and biochemical attributes (protein contents and anti-oxidant enzymes) after thirty days of NaCl stress. Results of the present study revealed an overall negative effect of salt stress on mean time to emergence, chlorophyll contents, root and shoot weight in maize. Ascorbic acid application at the rate of 0.5 mM was much effective in alleviating salt stress by improving germination, relative water contents, leaf photosynthetic pigments and overall growth. The enhanced growth might be due to the proposed involvement of increased anti-oxidant enzymes activity and proline at the expense of protein degradation. Thus it can be proposed that seed priming of ascorbic acid at low concentration is effective in ameliorating the deleterious effects caused by high soil salinity.

Keywords: Drought stress, Ascorbic acid, Maize

HYDROPONIC FOOD PRODUCTION IS BETTER OPTION TO COPE WITH THE PROBLEM OF FOOD SECURITY

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ABSTRACT

Tremendous amount of research has been conducted in the field of hydroponic systems. Recent research has given rise to new production techniques that are more efficient and self-sustainable than contemporary agricultural plant production practices which leave a negative footprint on the environment. Henceforth, hydroponic systems are emerging as a new technology that could potentially suffice the deficit in agricultural production and supersede conventional agriculture as the primary producer of vegetables. Hydroponic production is becoming an attractive frontier for investors and many studies revealed the benefits of hydroponic systems. The major advantage of hydroponic systems is the tight control over plants growth environment. That is, to reach the optimum production capacity, several parameters should be vigilantly controlled and monitored. The present situation of our world is too threatening; under such circumstances in near future, it will become impossible to feed the entire population using open field system of agricultural production only. Naturally, soil-less culture is becoming more relevant in the present scenario, to cope-up with these challenges. In soil-less culture, plants are raised without soil. Improved space and water conserving methods of food production under soil-less culture have shown some promising results all over the world.

Keywords: Lettuce, Over population, Nutrients, Soil

EFFECT OF ASCORBIC ACID ON MEMBRANE STABILITY AND YIELD OF HEAT STRESSED Bt COTTON

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ABSTRACT

Cotton (*Gossypium hirsutum* L.) is one of the important cash crops. Among all the abiotic factors that are responsible for reduction in yield, high temperature is the major one. All stages of crop are adversely affected by high temperatures; however, reproductive growth is found to be most sensitive in this regard. The present study was carried out to look into the effects of foliar applied ascorbic acid on cotton crop grown under heat stress conditions. Experimental material was comprised of heat stress imposition (H_0= No heat imposition, H_1= Heat imposition at square initiation, H_2= Heat imposition at flower initiation) and levels of foliar applied ascorbic acid (A_0= control/water spray, A_1= 15 mg L^{-1}, A_2= 35 mg L^{-1} and A_3= 55 mg L^{-1}). Heat was imposed to cotton crop by covering the plots with polythene sheet at reproductive stages for 5 days. Results showed that heat stress badly affected the yield and yield related components of cotton crop. Cell membrane thermostability (CMT) was also reduced under high temperature stress. Foliar application of ascorbic acid at 35 mg L^{-1} reduced the cell injury and improved yield and yield related component under all heat treatments. It was concluded from the experiment that heat stress imposed either at squaring or at flowering stage of crop disturbed physiological activities, reduced crop growth, seed cotton yield and impaired fiber quality. Maximum seed cotton yield, net income and benefit cost ratio were obtained when ascorbate was applied at 35 mg L^{-1}. Cotton, wherever grown in Pakistan, faces harsh environment (>42°C) during its reproductive phases. Therefore, exogenous application of ascorbic acid at these stages has great potential to improve overall productivity of cotton in the country.

Keywords: Heat stress, Ascorbic acid, Membrane stability

RESPONSE OF PHOSPHATE SOLUBILIZING BACTERIA IN COMBINATION WITH PRESSMUD IMPROVE GROWTH AND YIELD OF WHEAT UNDER ARID CLIMATE

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ABSTRACT

Phosphorus is an important macronutrient for the growth of plants and is often provided to crops through inorganic sources. About 80% of phosphorous cannot be utilized by crops due to immobilization and precipitation. In such situation, phosphate solubilizing bacteria (PSB) may play a key role in improving phosphorus availability to plants by dissolving insoluble and fixed soil phosphorus. Moreover, phosphatase activity of these phosphate solubilizing bacteria could further enhance the phosphorus availability from organic sources, if supplemented with organic amendments. A field experiment was conducted to evaluate the potential of phosphate solubilizing bacteria containing phosphatase activity with and without organic amendment (press-mud) for improving growth and yield of two wheat cultivars (Galaxy-13 & Ujala-2016). Wheat seeds were inoculated with well characterized phosphate solubilizing bacteria strain. The inoculated seeds were sown in sandy soil amended with and without pressmud. Results showed that combined use of phosphate solubilizing bacteria strain and pressmud caused significant increase in yield (38 and 69%), phosphorus content in root (1.3 and 3.3 fold) and in grain (32 and 136%) of wheat as compared to sole use of phosphate solubilizing bacteria strain and pressmud, respectively. This approach could be very effective to enhance the phosphorous availability to plants, plant growth and yield.

Keywords: Phosphate solubilizing bacteria, Pressmud, Phosphorus

EVALUATING THE PRODUCTIVITY AND QUALITY OF VARIOUS SUNFLOWER HYBRIDS BY APPLYING DIFFERENT IRRIGATION SOURCES

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ABSTRACT

Sunflower (*Helianthus annuus* L.*)* is a major oilseed crop grown for its edible oil across the globe including Pakistan. In Pakistan, the production of edible oil is less than the required quantity. The scarcity of water resources is one of major challenges all over the world. The water availability in arid and semi-arid is becoming a main factor to meet the challenges of increasing population. Based on this, a field experiment was conducted to evaluate the achene yield and fatty acid composition of different sunflower hybrids with the application of the various irrigation sources. Field trial was conducted at Agronomic Research Area, Bahauddin Zakariya University, Bahadur Sub-Campus Layyah. Seven sunflower hybrids, *viz.*, E.S.F.H 3391, E.S.I.H 35, S.H.F 80, A.Q.S.H.F 3, FMC1, PARSON and SINJI were sown at different irrigation sources (tube well irrigation, canal irrigation and sewage sludge irrigation). The result showed that hybrid Parson produced highest plant height (186 cm), stem diameter (2.20 cm), head diameter (18.38 cm), 1000-seed weight (89.7 g) and achene yield (2649 kg ha^{-1}) in comparison with other hybrids under this study. Among the irrigation sources, canal irrigation perform best and increase the yield traits and oil content (48.04%) and oleic acid (18.46%). In conclusion, hybrid Parson should be grown to apply canal irrigation water under arid climate of Punjab, Pakistan.

Keywords: Achene yield, Fatty acids, Oil contents, Sunflower hybrids, Irrigation sources

OPTIMIZING ZINC APPLICATION METHOD AND SOURCES FOR IMPROVING PRODUCTIVITY AND GRAIN BIOFORTIFICATION OF MUNG BEAN (*Vigna radiata* L.)

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ABSTRACT

The productivity of mung bean is low in arid and semi-arid soils with little or no application of fertilizers. Majority of mung bean growing regions of Pakistan are low in Zn content. This study was conducted to evaluate the zinc ($ZnSO_4$, Zn EDDHA and $ZnSO_4$ + Zn EDDHA) levels (5, 10, 15 kg Zn/ha respectively) and application methods (basal, foliar, basal + foliar together) of mung bean. The experiment was conducted at Department of Agronomy, Bahauddin Zakariya University Multan, Pakistan during the years 2017. Randomized block design was used for this study with 3 replications. The $ZnSO_4$ with basal application was found most effective for improvement in plant height, number of productive branches, number of leaves, leaf area, fresh weight, dry weight, number of pods per plant, seed yield per plant and 1000-seeds weight than the control.

Keywords: Mung bean, Zinc, Basal application

POTENTIAL OF ZINC SEED TREATMENT IN IMPROVING STAND ESTABLISHMENT, PHENOLOGY, YIELD AND GRAIN BIOFORTIFICATION OF WHEAT

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ABSTRACT

Wheat is chief cereal crop grown for meeting the food requirement of ever increasing masses of Pakistan. One of the major problems that hinder to exploit the potential of wheat yield is unavailability of micronutrients in balanced quantity. Zinc is an essential micronutrient because it is involved in many metabolic processes in plant. A field trail was conducted to exploit the potential of zinc seed treatment in improving stand establishment, phenology, yield and grain biofortification of wheat. The experiment was laid out in randomized complete block design in factorial arrangement with three replications with net plot size of 1.80 m × 4.5 m at Agronomic Research Area, University of Agriculture, Faisalabad. Seeds of two wheat cultivars (Faisalabad-2008 and Lasani-2008) were subjected to soak in aerated Zn solution of 0.1 and 0.01 *M* Zn solution for 12 h (seed priming). For seed coating, Zn was adhered with wheat seeds by using Arabic gum by using zinc sulfate ($ZnSO_4.7H_2O$) as source. Untreated dry seeds were taken as control. Field emergence was improved by Zn seed treatments, maximum number of seedling were observed in seed priming with 0.01 *M* Zn solution. Seed osmoprimed with 0.01 *M* Zn solution improved the grain yield, biological yield and other yield related traits in wheat. Grain and straw Zn enrichment were also enhanced in seed osmoprimed with 0.01 *M* Zn solution. Maximum net returns and benefit cost ratio were observed from seed osmoprimed with 0.01 *M* Zn solution.

Keywords: Zinc, Wheat, Biofortification

EVALUATING THE EFFECT OF BRASSINOLIDE FOR IMPROVING THE PHYSIOLOGY, GROWTH AND YIELD OF AUTUMN MAIZE UNDER TERMINAL DROUGHT

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ABSTRACT

Drought is one of the most wide spread and long lasting abiotic stresses causing yield reductions in semi-arid areas. Therefore the strategies are needed to produce optimum yields in water deficit conditions. Foliar application of growth hormones can be an effective and convenient strategy to cope with drought. The present study was executed to evaluate the protective role of brassinolide against drought imposed at different growth stages in maize. The experiment was undertaken at student's research area, Department of Agronomy, University of Agriculture, Faisalabad. The treatments were laid out in randomized complete block design having split plot arrangement with three replicates. Three irrigations levels ($I_{o=}$Recommended Irrigation, I_2=skip irrigation at silking, I_2=skip irrigation at grain formation) were allocated in main plots as main plot factor while three brassinolide concentrations (C_0= water spray C_1=0.5, C_2= 1, C_3=1.5 mg / L) were placed in subplots as subplot factor. For drought treatments, drought imposed at grain formation resulted in an increase in membrane permeability, leaf temperature while leaf chlorophyll, relative water contents, growth and yield traits showed a decreasing trend as compared to the drought imposed at silking stage. Foliar applied brassinolide helped in improving the plant chlorophyll contents, relative water contents, overall growth and yield attributes at all irrigation skip stages. For interaction, the plants receiving the 1 mg/L brassinolide concentration along with normal or skip irrigation treatments showed improved plant physiological, growth and yield attributes. In conclusion, the brassinolide helps in improving the physiology and productivity of maize hybrid subjected to drought stress at different stages.

Keywords: Drought, Brassinolide, Foliar application, Productivity

ROLE OF PHOSPHATE-SOLUBILIZING MICROORGANISMS IN SUSTAINABLE AGRICULTURE

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ABSTRACT

Compared with the other major nutrients, phosphorus is by far the least mobile and available to plants in most soil conditions. Although phosphorus is abundant in soils in both organic and inorganic forms, it is frequently a major or even the prime limiting factor for plant growth. The bioavailability of soil inorganic phosphorus in the rhizosphere varies considerably with plant species, nutritional status of soil and ambient soil conditions. To circumvent phosphorus deficiency, phosphate-solubilizing microorganisms (PSM) could play an important role in supplying phosphate to plants in a more environmentally-friendly and sustainable manner. The solubilization of phosphatic compounds by naturally abundant PSM is very common under in vitro conditions; the performance of PSM in situ has been contradictory. The variability in the performance has thus greatly hampered the large-scale application of PSM in sustainable agriculture. Numerous reasons have been suggested for this, but none of them have been conclusively investigated. Despite the variations in their performance, PSM are widely applied in agronomic practices in order to increase the productivity of crops while maintaining the health of soils. This review presents the results of studies on the utilization of PSM for direct application in agriculture under a wide range of agro-ecological conditions with a view to fostering sustainable agricultural intensification in developing countries of the tropics and subtropics.

Keywords: AMF, Fungus mycorrhizal, Fungus rock phosphate, Sustainable agriculture, BNF

IMPROVING THE PRODUCTIVITY AND GRAIN BIO-FORTIFICATION OF SPRING MAIZE (*Zea mays* L.) THROUGH ZINC NUTRITION UNDER DROUGHT CONDITIONS IN CHANGING CLIMATE

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ABSTRACT

Malnourishment is an increasing apprehension in the under-developed countries, which bring about miscellaneous health and social problems, such as mental problems, disruption in the immune system and inclusively poor health. Lack of water availability and malnutrition are serious threats to world food security and survival of the living organisms. To address and overcome these issues, a pot experiment was designed to improve the productivity and grain bio-fortification of spring maize (*Zea mays* L.) through zinc nutrition under limited moisture supply. Thirty two pots were placed in rain sheltered net house under the Faisalabad, Punjab, Pakistan climatic conditions during spring 2014. The treatments consist of two drought levels viz., well-watered (70% water holding capacity), and drought stress (35% water holding capacity), two genotypes viz., DK-6525 (Monsanto), and High corn-8288 (ICI), and two levels of zinc treatments (0 and 10 mg kg^{-1} of soil). The results revealed that zinc treated pots with 10 mg kg^{-1} soil had significant ($P<0.05$) results with 18.6 g root fresh weight per plant, 32.5 cm leaf length, 0.83 (-MPa) leaf water potential, and 33.90 mg kg^{-1} grain zinc contents over control. Among the two genotypes, DK-6525 perform better as compared to High corn 8288 under maximum zinc application with respect to morphological and physiological parameters. It was concluded from this study that application of Zn at 10.0 mg kg^{-1} of soil under well-watered conditions improved the growth, productivity and grain zinc contents as compared to moisture stress condition under semiarid climates.

Keywords: Zinc, Nutrition, Growth, Yield, Cultivars

GROWTH AND YIELD RESPONSE OF COTTON CULTIVARS AT DIFFERENT PLANTING DATES

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ABSTRACT

Cotton *(Gossypium hirsutum* L.) is an important fiber crop and is considered the back bone of Pakistan's economy. There are several yield limiting factors which create obstacles to achieve potential seed cotton yield. Among agronomic factors, planting time and cultivar selection are considered as key factors to get optimum seed cotton yield under a particular environmental conditions. For this, a field study was conducted to evaluate the effect of two planting dates viz., 15th May and 15th June and three cotton cultivars viz., FH-114, FH-142 and MNH-886 on seed cotton yield at Sahiwal, Punjab (Pakistan) during 2014. The results indicated that sowing of cotton on 15th May significantly enhanced the seed cotton yield (3631.8 kg ha^{-1}) by 45% over the late planting of cotton on 15th June and also improved the yield components. The cultivar FH-142 performed superior in terms of leaf area index, total dry matter (11018 kg ha^{-1}) and seed cotton yield (3281.0 kg ha^{-1}) as compared to the other cultivars. The different planting dates and cultivars significantly affected the sympodial branches per plant and average boll weight of the cotton crop. In conclusion, the selection of suitable cultivar (FH-142) and early planting of cotton at 15th May increased seed cotton yield under semi-arid conditions of Sahiwal.

Keywords: Seed cotton, Cultivar, Planting date, Semi-arid

ROLE OF IRRIGATION SCHEDULING IN REDUCING AGRICULTURAL WATER USE

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ABSTRACT

In future, irrigated agriculture will face water scarcity. Insufficient water supply for irrigation will be the norm rather than the exception, and irrigation management will shift from emphasizing production per unit area towards maximizing the production per unit of water consumed, the water productivity. To cope with scarce supplies, deficit irrigation, defined as the application of water below full crop-water requirements (evapotranspiration), is an important tool to achieve the goal of reducing irrigation water use. While deficit irrigation is widely practiced over millions of hectares for a number of reasons- from inadequate network design to excessive irrigation expansion relative to catchment supplies- it has not received sufficient attention in research. Its use in reducing water consumption for biomass production, and for irrigation of annual and perennial crops is reviewed here. There is potential for improving water productivity in many field crops and there is sufficient information for defining the best deficit irrigation strategy for many situations. One conclusion is that the level of irrigation supply under deficit irrigation should be relatively high in most cases, one that permits achieving 60–100% of full evapotranspiration. Several cases on the successful use of regulated deficit irrigation (RDI) in fruit trees and vines are reviewed, showing that RDI not only increases water productivity, but also farmers' profits. Research linking the physiological basis of these responses to the design of RDI strategies is likely to have a significant impact in increasing its adoption in water-limited areas.

Keywords: Agriculture, Evapotranspiration, Deficit irrigation, Water productivity

COMBINED APPLICATION OF ZINC AND POTASSIUM MITIGATES THE NEGATIVE CONSEQUENCES OF DROUGHT STRESS IN MAIZE (*Zea mays* L.) UNDER SEMI-ARID ENVIRONMENT

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ABSTRACT

Limited supply of moisture during the critical growth period of maize (*Zea mays* L.) is a serious threat to crop productivity and food security for the world's population. In this scenario, use of inorganic nutrients [potassium (K) and zinc (Zn)] might be useful to mitigate the negative consequences of drought stress. This 2-year field experiment was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad, Punjab, Pakistan. The objective was to identify the best combination of K and Zn to optimize the growth, yield and grain quality of maize hybrids under mild and severe drought stress (DS) conditions. The experiment consisted of three soil moisture regimes viz. 1) well-watered (I_1), 2) mild drought with 25 mm of potential soil moisture deficit (PSMD,I_2), 3) severe drought with 50 mm of PSMD (I_3) and six K, Zn treatments: control, 100 kg ha^{-1} K, 150 kg ha^{-1} K, 12 kg ha^{-1} Zn, 100 kg ha^{-1} K + 12 kg ha^{-1} Zn, and 150 kg ha^{-1} K + 12 kg ha^{-1} Zn. Increase in drought stress negatively influenced the water relations, grain yield, and grain quality of maize. Mild and severe drought stress decreased the yield by 10.8% and 30.9% as compared to that of the well-watered (control) treatment. The interactive effect of (well watered and 150 kg ha^{-1} K + 12 kg ha^{-1} Zn) treatment combination produced the highest yield compared to all other treatment combinations. The maximum average grain yield and protein contents of 8.4 tha^{-1} and 11.6% were obtained under the combined application of (well watered and 150 kg ha^{-1} K + 12 kg ha^{-1} Zn) which was probably because of the synergistic effects of K and Zn in alleviating the negative effects of limited moisture supply. Hence, maize crop growers are recommended to use the potassium at 150 kg ha^{-1} and Zn at 12 kg ha^{-1} to enhance maize production, farmer profit and tolerance against the drought stress in semi-arid conditions.

Keywords: Drought Stress, Potassium, Zinc, Water relations, Grain quality, Yield

EXOGENOUS APPLICATION OF PLANT GROWTH REGULATORS ON THE PERFORMANCE OF CHICKPEA GROWTH AND DEVELOPMENT UNDER RAINFED CONDITIONS

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ABSTRACT

Chickpea cropping areas of Khyber Pakhtunkhwa are less productive as compared to desert areas of other world due to soil type, varieties and dynamic and uncertain climate. Current field study was conducted to investigate the effect of exogenous application of plant growth regulators on the performance of chickpea under rainfed conditions at Research Area of Arid Zone Research Centre, Dera Ismael Khan in Rabi season of 2017-2018. Three plant growth regulators viz. potassium chloride (KCl), tap water and moringa leaf extract (MLE) were applied with different methods viz. seed priming; seed priming +foliar application; and foliar application at tillering stage. Each treatment was replicated thrice and experiment was laid out in randomized complete block design with factorial arrangement. Results of study showed that seed priming with potassium chloride significantly reduced time to start emergence, mean emergence time and time to complete 50% emergence as compared to control. Similarly seed priming with potassium chloride significantly improved vegetative and root extension traits i.e. plant height, leaf length, chlorophyll contents, number of tillers, root length, root area, root diameter, root volume and root length density by 11%, 10%, 16%, 11.6%, 20.56%, 25.89%, 1.11%, 19.32% and 18%, respectively, as compared to control. This benefit was attributed to energetic growth, nodulation and development, more photosynthesis, high reserves of metabolites, more root zone coverage and depth for stand establishment. So, exogenous application of plant growth regulator (KCl) will be a menace to progress the productivity of chickpea in rainfed areas of Pakistan.

Keywords: Chcikpea, Growth regulators, Rainfed areas

IMPACT OF VARIABLE SALINITY LEVELS ON GERMINATION AND GROWTH OF DIFFERENT SORGHUM CULTIVARS

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ABSTRACT

Soil salinity is a major abiotic stress in agricultural crop productivity worldwide. Salt stress has a significant effect on plant growth and development. This study was planned to determine the influence of variable levels of salinity stress on germination and growth attributes of different sorghum cultivars. The experiment comprised of four different levels of salinity stress i.e., T_1= 0 mM NaCl, T_2= 40 mM NaCl, T_3= 80 mM NaCl and T_4=120 mM NaCl and four sorghum cultivars i.e., C_1= YSS-9 C_2= Johar, C_3= Chakwal Sorghum and C_4= YS-2016. The results indicated that salinity stress reduced the germination and growth of sorghum cultivars. Among salinity levels, minimum time to 50% emergence, maximum germination percentage, root and shoot growth were recorded without salinity stress, whereas the maximum time to 50% emergence, lowest germination percentage and substantial reduction in root and shoot growth were recorded with 120 mM NaCl solution. Similarly, cultivar Chakwal Sorghum had maximum germination percentage, root and shoot growth, followed by YSS-9. Conclusively, salinity stress significantly reduced the germination and growth of sorghum cultivars. Moreover cultivar Chakwal Sorghum was characterized as more salt tolerant as compared to the other tested cultivars.

Keywords: Cultivars, Salinity stress, Germination, Growth

POTENTIAL OF SILVER AND ZINC NANOPARTICLES AS FOLIAR NUTRITION TO IMPROVE GROWTH AND YIELD OF PEANUT (*Arachis hypogaea* L.)

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ABSTRACT

Application of nanoparticles on crop plants is a newly evolved technology which received particular consideration with a prospective to gain crop yield. Keeping in view, the importance of this technology, a field study was undertaken during Kharif season, 2017 at Research Farm of College of Agriculture, Bahauddin Zakariya University, Bahadur Sub-Campus Layyah, Pakistan. In this study, the role of foliar application of zinc and silver nanoparticles was investigated on growth, yield and quality of peanut. These nanoparticles were applied in different concentrations individually and also in combination. Three concentrations of silver nanoparticles (10, 20 and 30 ppm) and zinc nanoparticles (2, 4 and 6 ppm) were used and compared with the control treatment (sprayed with distilled water only). Nanoparticles significantly affected all the studied parameters. The treatment where silver and zinc nanoparticles were applied together in 20 ppm + 2 ppm concentration respectively, caused maximum improvement in plant height, branches per plant, nodules per plant, pod yield seed yield and seed protein content. Leaf chlorophyll content was recorded highest under the sole application of 20 ppm silver nanoparticles. The maximum concentrations of both nanoparticles resulted in the suppression of leaf chlorophyll content, biological yield and seed yield. These results can be helpful to maximize the production potential of peanut crop.

Keywords: Nanoparticles, Zinc, Silver, Foliar application, Yield, Peanut

SYNERGISTIC EFFECT OF AMINO ACIDS AND MICRONUTRIENTS SPRAY TO ENHANCE GROWTH AND YIELD OF MUNG BEAN (*Vigna radiata* L.)

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ABSTRACT

Deficiency of macro and micronutrients hampers the production potential of all kinds of crops. Under dose and non-judicious application of nutrients made the situation worst to feed the ever increasing population. In such conditions, the use of macro- and micronutrients along with amino acids can be an effective approach to regain the production potential of a crop. To appraise this approach, this experiment was conducted to enhance the growth and yield of mung bean through foliar application of different quantities of micronutrients and amino acids. The recommended dose of NPK was used in all treatments while the micronutrients and amino acids were applied at recommended rate, ½ of recommended rate and 1.5 of recommended rate separately and also in combinations. Micronutrients and amino acids significantly affected and promoted growth and yield related traits like germination count, chlorophyll contents, number of nodules per plant, number of pods per plant, number of grains per plant, number of branches per plant, grain yield, biomass, plant height and thousand seed weight. The maximum seed yield (3460 kg ha^{-1}) was obtained where recommended dose of NPK was applied along with ½ dose of micronutrients and ½ dose of amino acids. This was comparable with seed yield of 2680 kg ha^{-1} and 2000 kg ha^{-1} obtained under recommended dose of NPK only, and control respectively. These results suggest that, in addition to soil applied NPK, the foliar application of micronutrients and amino acids combination is effective to enhance the production potential of mung bean crop under sandy soils.

Keywords: NPK, Amino acids, Micronutrients, Growth, Seed yield

MITIGATING CLIMATE CHANGE THROUGH CROP PRODUCTION STRATEGIES

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ABSTRACT

Climate change is posing serious threats to crop production. Among the most vulnerable countries to climate change, Pakistan has been ranked eighth. In a recent global greenhouse gas (GHG) emissions study from 2010-2016, Pakistan has been ranked 137th and has contributed only 0.47% of global GHG emissions. Adverse effects of climate change in Pakistan includes extreme temperatures, seasonal droughts, heavy rains, cyclones, devastating floods, unusual fogs, melting of glaciers, glacial lake outburst floods, landslides, avalanches in the mountain areas and threatening inflows into Indus river system. Climate modeling has forecasted declined rainfalls in winters, heavy rainfalls during summers and shrinkage of winter. Climate change can be mitigated through consumption of wood fuel in place of oil, coal and natural gas. Another important factor that can play an important role in mitigation of climate change is provision of alternate source of renewable energy. Biodiesel is carbon neutral as it is made from wood products, hence can be promoted as sustainable fuel. Moreover, building of dams and reservoirs, discouraging the use of fossils, managing extreme weather events, early warning and emergency plans for disaster prone areas might prove useful to reduce the adversities caused by climatic skepticism. Likewise, forest plantation conserves soil and protects it from harmful effects of flooding.

Keywords: Climate change, Crop production, Greenhouse gases, Climate modeling

EFFECT OF SEED INOCULATION, ORGANIC MANURES AND CHEMICAL FERTILIZERS ON QUALITY PARAMETERS OF MUNG BEAN (*Vigna Radiata* L.)

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ABSTRACT

To find out the effect of seed inoculation, organic manure and chemical fertilizers on seed protein contents, N-content of nodules and shoot of mung bean and N-content of soil, investigations were conducted at University of Arid Agriculture, Rawalpindi, Pakistan. The research materials consisted of two mung bean genotypes (NCM-209 and Chakwal-97) with treatments as control, seed inoculation at 10 g kg^{-1}, seed inoculation + 20 tons FYM ha^{-1}, seed inoculation + 20 tons poultry manure ha^{-1} and seed inoculation + 20 kg N ha^{-1} and 60 kg P ha^{-1}. Data were recorded on quality parameters of mung bean (*Vigna radiata* L.) like seed protein content, N-content of nodule, N-content of shoot of mung bean and N-content of soil. It was found that seeds produced in the plots treated with poultry manure and chemical fertilizers along with rhizobial inoculation showed higher protein content than in control and inoculation alone for both the varieties. Similarly, soil N-content at 0-15 and 15-30 cm was increased in all the plots when compared with control, however highest soil N-content was recorded in plots where chemical nitrogen was applied. It was also recorded that both the varieties did not differ for their ability to fix nitrogen. It is concluded that seed inoculation when combined with FYM, poultry manure and chemical fertilizers is a better option than inoculation alone for improving mung bean quality attributes in the area under study.

Keywords: Inoculation, Organic manures, Chemical fertilizers, Nitrogen, Protein, Mung bean

EFFECT OF NUTRITION, PLANTING TECHNIQUES AND EARTHING UP ON LODGING, CANE YIELD AND QUALITY OF SPRING PLANTED SUGARCANE

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ABSTRACT

Lodging of sugarcane badly affects the cane yield and quality. Lodging can be controlled by earthing up, wider row spacing and nutrition management. A field study was conducted during spring season 2016-17 to evaluate the effect of different row spacing, timing of earthing up and nutrition levels on cane yield and quality of sugarcane. Wider row spacing of 120 cm (standard) apart trenches were compared with (standard) and 60 cm apart furrows (conventional farmer practice). No earthing up was compared with earthing up done 90 days after sowing while NPK fertilizer was applied at 100-100-100, 150-100-100, 200-150-150 and 250-150-150 kg ha $^{-1}$. Maximum lodging was observed at narrow row spacing of 60 cm apart furrows. Lodging was reduced when earthing up was done 90 days after sowing but it affected the number of tillers. Incidence of lodging was intensified with the increase in nitrogen rate while lodging was decreased with increase in phosphorous and potash level. Maximum stripped cane yield (125 t ha^{-1}) was produced when earthing up was done 90 days after planting with fertilizer dose of 250-150-150 NPK kg ha^{-1}. Similarly maximum sugar yield (15.20 t ha^{-1}) was obtained when earthing up was done 90 days after planting with fertilizer dose of 250-150-150 NPK kg ha^{-1}. Planting of sugarcane at wider row spacing of 120 cm is most suitable option to control lodging. Earthing up should be done 90 days after planting with fertilizer dose of 200-150-150 NPK kg ha^{-1} to avoid lodging and minimize the cane yield and quality losses.

Keywords: Earthing up, Nutrition, Management, Lodging, Quality, Row spacing

ROLE OF JASMONIC ACID IN IMPROVING TOLERANCE OF RAPESEED (*Brassica napus* L.) TO Cd TOXICITY

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ABSTRACT

The well-known detrimental effects of cadmium (Cd) on plants are chloroplast destruction, photosynthetic pigment inhibition, imbalance of essential plant nutrients, and membrane damage. Jasmonic acid (JA) is an alleviator against different stresses such as salinity and drought. However, the functional attributes of JA in plants such as the interactive effects of JA application and Cd on rapeseed in response to heavy metal stress remain unclear. JA at 50 µmol/L was observed in literature to have senescence effects in plants. In the present study, 25 µmol/L JA is observed to be a "stress ameliorating molecule" by improving the tolerance of rapeseed plants to Cd toxicity. JA reduces the Cd uptake in the leaves, thereby reducing membrane damage and malondialdehyde content and increased the essential nutrient uptake. Furthermore, JA shields the chloroplast against the damaging effects of Cd, thereby increasing gas exchange and photosynthetic pigments. Moreover, JA modulates the antioxidant enzyme activity to strengthen the internal defense system. Our results demonstrate the function of JA in alleviating Cd toxicity and its underlying mechanism. Moreover, JA attenuates the damage of Cd to plants. This study enriches our knowledge regarding the use of JA for protection against Cd stress.

Keywords: Rapeseed, Cadmium, Jasmonic acid, Antioxidant enzyme, Malondialdehyde

CRITICAL ANALYSIS OF TOCOPHEROLS UNDER ABIOTIC STRESSES IN CELL SIGNALING

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ABSTRACT

Tocopherols (Tocs) are vitamin E group of lipophilic antioxidant compounds in chloroplast, exclusively synthesize by oxygenic photosynthetic organisms. Besides their antioxidant roles in photosynthetic organisms, Tocs are also essential components of human diets. In the model species *A. thaliana*, genes encoding the key enzymes of the tocopherol biosynthesis pathway have been identified and functionally characterized. Mutant and transgenic approaches with loss or gain of function of Toc pathway genes in Arabidopsis, Synechocystis sp PCC6803 and other crop species, are beginning to provide insight into tocopherol functions in photosynthetic organisms. From genetic approaches, it has been revealed that Toc function is beyond antioxidant activities, as in some cases it play role in cell signaling as well. Toc shows fluctuation in their quantity under different abiotic stresses, suggesting its critical role as antioxidant and as an indicator of stress tolerance in plants. Although, there is a growing body of knowledge about the individual enzymes required for Toc biosynthesis in plants, especially in Arabidopsis, the underlying mechanisms that regulate the entire pathway and fluctuation in Toc content and composition during plant development or during stress conditions remain poorly understood. During stress, Toc show alterations in its content and composition, therefore, understanding the induction of tocopherol biosynthesis during stress will be useful for developing strategies to engineer crops with enhanced tocopherol levels. So, the main aim of this study is to reveal the responses of important Toc enzymes under abiotic stresses in order to advance our genetic approaches and tools to unravel the functional mystery of Toc in plants. In addition, the role of Tocs in cell signaling will also be described in detailed.

Keywords: Tocopherol, Antioxidant, Abiotic stress, Arabidopsis, Cell signaling

EXOGENOUS APPLICATION OF NITROGEN AND POTASSIUM IN COMBINATION WITH MAGNESIUM TO IMPROVE COTTON GROWTH, YIELD AND QUALITY ASPECTS UNDER WATER DEFICIT CONDITIONS

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ABSTRACT

The quality of cotton crop and its modulation by fertilization has received attention in today agriculture. However, the importance of N, K and Mg as essential plant nutrients is now well established. These nutrients also improve the quality of cotton but little information is available if they applied in combination as foliar spray under environmental stress like drought. A two year field trial was conducted to evaluate the role of combined supplemental foliar spray of N, K and Mg on growth, yield and quality aspects of cotton under limited water supply. Water stress significantly decreased the growth, yield and quality characters of cotton. However, foliar application of N, K and Mg improved the number of bolls per plant, number of bolls per plant under both normal and water deficit conditions. Leaf area index was also been improved by foliar application of nutrients under both water levels. Whereas, boll weight and yield of cotton plants were severely affected by water deficit conditions, but foliar application of nutrients improved the boll weight and yield of cotton plants under limited water supply as compared to control. Water use efficiency, micronaire and fiber strength were significantly improved by foliar spray of N, K and Mg under normal irrigation and water deficit condition. Moreover, staple length, uniformity index and chlorophyll contents were not significantly affected by foliar nutrition under different water levels.

Keywords: Magnesium, Cotton, Chlorophyll, Micronaire, Fiber strength

BIOCHAR (SOIL CONDITIONER) IMPROVES WHEAT YIELD UNDER WATER-DEFICIT CONDITION DUE TO ENHANCED GAS EXCHANGE PARAMETERS AND BETTER ANTIOXIDANT DEFENSE SYSTEM

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ABSTRACT

Under soil water-deficit conditions, the production of toxic reactive oxygen species (ROS) at cellular levels adversely affect plant growth, development and ultimately final yield. There is a dire need to explore the environmental friendly and cost-effective approach for maximization of wheat yield under water-deficit conditions. Now-a-days, Biochar (BC), a soil amendment, is considered as a newly emerging tool to detoxify adverse effects of ROS in plants and to conserve moisture. Therefore, a trial was conducted at Experimental Research Area, Department of Agronomy Bahauddin Zakariya University Multan, Pakistan during winter season of 2015-2016 and repeated next year (2016-2017). The experiment was two-factorial in a randomized complete block design. The factors studied were biochar (cotton sticks @ 4 t ha^{-1}) application to soil and control (without biochar application), and irrigation water-regimes at critical growth stages i.e. tillering (T), booting (B), heading (H) and milking (M) containing treatments $I_{(T+B+H+M)}$, $I_{(T+B+H)}$, $I_{(T+B)}$ and $I_{(T+M)}$ while wheat was used as a test specie. The result depicted that the maximum grain yield was observed by applied treatment of BC with water-regimes at $I_{(T+B+H+M)}$. BC application to soil triggered plant antioxidant defense system and improved performance of gas exchange parameters under limited irrigation-regimes. BC application to soil under irrigation water-regimes at $I_{(T+B)}$ also resulted in greater benefit cost ratio (BCR) as compared to other treatments. The findings of this research suggest the farming as well as scientific community to adopt practices of application to soil for wheat production under water deficit condition of filed.

Keywords: Wheat, Biochar, Irrigation Water-regimes, Antioxidants, Gas exchange

THE INTERACTIVE BEHAVIOR OF PLANT GROWTH REGULATORS AND NPK ON GROWTH YIELD AND QUALITY OF Bt COTTON

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ABSTRACT

Cotton (*Gossypium hirsutum* L.) is a cash crop but to prove it, utilization of several natural and synthetic sources should be done wisely. It is known as world best trading crop because it play significant role in uplifting of country`s economy. More than fifty countries of the world are growing cotton in tropical areas. In Pakistan, cotton gained importance due to its heavy contribution in GDP and agriculture sector. Cotton yield reduction in Pakistan is due to many problems of which imbalance nutrition and agronomic practices cause major reduction if not managed properly. In Pakistan, the trend of PGR's application is very rare and these sort of studies could improve the focus of farmers towards it. A field study was conducted at Bahauddin Zakariya University Multan, Pakistan during 2017 to evaluate the efficacy of various plant growth regulators (PGRs) like naphthalene acetic acid **(**NA) and gibberellic acid (GA) on yield of Bt cotton (FH-142). The experiment was laid out in randomized complete block design with split plot arrangement each with three replications. Main plots treatments were four nutrition level (control, NPK at 150-100-50 kg ha^{-1}, NPK at 100-50-50 kg ha^{-1}, NPK at 50:50:50 kg ha^{-1}) while PGRs were applied in sub-plots (control, gibberellic acid at 25 g ha^{-1} and naphthalene acetic acid at 60ml ha^{-1}. Purpose of these PGR's was to check their effects on cotton crop, individually as well as by their interaction with NPK. Result indicated that plant growth regulators were physiological enhancers of cotton plants that ultimately increased mass as well as quality. Yield parameters like boll weight, plant height, seed cotton yield, fibre length and fibre fineness recorded significant results. From this study, it was confirmed that the interaction of NPK and PGR's boosted cotton yield and enhanced its quality.

Keywords: Cotton, Growth regulators, NPK

EFFECT OF THIOUREA IN IMPROVING PERFORMANCE OF MUNG BEAN UNDER SEWAGE WATER IRRIGATION

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ABSTRACT

Field trials on two different locations were conducted to study the response of different irrigation water sources viz., tube well (TW), tube well + sewage (TW + SW) and sewage (SW)) and exogenously applied growth regulators viz., distill water (DW), moringa leaf extract (MLE at 1:30) and thiourea (TU @ 1000 ppm) before and after flowering, on mung bean during the spring season, 2016. Study shows that, irrigation of TW + SW along with MLE spray improved the plant growth characters like number of branches, leaves, plant height, and number of pods. However, pods weight with grains, 1000 grains weight, economic and biological yield and harvest index were found maximum for TW + SW plots receiving foliar spray of TU. Leaf chlorophyll 'a' and 'b' contents were higher for mixed water treatment (TW + SW) along with foliar spray of MLE, while protein contents and antioxidants (SOD, POD and Catalase) activity were found maximum under same water treatment, but with exogenously applied TU spray both before and after flowering. For higher yields under semi–arid conditions, TW + SW irrigation, with before and after flowering foliar spray of Thiourea were found more effective.

Keywords: Mung bean, Sewage water, MLE, Protein, Antioxidants

EFFECT OF DEFICIT IRRIGATION AND MULCHING ON MAIZE YIELD, WATER USE EFFICIENCY AND CARBON SEQUESTRATION UNDER SEMI-ARID CLIMATE

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ABSTRACT

Pakistan is one of the highly affected countries by climate change. It has been indexed at the 12th place in the Global Climate Risk Index in terms of exposure to various extreme climate events over the period of 1993 to 2012. Soil moisture limits plant productivity in many areas of the world. The climate change along with urbanization have resulted in increased atmospheric concentrations of greenhouse gases like CO_2. Mulching is a viable option to enhance soil carbon by improving soil properties and water storage. Keeping in view, a field experiment was conducted to check the effect of deficit irrigation and mulching on carbon storage and water use efficiency (WUE). There were three irrigation levels i.e., I_1= eight irrigations (Max. irrigation), I_2= six irrigations (optimum irrigation) and I_3= four irrigations (Deficit irrigation). Wheat and maize straw was used as mulching material at rate 4 Mg ha^{-1}. In control, no mulch was applied. Water was applied at fixed rate. The effect of irrigations on straw and maize yield was significant. Results from ANOVA indicated statistically significant effect of irrigation and mulching on water use efficiency and evapotranspiration. The deficit irrigation (four irrigations) resulted in 25% increase in maize yield and 30% increase in WUE where wheat straw was applied as compared to control. Severe reduction in organic carbon was recorded in deficit irrigation (four irrigations). The maximum WUE was achieved with optimum irrigation (6 irrigations) that was 45% more as compared to DI. It was concluded from study that mulching alleviated the effect of deficit irrigation and significantly increased the carbon contents in soil profile.

Keywords: Maize, Water use, Mulching, Water deficit

ALTERATIONS IN BIOMASS PRODUCTION AND CHEMICAL COMPOSITION OF SORGHUM CULTIVARS GROWN FOR BIO-ENERGY PRODUCTION

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ABSTRACT

Biomass is a promising renewable energy source whose importance is increasing day by day in the context of climate change and depletion of fossil foils. A field study comprising four sorghum, cultivar i.e. YSS-9, Johar, Chakwal sorghum, and YS-2016, was conducted in 2017 to determine the best cultivar in terms of biomass production, quality and methane yield. The results indicated that all the cultivars had differential response in terms of biomass yield, chemical composition and methane yield. Cultivar Chakwal sorghum, produced maximum leaf area index, leaf area duration, crop growth rate, plant height, leaves per plant, and dry matter yield whilst cultivar YSS-9 performed poorly amongst the tested cultivars. Moreover, the maximum protein, neutral detergent fibers, and lignin contents were found in Chakwal sorghum that were comparable with those in Johar, while the lowest neutral detergent fiber and lignin contents were found in YSS-9. Cultivar YYS-9 produced the highest specific methane yield per kilogram of volatile solids, conversely, Chakwal sorghum produced maximum methane yield per hectare owing to higher dry matter yield per hectare. In conclusion, Chakwal sorghum can be grown successfully in semi-arid areas of Pakistan in order to get good biomass yield along with higher methane yield.

Keywords: Cultivars, Biomass yield, Chemical composition, Methane yield

EXOGENOUS APPLICATION OF SILVER NANO PARTICLES AND UREA IMPROVE GROWTH, YIELD AND MORPHO-PHYSIOLOGICAL DROUGHT ADOPTED TRAITS OF RAINFED CHICKPEA

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ABSTRACT

The contemporary challenges of sustainability, climate change and food security necessitates exploitation of new technologies for the agricultural sector. Nanoparticles (NPs) have potential to improve growth and yield of crops and judicious use of nanotechnology can transform rainfed agriculture into sustained food security. Present study was therefore conducted to look into possible role of foliar applied silver nanoparticles with urea on morpho-physiological, yield and yield attributes of rainfed chick pea. Three applications of various combinations of Ag-NPs and urea were exogenously applied during various growth stages of crop and data on morpho-physiological drought indices was recorded at full bloom stage, while yield parameters were recorded at maturity. Foliar application of silver nanoparticles alone or blended with urea significantly improved the morpho-physiological drought tolerance indices, yield and yield contributing parameters of rainfed chickpea compared with control/water spray. Exogenous application of 20 ppm AgNPs with 2% urea resulted in maximum number of pods per plant, seeds per pod, biological yield, seed yield, leaf area per leaf, relative water contents, potassium contents. Whereas, 10 ppm AgNPs with 2% urea resulted in maximum chlorophyll contents. Contrary, Use of 20 ppm AgNPs as sole application gave maximum 1000-seed weight, harvest index, chlorophyll stability index and leaf membrane stability index. However, treatments comprising higher concentration of AgNP (30 ppm) imparted negative effects on studied traits. It is inferred that silver nanoparticles had potential to improve growth and yield of rainfed chickpea with altered morpho-physiological responses. Nonetheless, further comprehensive experimentations are required to establish most appropriate concentrations of AgNPs with urea and their potential impact on environment.

Keywords: Nanotechnology, Silver nano particles, Chickpea, Physiological responses

COMPARISON OF WHEAT CULTIVARS (OLD AND NEW) UNDER AGRO CLIMATE OF DERA ISMAIL KHAN

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ABSTRACT

Every cultivar of wheat has its own production climate. An experiment was carried out in which different cultivars (old and new) were selected to grow under the agro climatic conditions of Dera Ismail khan. The study was laid out in randomized complete block design with three replications. There were 9 varieties under study which were Ujala-16, Millet-11, Dharabi-11, Galexy-13, Barani 70, Maxi Pak, Sonilika, Bahawalpur-79 and Blue silver. The data was collected on plant height, number of tillers per plant, number of spikelet per spike, spike length, grain weight per spike, grain weight per plant, number of grains per spike, 1000-grain weight, and grain yield, and analyzed statistically. Maximum plant height was shown by cultivar Bahawalpur-79 and it gained early maturity. Galexy-13 performed well regarding yield (5227.35 kg ha^{-1}) and yield attributes under agro climatic conditions of Dera Ismail Khan. Results also showed that the three latest cultivars have maximum yield potential than the old cultivars which showed minimum yield and yield attributes. These cultivars have a descending order of decreasing yield and yield attributes as Galexy-13 > Ujala-16 > Millet-11 > Blue Silver > Dharabi-11 > Bahawalpur > Maxi Pak > Barani-70 > Sonilika. Therefore, Galexy-13 and Ujala-16 is recommended for the agro-climate of Dera Ismail Khan to obtain maximum production of Wheat crop.

Keyword: Wheat cultivars, Yield components, Grain yield

QUALITY AND YIELD OF MAIZE (*Zea mays* L.) AS INFLUENCED BY APPLICATION OF ZINC AND FARM YARD MANURE

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ABSTRACT

Food security for increasing population is greatest challenge of current era in developing countries. Different options include increase crop production per unit area or increase in cultivable area. Later is not viable in most of cases. With only one option left, use of different strategies including balanced nutrition of crop is very useful strategy for enhancing yield per unit area of crops. Macronutrients are very essential component of crop nutrition but deficient micronutrients and organic manures are required for balanced nutrition. Some of micronutrients including zinc are deficient in majority of soils. Keeping in view the importance, present experiment was carried out to study the different levels of zinc with and without FYM in order to determine their role to improve the yield and yield components of maize. Experiment was performed at research area of University College of Agriculture, University of Sargodha. The trial was laid out in randomized complete block design with three replications. The experiment comprised of treatments viz., zinc and farm yard manure, alone and in combination. The results showed that maximum biological, grain yield and harvest index were recorded with the application of farm yard manure at 10 ton ha^{-1} + Zn at 2 kg ha^{-1}. Quality attributes of maize including crude protein, crude fat and crude fiber contents were also improved by same treatment. The study concludes that farm yard manure at 10 ton ha^{-1} + Zn at 2 kg ha^{-1} can be more effective treatment among all other treatments for improving zinc uptake as well as quality and yield traits of maize.

Keyword: Maize, Zinc, Farm yard manure, Grain quality

FOLIAR APPLICATION OF GROWTH PROMOTING SUBSTANCES STRONGLY INFLUENCE THE GROWTH AND YIELD OF HYBRID MAIZE

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ABSTRACT

Plant growth promoting substances (PGPS) are being widely used in crop production to increase productivity and to overcome harmful effects caused by environmental stresses. This study was conducted to determine the impact of various PGPS o the growth and yield of hybrid maize crop. The study was comprised of various PGPS i.e. kinetin (30 ppm), humic acid (2%), moringa leaves extract (2%), salicylic acid (2%), ascorbic acid (2%), and water spray and they were applied as foliar spray at 6 and 8 leaves stages. The results indicated that foliage feeding of kinetin, humic acid, MLE, ascorbic acid and salicylic acid appreciably improved the growth and yield attributes of hybrid maize as compared to control. Maximum leaf area index, crop growth rate and leaves per plant, grains per cob, 1000-grain weight, biological yield, and grain yield were recorded with the application of 2% ascorbic acid. Moreover, the highest value of chlorophyll (a, b) and total phenolic contents were recorded with kinetin (30 ppm). In conclusion all tested PGPS were variable in their effect, however, they improved the plant performance and may be applied to improve growth and yield of maize.

Keywords: Maize, Growth promoting substances, Growth, Yield

THE PHYSIOLOGICAL EVALUATION OF PRIMED MAIZE SEEDS UNDER LATE SOWING CONDITION

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ABSTRACT

Reduction and delay in germination of late sown maize is the major problem due to the high soil temperature and low water potentials. Therefore the purpose of this study was to evaluate the prime maize seeds under late sowing condition. A field experiment was laid out in randomized complete block (split plot) with three replications using FH-810 hybrid maize cultivar. Two different sowing dates were kept in main plot and priming techniques in sub plot. Under two sowing dates, the maize performance was analyzed through priming the seeds viz., hydropriming, osmopriming with $CaCl_2$, priming with moringa leaf extract (1:30) and osmopriming with salicylic acid; dry weeds taken as control. The collected data was analyzed by using Fisher analysis of variance technique and significant treatment means were compared using least significance difference test at 5% probability level. Results revealed that osmopriming with $CaCl_2$ reduced time to 50% emergence and mean emergence, improved emergence index, enhanced number of grains per cob, number of grains per row, number of rows per cob, grain yield, leaf area index, crop growth rate, as well as protein percentage while osmopriming with moringa leaf extract improved the total dry matter, leaf area duration, net assimilation rate, economic yield, harvesting index, chlorophyll a, and b contents. Other priming treatments were not much effective as compared to moringa leaf extract and $CaCl_2$. The present study suggests that seed priming with MLE and $CaCl_2$ are effective not only to improve seedling establishment but also the performance of maize under both optimal and late sown conditions.

Keywords: Physiological evaluation, Late sowing condition, Maize seed

EXPLOITING GREEN MANURING AS TOOL FOR SUSTAINABLE MAIZE (*Zea mays* L.) PRODUCTION

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ABSTRACT

Degradation of soil fertility and low soil organic matter are considerable reasons of low soil fertility and less productivity of maize in Pakistan. Nitrogen use efficiency and nutrient availability can be enhanced by adding organic matter in soil through organic (green manuring) amendments. So, keep in view this fact, a field experiment was conducted to check the effect of green manuring with inorganic fertilizers on the performance of autumn maize (*Zea mays* L.) by reducing recommended dose of NPK up to 50%. Experiment was conducted at Agronomic research area, University of Agriculture, Faisalabad during the autumn season 2014. Randomized complete block design with three replications, was used to conduct the experiment. Plot size was 6 m × 4.5 m with row to row distance of 75 cm. Seven different crops viz., cowpea, mung bean, green gram, mashbean, cluster bean, soyabean, jantar were used as a source of green manure in combination with 50% NPK. Standard procedures for recording parameters related to yield and quality of maize were followed. Application of organic amendments increased the maize crop yield. Maximum plant height at maturity (227 cm), cob length (21.67 cm), number of grain rows per cob (16.26), number of grains per cob (438), 1000 grain weight (300.3 g), biological yield (19.39 t ha^{-1}), grain yield (7.57 t ha^{-1}) and grain protein contents (9.95%) were recorded in T_{10} (jantar + 50% NPK of recommended dose). So, it is concluded that green manuring of jantar with inorganic fertilizers would be efficient management strategy for farming community in order to enhance maize production on sustainable basis.

Keywords: Green manuring, Sustainable maize, Inorganic fertilizers

INVESTIGATING THE EFFICIENCY OF Bt COTTON AS INFLUENCED BY VARIOUS PLANTING DATES AND PLANT GEOMETRY

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ABSTRACT

Cotton is known as major cash crop of Pakistan. It production is affected by various environmental factors throughout the country which reduce its production. A field study was conducted at Bahauddin Zakariya University, Multan, Pakistan during 2017 to evaluate the effect of four sowing dates on seed cotton yield and fiber quality at four different plant populations. The experiment was laid out in randomized complete block design (RCBD) with split plot arrangement, each with three replications. Main plots treatments were four sowing dates (15-April, 1-May, 15-May, and 1-June) while sub-plot treatments were four different spacing (24, 18, 12 and 6 inches). Results indicated that early sowing of cotton showed better vegetative and reproductive growth than late sowing. Results also revealed that 6-inch plant spacing provided best sympodial branches, boll weight, plant height, plant population, seed cotton yield, fiber length and fiber fineness when sown on 15-April. 1-May was next suitable sowing date after 15-April which produced higher quality traits and yield at 6-inch plant spacing. Early or late sowing than 15-April of cotton led towards lower cotton yield and quality due to unfavourable environmental conditions and short growth duration respectively. It is concluded that 15-April sowing at 6-inch plant spacing proved best for growing FH-Noor Bt variety at Multan, Pakistan.

Keywords: Cotton, Sowing date, Plant population

PRETREATMENT TACTICS TO INSTIGATE BIOETHANOL SYNTHESIS FROM WHEAT STRAW

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ABSTRACT

Voidance of lignin and hemicelluloses, modifications in crystalline structure and improvements in porosity of lignocelluloses of wheat straws are prime constraints to develop an economically worthwhile bioethanol production system. These complications can be diminished by following numerous pretreatments strategies to upregulate bioethanol synthesis form wheat straws. These pretreatments enhance cell wall vulnerability, surface area and porosity for enzymatic degradations while disrupt the crystalline structure of lignocelluloses. Chipping of wheat straws usually enhances release of sucrose and xylose from wheat straw and surface area for enzymatic actions and thus escalates degradability. Exposure of wheat straws to gamma radiations upregulates activities of endoglucanases and expansins in cell wall which ultimately exposes cell wall for attack of hydrolases. Exposure of chopped wheat straws to concentrated or even diluted sulfuric, fumaric and maleic acids accelerates synthesis of fermentable sugars, glucose and other monosaccharides from hemicellulosic straws. Oxides and hydroxides of ammonia, sodium, calcium and potassium boost the recovery of fermentable sugars from wheat straws**.** Heating of straws at temperature of 70°C and high pressure with ammonia followed by sudden drop of pressure enhances the release monosaccharides and reduce the damage to fermentable monosaccharides. Treating of straws with ozone at room temperature breaks lignin and cellulose and thus triggers degradation. Pretreatment with water and oxygen at 120°C temperature and 30 bars pressure degrade more than 90% of cellulose and releases carbon dioxide, carboxylic acid and phenolics. Treating with white rot, brown rot, soft rot, *Aspergillus niger* and *Aspergillus awamori* also boost the release of soluble sugars such as glucose, fructose, mannose, raffinose etc. Treatment of wheat straws with steam at temperature 180-210 °C disintegrates cellulose and hemicellulose crystalline structure and leads to synthesis of new bonds which eventually decrease shear strength of straws during degradation process. Treatment of straws with organic solvents such as acetone, ethanol, methanol and acetic acid using an alkaline or acidic catalyst at high temperature of 120-150°C also favor degradation of wheat straws. Conclusively, different pretreatments increase the yield and efficacy of release of monosaccharides that lead to the improved ethanol biosynthesis from complex lignocellulosic wheat straws.

Keywords: Biofuel, Decomposition, Residue management, Sustainability, Wheat

INFLUENCE OF TILLAGE AND NITROGEN FERTILIZATION ON WHEAT IN RICE-WHEAT SYSTEM

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ABSTRACT

In a rice-wheat cropping system, rice stubbles remaining in the field often delay early planting of winter wheat to utilize residual soil moisture and reduce production costs by using no tillage. A randomized complete block design in a split plot arrangement was conducted with four seasonal tillage methods [conventional tillage, CT; deep tillage, DT; zero tillage with zone disk tiller, ZDT; and happy seeder, HS] as main plots and five N levels [0, 75, 100, 125, and 150 kg ha^{-1}] as subplots during 2012 to 2013 and 2013 to 2014 growing seasons. Results showed that DT significantly decreased soil bulk density, penetration resistance, and volumetric moisture content than CT, ZDT, and HS. Wheat growth and yield parameters such as fertile tillers, plant height, root length, spike length, yields, and nutrient-use efficiency were significantly higher in DT compared with other tillage treatments. Wheat growth and yields were more increased by N fertilization at 125 kg ha^{-1} than other N rates. However, when the wheat plant productivity index was plotted over N rates, the non-linear relationship showed that N fertilization at 80 kg N ha^{-1} accounted for 85% of the variability in the plant productivity under DT and HS while ZDT will have the same productivity at 120 kg N ha^{-1}.

Keywords: Rice-wheat cropping system, Tillage methods, Nitrogen, Wheat productivity

NOVEL BIO-NANO FERTILIZERS FOR STRESS AMELIORATION AND BIO FORTIFICATION OF CROPS

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ABSTRACT

Nanotechnology can play an important role for sustainable development of modern agriculture. Pakistan has an alarmingly high level of malnutrition; 24% of the population is undernourished. The most recent estimates by the United Nations Food and Agriculture Organization (FAO) state that 37.5 million people in Pakistan are not receiving proper nourishment. Nanotechnology is a novel and innovative science that attracts researchers and scientists from different disciplines, including physicists, chemists, engineers, and biologists across the globe. Owing to its high surface area to volume size ratio, it exhibit significantly novel and improved physical, chemical, and biological properties, phenomena, and functions. Nano-fertilizer has not only potential to enhance nutrient use efficiency but also help in the reduction of the issue of fixation of micronutrients in case of commercially available sources. Effects of nano-fertilizers on plants have been reported in different studies. But a little has been addressed on the aspect of fortification of essential micronutrients (iron and zinc) and salt stress amelioration in staple crops. Various experiments conducted in controlled and natural conditions revealed that nutrient use efficiency and micronutrient fortification by nano-fertilizers is more efficient and cost effective as compared to traditional fertilizers. Also experiments were conducted to assess the effect of silicon nanoparticles on stress amelioration of rice. Preliminary results showed significant effect of nano-fertilizers on fortification of rice and maize as well as stress amelioration. In future agriculture, use of nano-fertilizers can be used as a sustainable option to ensure not only food security but also nutrient security.

Keywords: Nanotechnology, Biofortification, Stress amelioration, Food security

SEEDLING GROWTH AND NUTRIENT UPTAKE CAN BE IMPROVED BY SEED PRIMING TECHNIQUES IN MUNG BEAN (*Vigna radiata* L.)

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ABSTRACT

A chain of greenhouse and field trail was carried out at Agronomic Research Area, University of Agriculture, Faisalabad to study the response of mung bean crop to the diluted solutions of phosphorus (P) on seedling and nutrient uptake. Mung bean seed cv. NM-92 were soaked in P solutions 0.01% and 0.02% and also primed for four hours in water along with non-treated seed (control). The seed which was primed, was wash with distilled water to remove the adhering nutrient to seed and then was air dried. The aggregate of nutrient intro-greased into seed or adhered onto the seed coat was measured. Phosphorus was intro-greased in high amount in primed seed with 0.02% phosphorus solution, followed by seed primed in 0.01% p solution as compared to water soaked and dries seeds both in surface wash and non-washed seed. Similarly, seed that was primed with phosphorus solution have considerably improved seedling P concentration and uptake at 14 and 21 days after sowing as compared to control. Likewise priming of seed with the solution of P significantly increased fresh weight, dry weight and plant height of mung bean seedling after 21 days of sowing in field experiment.

Keywords: Nutrient uptake, Seed priming, Seedling growth, Mung bean

FOLIAR APPLIED SILICON IMPROVE THE GROWTH, BOLL RETENTION, LINT YIELD AND QUALITY OF COTTON

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ABSTRACT

Cotton is the most important fiber crop of Pakistan. Cotton growers have serious concerns on premature shedding of flowers, squares and bolls. Cotton square and boll shedding (or retention) has received much attention and generated much controversy, as lost squares and bolls results in decreased yield. Therefore, a field study was conducted to determine the effects of silicon (Si) application (0, 50, 100, 150, and 200 mg L^{-1}) on the growth, boll retention, yield and quality of cotton genotypes (Lalazar-14 and MNH-786) at Agronomic Research Area, BZU, Bahadur Sub Campus Layyah during kharif season 2017. Foliar application of Si was applied at vegetative [50 days after sowing (DAS)], and flowering (75 DAS). Experiment was layout in randomized complete block design with factorial arrangement. Results showed that the crop growth rate (5.27 g m^{-2} day^{-1}), leaf area index (4.82), and leaf area duration (292 days) were significantly higher in genotype Lalazar-2014 with Si application (150 mg L^{-1}). Similar trend was observed in yield related attributes in Lalazar-2014 with application of Si at the rate of 150 mg L^{-1} which produced more bolls (38 bolls per plant), boll retention (26.38%) and high seed cotton yield (2261 kg ha^{-1}). Moreover, 150 mg L^{-1} Si resulted in improvement of ginning outturn (8.2%), staple length (7.31%) and micronaire (27.8%). Cotton genotype Lalazar-2014 performed better as compared to MNH-786 at 150 mg L^{-1} of Si application. It is concluded that foliage applied 150 mg L^{-1} Si significantly improved the growth, boll retention, yield and quality of cotton.

Keywords: Boll shedding, Silicon, Seed cotton, Monopodial and sympodial branches

EFFECT OF EXOGENOUS APPLICATION OF PLANT GROWTH REGULATORS ON THE PERFORMANCE OF STRESS WHEAT (*Triticum aestivum* L.)

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ABSTRACT

Wheat cropping areas of Khyber Pakhtunkhwa are less productive due to dynamic and uncertain climate. Current field study was conducted to investigate the effect of exogenous application of plant growth regulators on the performance of wheat at Research Area of Arid Zone Research Centre, Dera Ismael Khan in Rabi season 2016-2017. Three plant growth regulators viz. potassium chloride (KCl), tap water and moringa leaf extract (MLE) were applied with different methods viz. seed priming; seed priming +foliar application; and foliar application at tillering stage. Each treatment was replicated thrice and experiment was laid out in randomized complete block design with factorial arrangement. Results of study showed that seed priming with potassium chloride significantly reduced time to start emergence, mean emergence time and time to complete 50% emergence as compared to control. Similarly seed priming with potassium chloride significantly improved vegetative and root extension traits i.e. plant height, leaf length, chlorophyll contents, number of tillers, root length, root area, root diameter, root volume and root length density by 19, 12, 14, 13.4, 17.83, 23.45, 2.19, 22.41 and 21%, respectively, as compared to control. This benefit was attributed to energetic growth and development, more photosynthesis, high buildup of metabolites, more root zone coverage for stand establishment. So, exogenous application of plant growth regulator (KCl) will be a menace to improve the productivity of wheat in Pakistan.

Keywords: Wheat, Abiotic stress, Plant growth regulators

EXOGENOUS APPLICATION OF MANNITOL ON CHICKPEA UNDER DIFFERENT IRRIGATION REGIMES

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ABSTRACT

Chickpea (*Cicer arietinum* L.) is an important grain legume after dry bean and peas and plays a vital role in the agriculture of arid areas. The major bottlenecks limiting its productivity and causing wide yield gap include biotic and abiotic stresses. Drought is the major abiotic stress which limits crop production. Keeping in view the low productivity of chickpea in Bhakkar, an experiment was conducted at the research area of Arid Zone Research Institute, Bhakkar during 2016-17 to investigate the effect of exogenous application of mannitol on yield and yield components of chickpea under different irrigation regimes. The experiment was laid out in randomized complete block design with a split plot arrangements of treatments with three replications. Each main plot (18 m²) was split up into three subplots (6 m²). An approved variety Bhakkar-2011 was used in plots. Supplemental irrigation at four levels i.e. 0, 2, 3, 4 irrigations were allocated to the main plot. Similarly, mannitol was spayed exogenously at four levels i.e., 0, 2, 3, 4% to the sub plot. Data were recorded on various growth and yield parameters. While the data were also recorded regarding the activities of antioxidant enzymes [ascorbate peroxidase (APX), peroxidase (POD), super oxide dismutase (SOD) and catalase (CAT)] to eliminate ROS produced by drought stress by foliar application of different concentrations of mannitol. Plants respond and adapt to drought stress by various physiological and biochemical changes. Drought generates oxidative stress in which reactive oxygen species are produced which can damage structures of proteins, DNA, and lipid membranes. Analysis of the data regarding the activities of antioxidants enzymes (SOD, POD, CAT, and APX) was statistically significant. Results showed that the treatment combination irrigated two times with 4% foliar application of mannitol at flowering stage surpassed all the treatments included in the experiment, giving the grain yield of 3977(kg ha^{-1}) followed by 3586 and 3157 (kg ha^{-1}) with 3% and 2% foliar application of mannitol and two irrigation, respectively.

Keywords: Chickpea, Water levels, Mannitol, Growth

FULVIC ACID HELPS TO IMPROVE THE PERFORMANCE OF WHEAT UNDER NORMAL AND HEAT STRESS CONDITIONS

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ABSTRACT

Terminal heat stress causes a significant decline in yield of wheat by affecting its different phases such as booting, fertilization, grain filling rate and grain filling. As an active biostimulant, fulvic acid can be used to ameliorate heat stress impacts in plants. To explore the effect of foliar applied fulvic acid, a field experiment was carried out at agronomic research area, University of Agriculture Faisalabad during Rabi 2016-17. Randomized complete block design with split plot arrangement having three replications and a net plot size of 3.0 m × 0.9 m was applied. In this experiment, main plot treatments were comprised of heat stress (no heat, heat at booting stage and heat at grain initiation stage) and sub-plot treatments included foliar spray of fulvic acid at varying levels (0, 1.25, 2.50 and 3.75 mg L^{-1}). The data were recorded according to standard procedures regarding water relations, crop growth and agronomic traits related to yield. These data were analyzed by using Fisher's analysis of variance technique to determine its variability and difference in treatments' means was compared by Tukey's HSD test at 5% probability level. Fulvic acid significantly increased superoxide dismutase, peroxidase and catalase activities, chlorophyll contents, water status of flag leaf and yield related attributes of wheat during normal and heat stress conditions. It is concluded that fulvic acid can be applied to improve crop growth and yield under normal and heat stress conditions.

Keywords: Wheat, Heat stress, Fulvic acid

ROLE OF INTEGRATED NUTRIENT MANAGEMENT IN SUSTAINABLE AGRICULTURE

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ABSTRACT

To meet the ever-increasing demand for food of the huge population of the Pakistan, and to exploit the high yield potential of cereals, it requires higher fertilizer doses, which are a non-renewable source of energy. The long-term fertilizer experiments have revealed that continuous application of suboptimal doses of chemical fertilizers to soil has resulted in the deterioration of soil health, environmental pollution and stagnation or decrease in crop productivity. Thus, integrated use of organic manures like farmyard manure, compost, green manures, crop residues, vermicomposting, bio-fertilizers, leguminous crops and locally available nutrient sources with optimal levels of NPK fertilizers is the need of the day that will not only improve the nutrient status and soil health but has also shown greater potential in stabilizing crop yields over a period of time. The integrated use of organics and chemical fertilizers at optimum levels as determined by soil tests in long-term fertilizer experiments indicate the build-up of micronutrient and secondary nutrient reserves such as Zn, Cu, Mn, Ca, Mg and S. It will also ensure increased crop productivity in an efficient and environmentally benign manner, without diminishing the capacity of the soil to produce for present and future generations. In other words, integrated nutrient management system is an ecologically, socially and economically viable approach, which on the whole is non-hazardous.

Keywords: Fertilizers, Organic manures, Productivity, Integrated nutrient management

BIOFORTIFICATION OF CROPS TO BRING FUNCTIONAL FOOD FROM FARM TO THE PLATE

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ABSTRACT

Pakistan is facing crisis of malnutrition over the years and needs immediate attention to micronutrient malnutrition which already disturbs half of the world population, especially in developing countries. Biofortified crops are obtained through breeding, providing sufficient genetic variation or by exploiting transgressive research. Biofortified crops are being developed with improved bioavailable concentrations of essential micronutrients to be deployed to consumers through the traditional channels. The insufficient intake of any essential micronutrient will result in metabolic impairment of individuals, possibly by increasing morbidity and death rates. By developing biofortified crops, there is an increase in calorie production and furnishing staple crops with the necessary micronutrients to satisfy the physiological needs. The research and breeding plans are ongoing to enrich the major food staples in un-industrialized countries with the most important micronutrients such as iron, vitamin A, zinc and folate.

Keywords: Malnutrition, Bioavailable micronutrients, Staple, Biofortification

SOIL APPLICATION OF ZINC, COPPER AND BORON IMPROVES LINT AND SEED COTTON YIELD IN SILT SOILS

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ABSTRACT

A field experiment was conducted on cotton cultivar CIM-499 to study the effects of zinc, copper and boron at the rate of 10, 5 and 5 kg per hectare respectively alone and in combination along with basel dose of NPK at the rate of 90:50:50 kg ha^{-1} in a randomized complete block design having four replications at the Agronomic Research Area, Gomal University, Dera Ismail Khan. Seed cotton yield was significantly increased by some fertilizers treatments over control. Application of Zn, Cu and B enhanced seed cotton yield, number of bolls per plant and boll weight. The application of 10 kg Zn, 5 kg Cu and 5 kg B seemed sufficient to overcome the hidden hunger of these micronutrients for sustainable crop production. Maximum seed cotton yield of 2762.06 kg ha^{-1} was obtained by applying 10:5:5 kg ha^{-1} of Zn:Cu:B in combination. The maximum net return of Rs. 5976 ha^{-1} and maximum benefit cost ratio of 4.04:1 was achieved from 5 kg B ha^{-1}. It is concluded that 10:5:5 kg ha^{-1} of Zn:Cu:B in the form of zinc sulphate, copper sulphate and borax can be applied to get the higher yield of cotton in micronutrient deficient areas of Dera Ismail Khan.

Keywords: Cotton, Soil type, Micronutrient, Fibre

FOLIAR APPLICATION OF SELENIUM ACCELERATES PHYSIOCHEMICAL AND ANTIOXIDANT PROCESS TO INHIBIT CADMIUM TOXICITY IN *Zea mays*

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ABSTRACT

Cadmium is the most toxic element present in the soil, air and water that cause deleterious effects on the growth, physiology, biochemical and antioxidant processes of plants. The present study was conducted at research area of Cholistan Institute of Desert Studies (CIDS), The Islamia University Bahawalpur in 2017 to measure the role of foliar application of selenium (Se) to mitigate the effects of cadmium toxicity on the vegetative growth in maize. An experiment was designed as randomized complete block design with two replications. The seeds were sown in pots. Cadmium was applied at the rate of 750 mg/kg sand and 1500 mg/kg sand after the completion of germination. Foliar application of selenium was applied at the rate of 0.2 mM, 0.4 mM and 0.6 mM. After harvesting of crop, the morphological (shoot-root length and their fresh weight), stay green, biochemical (TAA, TSS, TSP and NPK %age) and antioxidant (POD, SOD, APX and CAT) data were recorded by using standard procedures. Results concluded that cadmium toxicity reduced the morpho-chemical parameters and antioxidant processes of maize. However the foliar application of Se enhanced the morpho-physiochemical parameters and antioxidant processes. It was concluded that foliar application of Se improved the vegetative growth of maize by mitigating the deleterious effects of cadmium toxicity.

Keywords: Morphology, Physiochemical, Antioxidants, Cadmium, Foliar Se, Maize

MORPHOLOGICAL AND ANATOMICAL CHARACTERS ARE IMPROVED IN SAFFLOWER WITH FOLIAR AND SEED PRIMED SELENIUM UNDER SALT STRESS CONDITIONS

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ABSTRACT

Salt stress is one of the important threats in changing climate which affect the germination, growth and yield of plants. The present study was designed to examine the role of foliar supply and seed priming with selenium to combat the effect of salinity in safflower. Randomized complete block design with three replicates were used for this experiment. AZS-4 variety of safflower was selected to conduct this research. The seeds were sown in pots after seed priming with selenium (Se) at the rate of 2.5 mM. Salt stress was applied after the completion of germination. Different treatments of foliar and seed priming with Se along with control such as T_0 (control), T_1 (NaCl 200 mM + unprimed seeds), T_2 (NaCl 200 mM + Se 2.5 mM primed seeds), T_3 (NaCl 200 mM + Se 2.5 mM in soil + unprimed seeds), T_4 (NaCl 200 mM + Se 5 mM in soil + unprimed seeds), T_5 (NaCl 200 mM + Se 2.5 mM in soil + primed seeds), T_6 (NaCl 200 mM + Se 5 mM in soil + primed seeds), T_7 (NaCl 200 mM + Se 2.5 mM in foliar + unprimed seeds), T_8 (NaCl 200 mM + Se 5 mM in foliar + unprimed seeds), T_9 (NaCl 200 mM + Se 2.5 mM in foliar + primed seeds) and T_{10} (NaCl 200 mM + Se 5 mM in foliar + primed seeds) were applied at the vegetative stage of safflower. After harvesting of crop, the morphological (shoot-root length and their fresh and dry weight), stay green and anatomical (root, stem and leaf anatomy) data were recorded by using standard method. Results concluded that salt stress decreased the morphological parameters and decreased the anatomical features of safflower. However, the foliar application and seed priming with Se increased the morpho-physiological and anatomical characters. It was concluded that seed priming and foliar application of Se at 5 mM as foliar + primed seeds + NaCl 200 mM improved the vegetative growth of safflower by alleviating the adverse effects of salt stress.

Keywords: Salt stress, Morpho-anatomy, Foliar Se, Seed priming, Safflower

IMPACT OF FOLIAR AND SEED PRIMED SILICON ON GROWTH AND ANATOMICAL FEATURES OF SAFFLOWER UNDER DROUGHT STRESS CONDITIONS

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ABSTRACT

Drought stress is one of the major environmental stresses which adversely affect the growth, and anatomy of crops. The present study was conducted at research area Cholistan Institute of Desert Studies (CIDS), The Islamia University Bahawalpur in 2017 to measure the role of foliar application and seed priming with silicon to alleviate the effects of drought stress on the vegetative growth in safflower. This experiment was designed as randomized complete block design with three replications. AZS-9 (16493) variety of safflower was selected to conduct this research. The seeds were sown in pots after seed priming with silicon (Si) at the rate of 2.5 mM. The drought stress was applied after the completion of germination. Different treatments of foliar and seed priming with Si along with control such as T_0 (control), T_1 (drought stress 50% FC + unprimed seeds) , T_2 (drought stress 50% FC + Si 2.5 mM primed seeds), T_3 (drought stress 50% FC + Si 2.5 mM in soil + unprimed seeds), T_4 (drought stress 50% FC + Si 5 mM in soil + unprimed seeds), T_5 (drought stress 50% FC + Si 2.5 mM in soil + primed seeds), T_6 (drought stress 50% FC + Si 5 mM in soil + primed seeds), T_7 (drought stress 50% FC + Si 2.5 mM in foliar + unprimed seeds), T_8 (drought stress 50% FC + Si 5 mM in foliar + unprimed seeds), T_9 (drought stress 50% FC + Si 2.5 mM in foliar + primed seeds) and T_{10} drought stress 50% FC + Si 5 mM in foliar + primed seeds) were applied at the vegetative stage of safflower. After harvesting of crop, the morphological (shoot-root length and their fresh and dry weight), SPAD and anatomical (root, stem and leaf anatomy) data were recorded by using standard procedure. Results concluded that drought stress reduced the morpho-physiological parameters and modified the anatomical characters of safflower. However the foliar application and seed priming with Si enhanced the morpho-physiological and anatomical parameters. It was concluded that seed priming and foliar application of Si at Si 5 mM as foliar + primed seeds under 50% FC drought stress improved the vegetative growth of safflower by alleviating the adverse effects of drought stress.

Keywords: Growth, Anatomy, Foliar silicon, Seed priming, Drought Stress, Safflower

IMPACT OF DIFFERENT PLANT SPACING ON SUCKING INSECT PESTS POPULATION IN COTTON

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ABSTRACT

Cotton is an important cash crop of Pakistan. It is being attacked by different kind of insect pests. Among them, sucking insect pests especially whitefly, thrips and jassid are the most damaging insect pests. In dense planting, attack of these pests is increased. Present study was conducted to evaluate the effect of different plant spacing on the population dynamics of sucking insect pests of cotton production on four different cultivars of cotton i.e., Cyto-124, MNH-1016, FH-142 and Lalazar. Research trial was conducted on the Research Farm of Muhammad Nawaz Shareef University of Agriculture, Multan. Plant to plant distance was maintained for all cultivars as 6, 9, 12, 15 and 18 inches with row to row distance at 30 inches. Insect pest population data for whitefly, thrips and jassid were taken on weekly basis. Our result revealed that whitefly population was high in treatments where cotton was sown at plant to plant distance of 6 inches, which decreased respectively by increasing the spacing of the plants. Jassid and thrips population also showed more impact on the low spacing and their impact also decreased in the 18 inches plant space. So we could recommend 15 and 18 inches plant to plant distance more beneficial for decreasing the impact of the sucking insect pests losses in the different cultivars of cotton.

Keywords: Cotton, Sucking insect pests, Plant spacing, Whitefly, Thrips, Jassid

OPTIMIZATION OF PHOSPHORUS APPLICATION FOR WHEAT (*Triticum aestivum* L.)

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ABSTRACT

Phosphorus nutrition has potential to boost crop productivity under a wide range of environments. In future, heat stress would be major threat for crop production. Pakistan is included top ten countries, which are more suffering drastic effects of climate change. Wheat *(Triticum aestivum* L.*)* is an important cereal crop for the majority of the world's populations and is staple food crop of the Pakistan. Crop yield has reduced due to limited water availability at critical stages, poor soil fertility and low organic matter contents. This field study was conducted to evaluate the phosphorus application methods and optimal dose for the growth, yield and quality of wheat. The experiment was laid out in split plot arrangement with three replications. Wheat variety Meraj-2008 was sown on November 26th, 2016 using seed rate of 150 kg/ha. Fertilizer application methods used were, i. M_1= line sowing with broadcast of fertilizer, ii) M_2= line sowing with band application of fertilizer, iii) M_3= ridging after broadcast of wheat seed. The level of phosphorus were applied as 0, 30, 60, 90 and 120 kg/ha. Yield parameters like number of fertile tillers per unit area, plant height, spike length, number of grains per spike, number of spikelet per spike, 1000 grains weight and economical yield were recorded and analyzed by using Statisca programme and differences among treatments means were compared by using least significant differences (LSD) test at 5% probability level. Maximum grain yield obtained when phosphorus was applied at 120 kg/ha through ridge application.

Keywords: Fertilizer application methods, Phosphorus level, Wheat

USING BIOCHAR AS A SOIL AMENDMENT FOR REDUCING THE AVAILABILITY AND UPTAKE OF HEAVY METALS IN *Zea mays* L. THROUGH SEWAGE WATER

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ABSTRACT

In past years, soil contamination with different heavy metals due to contaminated water has become a very critical environmental issue. Sewage water contains different heavy metals and micro-nutrients such as Ni, Cd, Cr, Pb, As, Zn, Cu, Mn, Fe, B. The purpose of this study was to use the biochar as a soil amendment for reducing the accessibility & uptake of heavy metals in the *Zea mays* L. Biochar is typically an alkaline material which can increase the soil pH level and also helps in stabilization of heavy metals. Biochar application for immobilization and remediation of heavy metal contaminations from soils and water can provide us a new solution for the problem of soil and water pollution. Maize is the 3rd important cereal crop in the world. Soil was collected from the fields of Muhammad Nawaz Shareef University of Agriculture, Multan. This pot experiment was conducted in earthen pots were filled with 10 kg soil, arranged in CRD design. Treatments were applied as biochar application at the rate of 0.5, 1.0 and 1.5% w/w and control was treated with distilled water and sewage water. Domestic sewage water having different heavy metals (e.g. Ni, As, Fe, Mn, Zn, Cd, Cr, Cu and Pb) was applied as an irrigation source for the uptake of heavy metals. The impacts of these biochar rates on translocation and availability of heavy metals in maize plants were examined. Moreover, the effects of treatments on pH, EC, bulk density and soil moisture content was evaluated. Thus, the best production was noticed with biochar (at the rate of 1.5% w/w). It also lead towards decrease in the heavy metal uptake. It produced the best plant height, best chlorophyll content and higher shoot weight, with the improved soil organic matter, EC and pH.

Keywords: *Zea mays*, Heavy metal, Nutrient uptake, Biochar, Sewage water

FARM YARD MANURE BIOCHAR APPLICATION IMPROVES WHEAT PERFORMANCE AND REDUCES THE BIOAVAILABILITY AND PHYTOTOXICITY OF CADMIUM

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ABSTRACT

Soil contamination with heavy metals has become a global concern because of its adverse effects on health and food security. Soil amendments including biochar can reduce the bioavailability and phytotoxicity of heavy metals in contaminated soils and decrease their risk of entering the food chain. A pot experiment was conducted in the greenhouse of College of Agriculture BZU, Bahadur Campus Layyah Pakistan (2016-2017) to investigate influence of biochar on the bioavailability of Cd to wheat in alkaline soil. Biochar with different sources poultry manure (PM), Farm yard manure (FYM) and sugar cane press mud (PS) were used. Wheat (Galaxy-13) was used in the plant growth experiment as a test crop. Normal soil was artificially contaminated at 5 mg kg^{-1} (highly toxic) with $CdNO_3$. $4H_2O$ salt. The experiments were laid out in CRD with three replications. The treatments were T_1: control, T_2: PM BC at 5 t ha^{-1}, T_3: PM BC at 10 t ha^{-1}, T_4: FYM BC at 5 t ha^{-1}, T_5: FYM BC at 10 t ha^{-1}, T_6: PS BC at 5 t ha^{-1}, T_7: PS BC at 10 t ha^{-1}. All pots were arranged in complete randomized design with three replication. The results indicated that the application of FYM BC increased the germination, number of tiller, chlorophyll content, plant height, spike length, biological and economic yield and reduced the Cd concentration. In conclusion, the results clearly indicate that FYM biochar (5-10 t ha^{-1}) application was very effective in metal immobilization, thereby reducing the bioavailability and phytotoxicity of cadmium.

Keywords: Cadmium, Biochar, Chlorophyll content, Wheat, Growth

INTERACTIVE INFLEUNCE OF BIOCHAR, PGPRs AND SYNTHETIC FERTLIZERS ON PRODUCTVITY OF PEANUT (*Arachis hypogea* L.) UNDER AN ARID CLIMATE

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ABSTRACT

Peanut (*Arachis hypogea* L.) is an important oilseed crop of Pakistan which is grown widely in rainfed regions of Pakistan. It is very less input requiring crop which can grow well under diverse environment conditions. Pegging is the particular character of peanut which makes it unique among the other oilseed crop. The sandy loam soils are best for its production. However, it is not being grown in Thal area which may a potential area for its production. In our experiments, we found that peanut can be a cash crop in thal region which can provide more profit than cotton from per unit area. In this study, we evaluated the role of PGPRs and synthetic fertilizers accomplished with biochar on peanut productivity. The experiment consisted of following treatments viz., i) control, ii) application of synthetic fertilizer, iii) application of PGPRs, iv) biochar (2.36 t ha^{-1}), v) chemical fertilizer + PGPRs, vi) chemical fertilizer + biochar, vii) biochar + PGPRs and viii) PGPRs + biochar + chemical fertilizer. This study indicated that the highest pod yield and seed yield was recorded when biochar was applied in combination with PGPRs and synthetic fertilizers which was attributed to more number of pod plant and highest seed weight in this treatment. In crux, biochar application might be a pragmatic option to boost peanut yield in thal area combined with PGPRs.

Keywords: Peanut, Thal area, Biochar, PGPRs

ZINC APPLICATION IMPROVES THE SEED YIELD, OIL CONTENT AND FATTY ACID COMPOSITION IN CANOLA CULTIVARS IN SUB-TROPICAL REGION OF PUNJAB, PAKISTAN

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ABSTRACT

Pakistan is critically deficient in edible oils due to rapid increase in population and local production doesn't met the total oil demands. Canola is an important non-conventional oil seed crop of Pakistan. Zinc (Zn) is an important micronutrient which is necessary for plant's growth and development. It has wider use for agronomic and horticultural crops and yield is effected by its deficiency. Based on this, a 2-yrs field study was conducted to evaluate the effect of Zine application on seed yield, oil content and fatty acid composition of canola cultivars under sub-tropical region. Four canola cultivars *viz.*, Faisal Canola, Pakola, PARC Canola hybrid and Rainbow were grown with three Zn levels (0, 5 and 10 kg Zn ha^{-1}). Result revealed that cv. Rainbow performed better as compared to other cultivars. Zn application also showed the significant effect on seed yield, oil content and fatty acid composition. Increasing Zn rates (0 to 10 kg ha^{-1}) enhanced the seed yield, oil content and fatty acid profile. In conclusion, the cv. Rainbow with Zn application at 10 kg ha^{-1} should be grown to harvest highest seed yield, oil contents and improved fatty acid profile in sub-tropical region of Punjab, Pakistan.

Keywords: Zinc application, Yield component, Oil content, Fatty acid profile, Canola cultivars

EFFECT OF TILLAGE SYSTEM AND WEED MANAGEMENT PRACTICES ON WEED SEED BANK IN SOIL

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ABSTRACT

In this study, we characterized the size of weed seed bank in soil at different depths and species composition under different tillage systems and weed management practices. Seed bank was monitored before sowing and after harvesting during 2013 and 2014. Tillage treatment were cultivator, rotavator, moldboard (MB) and chisel plough with chemical weeding (Atrazine 330 EC at 1.00 kg a.i. ha-1) at 20 DAS, hand weeding at 20 and 40 DAS and no weeding. Soil samples collected were quantitatively analyzed in germination phase and seed elutriation. There were twelve narrow leaved and four broad leaved weed species. Horse purslane, jungle rice, false amaranth and Johnson grass weeds were most abundant constituting 60% of the weed flora. At harvest, density of narrow-leaved weeds was greater (63%) as compared with broad-leaved weeds (37%). Before sowing narrow leaved were just 40% of weed flora. In the germination phase, soil samples collected from the 0-10 cm soil layers were with 30% germinating seeds while at 15-20 cm and 20-25 cm soil core, only 8-10% seeds were able to show germination. Data collected after harvest indicated that all tillage systems redistributed weed seeds vertically. Tillage system especially MB was more pronounced in changing weed seed bank status of the soil (3,800 seeds m-2). Weed seed density was highest in cultivator tilled plots (10,920 seeds m-2) at top 5-cm soil surface. Hand weeding at 20 and 40 DAS was thrice as effective as atrazine spray. MB plough reduced weed seed density in the germination zone and hand weeding was effective in reducing weed flora of the experiment.

Keywords: Tillage, Seedbank, Weeds

IMPROVING MAIZE PRODUCTIVITY AND SOIL FERTILITY THROUGH ALTERNATIVE SOURCES OF POTASSIUM

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ABSTRACT

The extensive agriculture and growing of exhaustive crops lead to decline in K status of soils due to incessant removal by crops without paying back to soil. Moreover K fertilizers are costly and farmers cannot afford it. Therefore substitution of K fertilizer from agriculture waste is a sustainable approach to improve crop productivity and soil fertility without the risk of environmental pollution. Field experiments were carried out to improve maize productivity and soil fertility through alternative sources of K in summer 2015 and 2016 at Agronomy Research Farms of The University of Agriculture Peshawar. The experiment were consisted of two different organic materials used as source of potassium i.e. maize cobs and sawdust. The organic materials were added in three different forms i.e. as such (residues), biochar and ash form. A control treatment and chemical fertilizer (KCl) were also included in the experiments for comparison. All the treatments were analysed for nutrients content (N, P and K) and were applied at such rate that 60 kg K ha-1 was obtained from each treatment. The results indicated that application of potassium improved crop growth, yield and soil properties as compared to no K application. Chemical fertilizer enhanced crop growth but the final yield and soil properties were improved with organic sources of K. Addition of K from maize cobs increased plant height, leaf area, leaf area index, biological yield and harvest index of maize. Soil organic matter was increased with addition of sawdust, while the effect of organic material on soil pH and soil EC were not significant. Among different forms of organic material, biochar increased plant height, biological yield, harvest index and soil organic matter. Soil pH was increased with addition of organic materials in ash form.

Keywords: Soil fertility, Maize, Maize cobs, Sawdust, Biochar, KCl

AGRONOMIC PERFORMANCE OF BIO-PRIMED SOYBEAN SEED UNDER SANDY SOIL

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ABSTRACT

Priming of seeds with micro-organisms is an environment friendly and potent substitute to other types of seed priming materials in terms of receiving better growth and yield. Seed bio-priming was tested on soybean in a field experiment during Kharif season 2016. For this purpose, three strains of microbes (SR-5-1 + MR-1/1 + MR-1/2) were selected and their sole and combined priming effect was evaluated through observing germination, growth and yield of two soybean varieties. Bio-priming significantly affected seed germination, growth and yield related traits. Treatment which includes all the three types of microbes produced superior results than the rest of the treatments which contained sole or dual microbes application. The genotype Rawal, when bio-primed with a mixture containing all the three microbes, produced higher seed yield of 1902 kg ha^{-1} than the genotype NARC-2 (1873 kg ha^{-1}). The average yield of both genotypes increased by 48.9% when bio-primed with three microbes together than the untreated seeds. These results proposed that the seed bio-priming with multiple microorganism has a great potential to improve soybean seed yield under relatively less fertile soils.

Keywords: Bio-priming, Genotypes, Microbes, Germination, Yield

INTEGRATED USE OF MANURES AND NP FERTILIZERS ON SOIL CARBON SEQUESTRATION AND WHEAT GROWTH

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ABSTRACT

Concentration of CO_2 is increasing since the last two centuries to a concentration from 275 ppm to 385 ppm. Carbon (C) present in soil is twice the concentration of atmospheric carbon and can act as either the source or the sink of the atmospheric CO_2. The study aimed to assess the carbon sequestration potential of organic manures during wheat crop season and to quantify the influence of organic manures on productivity of wheat crop. A field experiment with RCBD design was conducted to evaluate the effect of organic manures and NP fertilizers on soil carbon pools and wheat productivity. Experiment was comprised of the following treatments i.e. Farm yard manure, poultry manure at the rate of 20 t ha^{-1} and 0/0, 20/20, 40/25 and 60/30 kg N/P ha^{-1}. Statistical analysis revealed that the 40/25 kg N/P fertilizers and PM significantly ($p < 0.05$) increased grain yield in all locations over control and also show better results than FYM but not significant. Laboratory analysis confirmed that considerable amounts of macronutrients and small amounts of micronutrients were supplied by PM and FYM. The application of PM with 40/25 kg N/P fertilizers alone produced average grain yields of 5.76, 5.61 and 5.93 t ha^{-1}, respectively, compared to 3.53 t ha^{-1} for the control. Farmyard manure and poultry manure significantly ($p<0.05$) increased soil carbon sequestration and O.M % of the soil. Based on the results of this study, the integrated use of properly managed FYM and low rates NP fertilizers could be used to improved soil carbon sequestration, soil health and wheat crop yield.

Keywords: Carbon sequestration, Organic manures, Wheat, Soil carbon pools

IMPROVING CLIMATE THROUGH TREE PLANTATION

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ABSTRACT

Farmers are facing problems regarding climate change. Higher temperature and erratic rainfalls disturbs harvesting time which results in lower yield. Moreover, mostly farmers have no budget for their business and family expenditures. This situation will reduce yield up to 25% in future. Mitigation strategies can reduce losses and improve agriculture production. The cheap method to reduce climate disasters is tree plantation. It is very interesting approach which is easily adopted by people. The tree leaves absorb carbon dioxide and use it as carbon to producing biomass. The ability of tree to carbon requesting is higher than other methods. Trees are used as shelterbelts in arid to semiarid regions. Shelterbelts reduces wind speed by 15 to 50% and provide protection to annual crops. It maintains sustainable biodiversity. Now, it is our urgent need to add trees in our cropping system as according to agroforestry rules. Plant trees in homes, schools, roads and all over your near places by the collaboration of local community. Spread awareness to the people through newspapers, television programs and local magazines will admire the people to plant trees. Plant trees in urban areas will definitely improve weather and reduce temperature. The government and private organization will take part actively in tree plantation campaigns. This practice will safe this planet from disasters and improve livelihood of people.

Keywords: Carbon sequestration, Agroforestry, Tree plantation

BIOCHAR: A PROMISING CARBON NEGATIVE TECHNOLOGY TO MITIGATE CLIMATE CHANGE

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ABSTRACT

Climate change is a most critical challenge of 21st century faced by mankind. This is the major reason of a huge consensus between 195 nations in Paris (Paris Agreement 2015) to develop a combined action plan to halt rising temperature well below 2 ˚C by end of the century. Although CO_2 has very low global warming potential compared to other greenhouse gases like nitrous oxide (N_2O) and methane (CH_4), its huge concentration in the atmosphere due to anthropogenic interventions lead the role of global warming. This is why carbon sequestration has become so important parameter in national action plans of nations around the world. Biochar (a photosynthetically fixed carbon converted to a stable pyrogenic carbon) amendment in degraded agricultural soils has shown promising opportunities to address carbon sequestration issues worldwide. The recalcitrant nature (stable against microbial degradation and high temperature environment) of biochar, make it a promising climate change mitigation strategy. In addition biochar application in variety of soils in different ecosystems has been observed to change the dynamics of nitrogen (N). For instance, mineral N leakage to atmosphere in the form of N_2O or leaching with water to ponds and rivers is major problem of N use in agriculture. Moreover, N_2O has 298 folds global warming potential of CO_2. Luckily, biochar amendment in agricultural soils has shown significant reduction in mineral N leaching (NO_3^-) or in some cases reduce N_2O emission. In the present study under temperate field conditions with sandy soil, we used three levels of biochar, (i) control (no biochar), (ii) BC-15 (biochar 15 t ha^{-1}) and (iii) BC-30 (biochar 30 t ha^{-1}). The filed was sown with conventional cropping sequence of the region with first crop as Maize, winter wheat, peas (green manure crop), summer barley and again maize during the 4th year of experimentation respectively. Results revealed, greater nitrate retention/capture in top 0-15 cm soil zone (where BC was incorporated) compared to control. The results of reduced NO_3^- leaching were consistent throughout the study years (04). Interestingly, we further explored that the nitrate capture in BC amendment zone was associated with biochar particles rather than any other source. Repeated extractions of biochar particles collected on different soil sampling dates during the four years revealed that field ageing of biochar may explains its sink-source relationship with mineral N (NO_3^-). In crux, that BC should be further explored for any negative or positive effects on mineral N capture/retention or loss as N_2O and effects on agroecosystem.

Keywords: Biochar, GHGs, Mitigation

REMOTE ESTIMATION OF WHEAT YIELD BASED ON VEGETATION INDICES DERIVED FROM TIME SERIES DATA OF LANDSAT 8 IMAGERY

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ABSTRACT

Prior crop yield estimation is important for planning and taking various policy decisions. Satellite remote sensing data is being used to monitor the monitoring and yield estimation. With the recent development in satellite remote sensing technologies increased its spatial and temporal resolution enabled enormous application for the users with low cost. The current study was planned based on time series Landsat 8 remote-sensing data for real time estimation of wheat (*Triticum aestivum* L.) yield and compared with ground truthing wheat yield data for validation in district Chakwal for growing season 2015-16. Wheat yield data collected from an area of 10 × 10 m at 43 sites along with GPS positions at farmer's field. Different indices like EVI, GNDVI, NDVI and WDRVI were derived from time series Landsat 8 imagery throughout the growing season (2015-16). Linear regression models were developed between all the indices and ground truthing wheat yield data and analyzed based on Coefficient of Determination (R^2) and Root Mean Square Error (RMSE). The results showed that most of the indices showed higher values for the month of March-2016 as compared to the other months. This showed that crop was at the booting and anthesis stage in these months. The EVI and GNDVI indices showed better accuracy and precision with coefficient of determination (R^2) 0.89 and 0.82 values with RMSE value of 203.83 and 224.67 respectively for the month of March-2016. This indicated that Landsat 8 imagery can be used for reliable estimation of wheat yield prior to harvest which can be useful for planning and maintaining national food security stock timely.

Keywords: Wheat yield, Time series, Landsat 8, Vegetation indices

REMOTE ESTIMATION OF WHEAT CHLOROPHYLL CONTENT BY USING LANDSAT 8 IMAGERY IN DISTRICT CHAKWAL

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ABSTRACT

Monitoring crop bio-physical properties non-destructively can provide a rapid and accurate understanding of its response to various environmental influences. Crop chlorophyll content is an important indicator of crop health and therefore estimation of crop yield. In recent years, remote sensing has been accepted as a robust tool for site-specific management by detecting crop parameters at both local and large scales. The present research assessed the potential of high resolution satellite imagery to predict wheat chlorophyll content coupled with ground-based information for accurately monitoring crop chlorophyll status in Chakwal district. The current study was performed at several locations (51 sites) in Chakwal district during Mid-March, 2014 for wheat crop. The chlorophyll contents were nondestructively measured by using chlorophyll meter (SPAD-502 Minolta) and at the same sites GPS positions were also recorded for correcting the geo-references sites. The cloud free scenes of LANDSAT 8 were acquired during the same time when ground-truthing campaign was performed. Vegetation indices including Normalized Difference Vegetation Index (NDVI), Green Normalized Difference Vegetation Index (GNDVI), Chlorophyll Absorbed Ratio Index (CARI), Modified Chlorophyll Absorbed Ratio Index (MCARI) and Transformed Chlorophyll Absorbed Ratio index (TCARI) were derived by LANDSAT 8 image by using ERADAS Imagine (v.2014) for chlorophyll determination. The regressional analysis was performed between ground-truthing data and satellite derived vegetation indices for assessing the accuracy. The results demonstrated the effectiveness of using LANDSAT 8 high resolution satellite images to map spatial variation of wheat chlorophyll content through satellite-derived vegetation indices. MCARI and NDVI were revealed to be sensitive indices for assessing wheat chlorophyll content with highest coefficient of determination R^2 = 0.90 and 0.93 respectively. The results suggested that use of high spatial resolution satellite imagery for the retrieval of crop chlorophyll content provides an accurate and quick assessment of crop health status at a larger scale which will help in managing crop nutrition requirement in real time.

Keywords: Stay green, Semi-arid climates, NDVI

COWPEA (*Vigna unguiculata*) GREEN MANURING AND MULCHING EFFECTS ON WHEAT UNDER RAINFED CONDITIONS IN CHAKWAL DISTRICT

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Moisture conservation is a critical issue in rainfed agriculture, particularly in Pothwar region. Rainfall is concentrated in summer, with about 70% by monsoon rainfall in 3 months July-Sep. The aim of present study was to evaluate the effects of cow pea mulching on wheat under rainfed conditions. A three year (2014-15 to 2016-17) field experiment was executed at the research farm Soil and Water Conservation Research Institute Chakwal in collaboration with ICARDA Pakistan to study the effect of cowpea (*Vigna unguiculata*) as a mulch with no till and as incorporation in wheat (*Triticum aestivum*) under rainfed conditions. The field soil was sandy loam having no soil problem (pHs: 7.8, ECe: 0.48 dS m^{-1}) with low soil nutrients (OM: 0.53%, available P: 4.8 mg kg^{-1} and extractable K: 88 mg kg^{-1}). Cowpea was sown as green manure in last week of June. The biomass of green manure crop was 19.14, 15.20, 18.75 and 25.69 t ha^{-1} in the treatment where cowpea was incorporated into the soil and it was 18.49, 13.72, 17.15 and 24.29 t ha^{-1} in the mulching treatment during 2014, 2015, 2016 and 2017 respectively. Average of three year results depicted that the highest wheat grain yield of 3660 kg ha^{-1} was in the incorporated treatment followed by 3314 kg ha^{-1} in control and 2934 kg ha^{-1} in mulching treatment. The incorporation of green manure crop increased 10.4% wheat grain yield, 9.6% wheat straw and 3.2% productive tillers per m^{-2} compared with control. Mulching decreased 11.5% wheat grain yield, 11.0% wheat straw and 12.4% productive tillers per m^{-2} as compared to control. Maximum soil moisture contents (0-15 cm and 15-30 cm) were observed in the incorporated treatment at sowing, 02 months after sowing, 04 months after sowing and at harvesting. Net profit was Rs. 51881 ha^{-1}, Rs. 55789 ha^{-1} and Rs 37475 ha^{-1} in control, incorporated and mulching treatments, respectively. Green manuring is a viable practice under rainfed conditions. Therefore cowpea green manuring and mulching need to be further studied in dry conditions and changing climate scenario.

Keywords: Wheat, Rainfed areas, Mulching, Water conservation

EFFECT OF SEED RATE AND ROW SPACING ON GREEN FODDER YIELD OF PROMISING LINE OF MAIZE (MS-2010)

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ABSTRACT

A two years field study was conducted to figure out the optimum planting geometry and plant density for a newly developed fodder maize line "MS-2010". Other objective of this study was to investigate the effect of plant density in terms of seed rate and row spacing on various growth parameters and green fodder yield of maize. Three levels of seed rate used were 75, 100 and 125 kg ha^{-1}; whereas three levels of row spacing were 15 cm, 30 cm and 45cm. It was found that seed rate is more significant in determining the effect of planting density on growth parameters of fodder maize. Plant height and leaf area were significantly affected by seed rate. Green fodder yield was affected both by seed rate and row spacing significantly. Moreover, it was also observed that both the seed rate and row spacing interacted with each other significantly to affect the growth parameters and green fodder yield.

Keywords: Maize, Seed rate, Row spacing, Green fodder yield, Punjab, Pakistan

EFFECT OF LAST CUTTING DATE ON SEED PRODUCTION OF NEW BERSEEM (*Trifolium alexanrinum* L.) LINE SB-11

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Abstract

The study to check the effect of last cutting dates on seed production of berseem SB-11 (a new line of berseem) was conducted at Fodder Research Institute, Sargodha, Punjab-Pakistan during 2015-16 & 2016-17. Different parameters, number of plants per unit area, plant height, number of heads per plant, number of seeds per capsule, seed yield and fodder yield were taken in to consideration. The results depicted that in case of berseem seed yield was maximum if crop was left for seed on 10th of March to 20th March i.e., 0.36 t ha^{-1} and 0.34 t ha^{-1} respectively and lower seed yield of 0.062 t ha^{-1} was noted when crop was left for seed on 20th April.

Keywords: Berseem, SB-11, Grain yield, Fodder yield production, Punjab, Pakistan

LEGUME NUTRITION: NM-2016 CULTIVAR OF MUNG BEAN PERFORMS BEST TO ACQUIRE PHOSPHORUS UNDER PHOSPHORUS STRESS CONDITIONS

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ABSTRACT

Mung bean (*Vigna radiata* L.) is an important pulse crops, relays to Leguminosae family. The ability of pulse crop to fix atmospheric nitrogen, fulfill the requirement of nitrogen and improve soil fertility. Phosphorus (P) is an essential element for plants. P is an important yield determining nutrient in legumes. In soil, total P is high but in soil solution P is in low amount in the soil, it is due to strong bounding of phosphate ions with soil elements. Phosphorus fertilizer is applied in soil for plant growth, this applied P precipitate with other nutrient element such as Ca^{2+}, Al^{3+}, and Fe^{3+} as a result more need of P fertilizers application in soil. Due to this reason it is time to need enhance the P use efficiency in legumes. A pot experiment was conducted at Agronomic Research Farm, University of Agriculture Faisalabad to evaluate mung bean genotypes traits under low P levels. The experiment was comprised of three phosphorus levels i.e. 5 mg/kg sand (control), 20 mg/kg sand, and 40 mg/kg sand. Five mung bean genotypes i.e. NM11 (V_1), AZRI (V_2), 08009 (V_3), NM-2011 (V_4) and NM-2016 (V_5) were cultivated to study their phosphorus acquiring efficiency. With four replications, the experiment was laid out complete randomized design (CRD). Data was collected on P uptake and P use efficiency in mung bean, physical and physiological parameters was also determined. The results indicated that no. of lateral roots were significantly increased in NM-2016 (V_5) when 5 mg P/kg soil was applied. Leaf area significantly increased in Azri (V_2) amongst all cultivars with maximum when 40 mg P and 20 mg P were applied. NM-2016 (V_5) showed the lowest degree of shoot/root ratio length. It is concluded that NM-2016 (V_5) adapted well in their various root parameters under phosphorus stress conditions.

Keywords: Mung bean, Phosphorus, NM-2016

GENOTYPIC VARIATIONS IN MAIZE TO ACQUIRE PHOSPHORUS FROM SOIL

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ABSTRACT

Phosphorus is an indispensable nutrient required for plant growth and development. Similarly, the selection of suitable cultivar remarkably influences the phosphorus use efficiency. Maize is one of the most utilized cereal in the world. In Pakistan, maize is one the major crops grown for grains and fodder. A field experiment was carried to investigate the suitable rate of phosphorus application for enhancing the growth, productivity of maize and to sort out more phosphorus efficient genotypes. The proposed investigation was performed in randomized complete block design in factorial arrangement with three replicates. The experiment was comprised of phosphorus rate i.e. Control (without P application), 40 kg ha^{-1}, and 80 kg ha^{-1}. Six maize genotypes V_1:CS-2Y10, V_2:KSC-SB 9663, V_3:FH-949, V_4:30Y87, V_5:NT-6621, and V_6:DK-6789 were grown to study their relative phosphorus use efficiency. The results indicated that different phosphorus rates had significant impact on the growth and yield of maize genotypes. In case of phosphorus rates maximum plant height leaves per plant, cob weight, number of seeds per cob, 1000 seed weight and grain yield was recorded with phosphorus application at the rate of 80 kg ha^{-1}. In case of genotypes FH-949 performed significantly better and had maximum plant height leaves per plant, cob weight, number of seeds per cob, 1000 seed weight and grain yield as compared to the other cultivars. In conclusion, various maize cultivars performed significantly different for various agronomic parameters. Further, P content status in soil and plant will further unleash the relative phosphorus use efficiency of maize genotypes.

Keywords: Maize, Phosphorus, Genotypes

PHOSPHORUS MANAGEMENT IN PULSES

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ABSTRACT

Phosphorus (P) is one major required nutrients for plant growth but it is also one of growth-limiting nutrient. Due to very high fixation of P in soil, much of the world soils are quite low in plant-available phosphorus, though having appreciable amount of total P. P deficiency is one the major problems of modern agriculture. Pulses are very important crops, nutritionally and environmentally. They belong to legume family, nurture soil by fixing atmospheric N and overall improve the soil medium for plant growth. In Pakistan, pulses are not getting much attention from the government. Farmers are more attracted towards high-priced crops, mostly cereals. As a result, pulses cultivation occurs on marginal lands. Being legumes, they can fix atmospheric N via symbiosis through the formation of nodules. P promotes the development of roots and seedlings, the encouraged roots and seedling growth are pre-requisites for the nodule development. Further, N fixation takes high amounts of energy. Pulses are efficient utilizer of soil bound P due to high secretions of root exudates into the soil through roots or due to mycorrhizal associations. The seed treatment with relative naturally occurring fungi can greatly enhance P uptake form soil. There are great variations among various pulses for P demands, even vary within varieties. Phosphorus efficient varieties are needed to be developed in this regard. The current practice of lower P fertilization than recommended (even no P fertilization at all) is one of the major reasons of low productions for pulses. Pulses are sensitive to over dosing of P at germination and seedling stage. The P fertilizer should be placed at proper distance from the seed or may be applied in splits. For better P management, intensive crop rotations should be employed with recommended P additions in crops other than pulses.

Keywords: Pulses, Nutrient management, Root growth

WEED DYNAMICS AND PRODUCTIVITY OF RICE AS INFLUENCED BY ALLELOPATHIC CROP RESIDUE MULCHES IN RICE-WHEAT CROPPING SYSTEM

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ABSTRACT

Weeds pose serious threat to rice productivity especially direct seeded rice. Use of allelopathy in recent years has emerged as a pragmatic approach for sustainable weed management in various field crops including rice. Returning of allelopathic crop residues as mulches to soil may be one of the best management strategy to manage weeds and sustain the productivity on long term basis. A 2-year study was conducted to investigate the influence of different allelopathic crop residue mulches (wheat straw mulch, rice residues mulch, sorghum residues mulch) at 4 tons/ha and nitrogen (N) sources (control, urea, calcium ammonium nitrate, ammonium sulphate) at 100 kg/ha were used as experimental treatments. The experiment was laid out in Randomized complete block design (RCBD) in factorial arrangement with three replications. Rice cultivars "Super Basmati" was sown by direct seeding method using hand drill. Results indicated that all the mulches significantly influenced density and dry biomass of all kind of weeds. Maximum suppression of weeds was noticed with plastic mulch over control. Amongst the allelopathic mulches, on an average, better reduction in density and dry biomass of all kinds of weeds was observed by the wheat mulch as compared to sorghum and rice mulch. Amongst the crop residue mulches, highest paddy yield was observed in wheat mulch over control. Use of allelopathic crop residue mulches might be a viable option to control weeds and improve the direct seeded rice productivity.

Keywords: Weed dynamics, Rice, Crop residues mulch, Allelopathy, Rice-wheat system

COMPARISON OF CONVENTIONAL VERSUS DEEP TILLAGE SYSTEMS ALONGWITH VARIOUS SOWING METHODS AFFECT GROWTH AND YIELD RELATED TRAITS OF COTTON

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ABSTRACT

Proper seedbed preparation and selection of proper sowing method before sowing of crop in the field plays a significant role in obtaining highest yields of any crop. A two year field research during 2010 and 2011 was conducted, to explore the response of cotton to tillage and sowing methods. The aim of the experiment was to assess most suitable and economical tillage system and planting method for cotton crop. Experiment was comprised of two tillage systems viz; conventional tillage (one time disc harrow + two cultivations + planking) and deep tillage (chiseling twice + one cultivation + planking) along with three sowing methods viz; flat sowing, ridge sowing and bed sowing. Split plot design was used with three replications. Experimental results indicated that deep tillage amplified yield by 18.7% during 2010 and 11.14% during 2011. Bed sowing exhibited higher yield contributing traits of cotton as compared to ridge and flat sowing. Deep tillage with bed sowing gave maximum net returns of Rs. 121556 with BCR of 1.81 during the year 2010, while during 2011 it was Rs. 68627 with BCR 1.45. It was concluded that deep tillage produced more number of plants which contributed towards highest seed cotton yield. Moreover deep tillage was more costly except in bed sowing of cotton crop.

Keywords: Cotton, Bed sowing, Deep tillage, Net return

EFFECT OF ADDITIVES ON FERMENTATION AND IN-SITU DEGRADATION KINETICS ON SILAGE OF CORN STOVER

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ABSTRACT

Corn stover silage is a very promising approach due to an efficient and economical long-term storage method for large volume of plant-based material. A laboratory study of two years was undertaken to determine nutritional and in-situ degradability of corn stover silage ensiled with different additives during autumn 2014 and 2015 at Animal Nutrition laboratory, University of Agriculture Faisalabad, Pakistan. Corn stover collected after harvesting was chopped and preserved in plastic containers under normal conditions according to following treatment plan: Control (S_1,untreated stover), Stover ensiled with 0.4% solution of urea (S_2), Stover treated with 4% solution of molasses(S_3), Stover treated with 4% solution of each urea and molasses in combination (S_4). Nutritional and fermentation characteristics of silage were determined 40 days after the completion of ensiling period. Fisher's analysis of variance technique was used to analyze data while differences among treatment means were compared using Tukey's Test at 5% probability level. Results revealed that corn stover ensiled with combination of urea and molasses (S_4) showed high percentage of crude protein (8.6 and 8.9%) in both years, respectively with increased degradability rates of dry matter (65 and 66%) and neutral detergent fiber (50 and 53%, respectively).The results revealed that addition of urea and molasses as additives improved digestibility of silage by increasing fermentation characteristics and degradability rate of silage. These parameters were further enhanced on the addition of both the additives in combination.

Keywords: Corn stover, Degradability, Molasses, Silage quality, Urea

B. CROP PESTS AND DISEASES

TOXICITY OF IMIDACLOPRID AGAINST INSECT PESTS OF STORED MAIZE AND WHEAT

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ABSTRACT

The current increased demand of improve quality of crops requires steps to reduce the losses of the crops. The main issue of crops is the quality and safety of the plants which is considerably threatened by stored insect pests. In the present study, we investigated the insecticidal efficacy of Imidacloprid on wheat and maize, against adults of three major stored-grain species, the rice weevil, *Sitophilius oryzae* (L.) (Coleoptera: Curculionidae), the lesser grain borer, *Rhyzopertha dominica* (F.) (Coleoptera: Bostrychidae) and the red flour beetle, *Tribolium castaneum*. For this purpose, bioassays were carried out with indoxacarb at the doses 1, 2 and 4 ppm. Moreover, the treated grains were left at the laboratory for a period of six months, in order to examine the residual effect of indox Imidacloprid, by conducting bioassays at monthly intervals. Wheat grains exposed to Imidacloprid showed 100% mortality rate of *Tribolium castaneum, Stilophilus oryzae* at 1 ppm during six months storage period while there was 100% mortality rate of *Rhyzopertha dominica* at 2 ppm and 4 ppm but 1 ppm showed 90% of mortality rate. Maize grain exposed to Imidacloprid showed 60% mortality rate of *Stilophilus Oryzae* at 1 ppm, 70% mortality rate at 2 ppm and 90% mortality rate at 4 ppm whereas Imidacloprid showed 100% mortality rate for *Tiribolium castaneum*, *Rhyzopertha dominica* at 1 ppm, 2 ppm and 4 ppm. But mortality rate decreased from first interval to the last interval. This showed that Imidacloprid is efficient to store maize grain. This eco-friendly insecticide showed its best results overall during six months for the storage of wheat and maize grains against the insect-pests.

Keywords: Eco-friendly insecticides, Imidacloprid, Maize grain, Mortality rate, Wheat

POSTHARVEST DISEASES OF CITRUS: DETECTION AND MANAGEMENT

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ABSTRACT

Citrus is attacked by a no. of animate and inanimate diseases. Pathogenic species like *Colletotrichum gloeosporioides*, *Botryodiplodia theobromae*, *Phomopsis citri*, *Elsinoe fawcettii*, *Penicillium italicum*, *P. digitatum* and *Phytophthora citrophthora* are commonly found associated with citrus trees in most of the citrus growing areas of Pakistan. The inoculum of these pathogens is also carried in postharvest phase. These pathogens may cause colossal losses in pre- or postharvest phase. They may cause rotting or decay symptoms during extended period of storage. Normally 30 to 40% of citrus fruit is deteriorated due to lack of proper plant protection measures and postharvest handling practices. In the present study, symptoms expression of citrus diseases was recorded in selected orchards of citrus growing areas of Punjab. Different plant extracts and inorganic salts were also tested to ensure eco-friendly management of blue and green mould of citrus. It may be inferred from the current work that control of postharvest diseases of citrus is possible through use of natural compounds and inorganic salts. This research will be much helpful to provide an alternative to poisonous fungicides.

Keywords: Citrus, Pathogens, Pre- and postharvest, Management

BIOLOGICAL CONTROL OF COTTON INSECT PESTS: A CASE STUDY FROM NORTHERN CHINA

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ABSTRACT

In China, introduction of *Bt* cotton has tremendously suppressed the population density of the target pest species, cotton bollworm *Helicoverpa armigera* since 1997. However, densities of sap-sucking insects (i.e. non-target species) especially the cotton aphid population is expected to increase due to the decreased application of pesticides. *Aphis gossypii* Glover (Homoptera: Aphididae) is one of the most important sap-sucking insect pests in *Bt* cotton ecosystems in China. Response of cotton aphid was evaluated to top-down influence (natural enemies) by selectively restricting or allowing predator access (using various exclusion cage types). In addition, we studied the seasonal population dynamics of cotton aphid and associated natural enemies at different growth stages using open field cotton survey for three years (2011-2013) at Langfang Experimental Station (IPPCAAS, China). During three seasons, we observed strong evidence for top-down control of the aphid population growth in cotton crop. The cotton aphid populations peaked in early June to late July (early and medium growth stages). Over all during three seasons, the population densities of cotton aphids were highest on medium growth stage while second largest numbers recorded on early growth stage and lowest numbers of cotton aphids were recorded on late growth stages. In response to reduce the cotton aphid population growth, the natural enemy species population was highest on medium growth stage with second higher numbers were recorded on late growth stage and the lowest numbers were recorded on early growth stage. The results demonstrated that among top-down forces, the key natural enemy of the cotton aphid was aphid parasitoids (*Trioxys* spp., *Aphidius gifuensis*), coccinellids and spiders (along with Anthocorids) on medium and late growth stages (following the aphid peaks in respective season) in *Bt* cotton ecosystem. We also observed multiple predatory coccinellids, Chrysopids and spiders in cotton. This study will help to set the appropriate sampling times, accurate predictive models, and sustainable conservation techniques to enable incorporating biocontrol services provided by these natural enemies in improved IPM strategies for Bt cotton fields both in China and Pakistan.

Keywords: *Aphidius gifuensis*, Coccinellidae, IPM, *Trioxys* spp., Aphid, Top-down control

SCREENING OF BRINJAL GENOTYPES AGAINST ROOT KNOT NEMATODE, *Meloidogyne incognita* (KOFOID AND WHITE) CHITWOOD

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ABSTRACT

In vitro and *in planta* study was carried out to determine the effect of brinjal root diffusates and to screen brinjal genotypes against root knot nematode, *Meloidogyne incognita*. *In vitro* study three different brinjal root diffusates (D1, D2 and D3) obtained from a resistant brinjal line (10/A-1 (14) at three different time intervals (6, 12 and 24 hrs) were evaluated against percent eggs hatching and J2s's mortality of *M. incognita* at three different incubation periods viz., 24, 48 and 72 hrs. Egg inhibition (96.5%) and J_2s mortality (90.5%) were maximum for diffusate D3 at 72 hrs of exposure. The inhibition of eggs and mortality of juveniles increased with increase in the exposure time. In a screening trial, the reaction of 16 brinjal genotypes to root knot nematode, *M. incognita* was evaluated in pots by applying standard level of inoculum @ 5000 eggs of nematodes per seedling. Galling index ranged (GI) from 2.0 on brinjal line 10#1 (14) to 5.5 on Black local cultivar. Two brinjal lines i.e. 10#1 (14) and 10/A-1 (14) were categorized as "Resistant" since these two lines showed minimum galling incidence and number of galls on their roots. Five germplasm i.e White egg (self) 14, 15# 1(14), 10 # 2, 15 # 2 and Neelum Hybrid was rated "Moderately Resistant (MR)". Six genotypes i.e White-B, Nirala-8, NARC-med-long, Dilnasheen, White-B (Green) and Kanha were rated as "Moderately Susceptible (MS)". The cultivars, Black local, Neelum Local and Banda with maximum number of galls were rated as "Susceptible". The galling index was directly related to number of egg masses, adult females and reproduction factor and inversely related to other growth parameters (fresh and dry shoot weights and lengths). Current study suggests that resistant germplasm of brinjal can suppress root knot nematodes, *M. incognita* suppression and could be used as source of resistance in breeding program for developing nematode's resistant cultivars.

Keywords: Brinjal, Root diffusates, Mortality, *Meloidogyne incognita*, Screening, Resistance

EFFECT OF DIFFERENT PLANT SPACING ON POPULATION DYNAMICS OF TWO SUCKING INSECT PESTS OF COTTON

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ABSTRACT

Cotton (*Gossypium hirsutum* L.) is the main cash and fiber crop of Pakistan. It is infested by a large number of sucking and chewing insect pests. The plant density has significant effect on the population of such pests. In the current study, population dynamics of whitefly, *Bemisia tabaci* Genn. (Homoptera: Aleyrodidae) and thrips, *Thrips tabaci* (Thysanoptera: Thripidae) was studied on BS-70 cotton variety under three row spacing (75 cm without mapiquate chloride (growth inhibitor), 30 cm without mapiquate chloride and 30 cm with mapiquate chloride) with different plant densities. The results indicated that the population of both sucking pests varied significantly in three row spacing ($P<0.01$) with maximum population recorded in line spacing of 30 cm without mapiquate chloride, followed by line spacing of 75 cm without mapiquate chloride and 30 cm with mapiquate chloride. Peak population was observed on August 28, 2016 for whitefly (5.16-3.42 adults and nymph/leaf) and June 5, 2016 for thrips (15.11-6.42 adults and nymph/leaf). The results will be helpful in the management of sucking pests of cotton.

Keywords: Ultra-narrow row spacing, Plant growth regulator, Plant density, Pest infestation

EFFECT OF DIFFERENT FUNGICIDE SEED TREATMENTS ON OCCURRENCE OF GRAM WILT

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ABSTRACT

Chickpea (*Cicer arietinum* L.) is the world's third most important pulse crop. It belongs to the pea family with short, hairy pods containing usually two seeds. Chickpea is an important high protein crop of "Thal" area in Pakistan having major source of protein in animal feed and human diet especially for low income group, by supplementing their cereal diets. Efficacy of three different fungicides was studied in field laboratory against occurrence of gram wilt. Field study showed that Divind Star 036FS (difenconazole + cyproconazole) @1 ml/ kg of seed was proved to be best by minimum disease occurrence with mean of 8.45% compared with 59.16% in control. Although statistically similar results were obtained of all three fungicide treatments with efficacy order of Divind Star 036FS > Teranil 45 DP > Dynasty 125 FS. Divind Star 036FS was also proved most effective for better yield followed by Teranil 45 DP (bromothelanil) 5 gm/ kg of seed with mean of 340.67 & 332.66 grams per m^2 respectively. Control plot showed minimum yield with mean of 193 grams per m^2. Comparative study of percent germination of gram crop in field after seed treatment with three different fungicides showed that Dynasty 125 FS (ezoxystrobin + fludioxonil + mefenoxam) @ 3 ml/ kg of seed was best with maximum mean germination of 78.33% over control with mean germination of 55% only.

Keywords: Chickpea, Gram blight, Humidity

RECENT TRENDS IN BIOLOGICAL CONTROL OF *Cydia pomonella* (LEPIDOPTERA: TORTRICIDAE) IN BALOCHISTAN, PAKISTAN

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ABSTRACT

Biological control of *Cydia pomonella* in Pakistan especially in Balochistan province is a new phenomenon for apple growers. Majority of the apple growers solely rely on application of chemicals to regulate *C. pomonella*. The non-judicial use of toxic chemicals on apple fruit resulted in restriction of this product in international market due to prevalence of toxic chemicals above the permissible level. Centre for Agriculture and Biosciences Internationals (CABI) through its project "Phytosanitary Risk Management Program in Pakistan" initiated its activities to implement the biological control for *C. pomonella* in Balochistan province during 2014 and is in progress. The objective of this program was to explore the natural enemies associated with *C. pomonella* and to design mass rearing technologies for their deployment at farmer's field. The extensive field surveys of apple growing areas of Balochistan province resulted in discovery of two larval parasitoids namely *Dibrachys microgastri* and *Elasmus sp. nr. johnstoni*. These were also first records from Pakistan. The explored parasitoids were brought to CABI Biocontrol Laboratory at Agriculture Research Institute Quetta and their mass rearing techniques were developed after series of experiments. By the year 2017, about 1.17 million parasitoids were released at apple growing areas of Balochistan. To assess the impact of released parasitoids, fortnightly data on percent parasitism was recorded using corrugated paper bands. The % parasitism was found ranging between 52-85% in different elevations. Moreover, the trends of *C. pomonella* adult population were also recorded with help of pheromone traps which also showed significantly high declined trendin treated orchards (where parasitoids were released). Based on the results, it is recommended that utilization and conservation of natural enemies of *C. pomonella* in Balochistancan be achieved and can provide a sustainable management of this notorious pest without application of toxic chemicals.

Keywords: Balochistan, Biological Control, *Cydia pomonella*, Parasitoids

IDENTIFICATION OF POTATO VARIETIES RESISTANT TO LATE BLIGHT UNDER DIFFERENT AGRO-ECOLOGICAL DOMAINS IN PAKISTAN

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ABSTRACT

Late blight caused by *Phytophthora infestans* is an economically important disease of potato causing substantial yield loss each year in Pakistan. Screening potato genotypes for resistance to *P. infestans* under different agro-climatic conditions is one of the most important activities of Potato Research Institute prior to advancing yield evaluation and release of varieties for commercial production. In 2016-17, potato varieties were screened at Sahiwal, Sialkot, Murree and Kaghan research locations under natural epiphytotic conditions where late blight severity on a susceptible variety reaches 100% foliar infection. Late blight susceptible potato variety Diamant and Cardinal were planted after each set of nine test rows at the spacing of 25 cm x 60 cm and were also used as boundaries of experiments to increase the inoculum pressure on tested germplasm. Potato germplasm lines FD-63-1, FD-74-28, FD-73-75, FD-74-21 and FD-69-2 were consistently found to be resistant to late blight in these years and under above agro-climatic conditions.

Keywords: Late blight, Agro-climate, Foliar infection, Screening

INSECTICIDAL POTENTIAL OF MEDICINAL PLANTS CULTIVATED IN PAKISTAN AGAINST *Trogoderma granarium* EVERTS

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ABSTRACT

The objective of present study was to appraise the insecticidal bioactivity of medicinal plants; *Moringa olifera* (Sohanjana), *Calotropis porcera* (Ak) and *Citrullus colocynthis* (Tuma) against most destructive primary insect pest of stored grains khapra beetle, *Trogoderma granarium* Everts (Coleoptera: Dermestidae). Bioassays were carried out to examine the toxicity of plant extracts at four dose rate viz; 2.5%, 5.0%, 7.5% and 10.0% for mortality, repellency and growth inhibition effects in *T. granarium*. The outcomes evidenced that mortality of 5 days old larvae of *T. granarium*increased with dilution level from 2.50 to 10.0% and with time exposure from 2 to 10 days. Plant extract of *C. colocynthis* at 10.0% concentration reported maximum mortality (46.06%) after 10 days interval, while other two plants *M. olifera* and *C. porcera* forced a maximum 37.07% and 30.33% mortality at 10.0% dose rate after 10 days. For deterrence effect, filter paper treated with 10.0% extract of *C. colocynthis* evidenced maximum repellency (91.11%) from three plants after 3 days interval. In growth inhibition test for the larvae of *T. granarium*, again insecticidal activity of *C. colocynthis*'s extract was more efficient than *M. olifera* and *C. porcera* as it reported maximum pupae (62.07%) and adult inhibition (66.67%). Results signifying that immature of *T. granarium* were more susceptible to crude extract of *C. colocynthis* than *M. olifera* and *C. porcera*. These findings suggested that naturally occurring plant extracts have decent insecticidal potential for the control of *T. granarium* and can be used in the IPM program of stored grains pest management.

Keywords: Bioactivity, Primary insect pest, Toxicity, Mortality, Repellency

IMPACT OF DIFFERENT PLANT EXTRACTS AGAINST CHARCOL ROT DISEASE AND YIELD ATTRIBUTES OF MUNG BEAN

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ABSTRACT

Mung bean (*Vigna radiata* (L.) Wilczek) is a major source of proteins, energy, minerals and vitamins. But its productivity decreased through infection of diseases in which Charcoal rot is major problem which is caused by *Macrophomina phaseolina* (Tassi) Goid. To control the infection of disease, a trial was conducted at research area of department of Plant Pathology, UAF. The susceptible advance line (14101) was seed treated with five plant extracts and results showed that minimum disease incidence under field condition was recorded on plants by seed treatment with Neem (*Azadirachta indica* (29.14) followed by Dhatura (31.73), Aak (*Calotropis procera)*(40.57), Eucalyptus (44.10), Bhang (48.48) , as compare to control (52.77). During in vitro evaluation of five plant extracts for the control of *Macrophomina phaseolina* (Tassi) Goid, in which the PDA mixed with five plant extracts @ concentration of 0.25%, 0.5% and 1%, in which maximum growth reduction was observed with amendment of Eucalyptus (4.34) followed by Bhang (4.63), Aak (4.87), Dhatura (5.0), Neem (5.32), as compare to control (7.58). Maximum yield was obtained with seed treatment of Neem (361.72 kg/ha) followed by Dhatura (317.94 kg/ha), Aak (292.63 kg/ha), Eucalyptus (244.09 kg/ha), Bhang (240.55 kg/ha) as compare to control (213.80 kg/ha). Maximum no. of pods were obtained with seed treatment of Neem (188) followed by Dhatura (140), Aak (97), Eucalyptus (67), Bhang (65), as compare to control (44).

Keywords: Mung bean, Plant extract, Charcol rot

MANAGEMENT OF COMMON SCAB OF POTATO THROUGH NUTRITION

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ABSTRACT

Common scab of potato is most important disease of potato in all over the world. It reduces market and cosmetic values of potato due to presence of obnoxious scab lesions on skin of tubers. In present study we evaluated effect of fertilizer NPK with different concentrations on development of common scab of potato. Three concentrations of N ($N_{1=}$ 100 kg, $N_{2=}$ 125 kg, N_3 75 kg), P ($P_{1\ =}$75 kg, $P_{2=}$ 100 kg, P_3= 50 kg) and K ($K_{1=}$ 50 kg, $K_{2=}$ 75 kg, $K_{3=}$ 25 kg) were used in experiment. The experiment was laid out in (RCBD) randomized complete block design in research area of department of plant pathology, University of Agriculture Faisalabad. These concentrations of fertilizers significantly reduced disease incidence. Maximum disease incidence (61%) was recorded in N_1 as it is in N_2 disease incidence was (54%) and in N_3 (42.2%). In case of P treatment P_2 showed minimum disease incidence (40.6%) as compared toP_1 (52%) and P3 (45.6%). Maximum reduction of disease was observed in K_1 (44%) and minimum disease severity was observed in K_3 (40%).

Keywords: Potato, Common Scab, Nutrition

EFFECTIVE MANAGEMENT STRATEGY ADOPTED FOR ALTERNARIA BLIGHT OF BRASSICA IN FAISALABAD-PAKISTAN

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ABSTRACT

Mustard (*Brassica juncia*) is the leading oilseed crop of Pakistan. It provides the 20% oil requirement of Pakistan. This fleshy crop is affected by various biotic and abiotic factors. One of the yield limiting biotic factor is *Alternaria* blight, caused by *Alternaria brassicae*. Genetic resistance is best mechanism to manage this pathogen but such germplasm is unavailable. Several other strategies are utilized but no one is going to give quick remedy other than the management by chemicals. Experiment was conducted on brassica lines and eight fungicides were applied @ 0.25% and 0.5%. All fungicides showed decrease in disease incidence as compared to control. Least disease incidence (30.8%) was observed after the application of 0.5% concentration on DGL and (32.5%) on BSA. It is suggested that these fungicides can be used in the field for effective management of Alternaria blight of brassica.

Keywords: Mustard, *Brassica*, *Alternaria* blight, Fungicides, Management

MOLECULAR CHARACTERIZATION OF COTTON LEAF CURL VIRUS ISOLATES FROM VARIOUS ADVANCED COTTON LINES OF PUNJAB

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ABSTRACT

Cotton leaf curl virus is the most damaging virus of cotton (*Gossypium hirsutum* L.). CLCuD is caused by monopartite begomovirus which carry DNA-A component and beta-satellite transmitted by *Bemicia tabaci*. Present research was designed to amplify the circular single stranded molecule of begomovirus associated with CLCuD through RCA technique. Twenty lines/varieties of cotton were evaluated for their response against cotton leaf curl virus. The field trial for this purpose was carried out in research area of Department of Plant Pathology, University of Agriculture, Faisalabad. Total DNA from these samples were isolated by using CTAB method Cetyl Trimethyl Ammonium Bromide. Full length DNA-A component identification of virus from diseased plants were polymerized into millions of copies through PCR by using universal primers (begomo 01 and begomo 02). Further insilico analysis of different viruses with restriction enzymes EcoRI and PstI was done. The residual viral titer which is evaluated through PCR and its value was compared with the visually observed symptoms to evaluate the plant response. All varieties showed disease symptoms. Susceptible varieties were FH-114. MNH-886, LALAZAR, MS-71, MS-289, FH-682, FH-900, Z-31, ALI AKBR-703, N-112. Moreover, moderate susceptible varieties were FH-942, FH-142, MNH-86, CM-595, HUMA-15, ALI AKBR-905. However, moderate resistant varieties were FH-941, CM-595, ALI AKBR-905, CA-12.

Keywords: Cotton, CLCV, Begomovirus, Elite lines, Screening, Molecular characterization

IMPACT OF PROTEINS ON PHYSIOLOGY OF RICE AFTER THE INFECTION OF *Magnaporthe grisea*

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ABSTRACT

Rice is economically important staple crop in different countries is expected to have increased production by 40% in 2030. Challenge will have to go through less land and water for its cultivation with less fertilizers and chemicals. Diseases, insects and weeds are responsible for yield losses of up to 25% in rice but most serious and widespread disease is blast caused by the ascomycete fungus *Magnaporthe grisea*. It can infect various parts of rice including leaf, stem, spike and roots. It causes annual yield losses corresponding to 275 thousand tons of rice and requires the extensive use of fungicides. Commonly it is managed using fungicides, resistant cultivars, agronomical practices and biotechnological methods. Rice resistance to blast is widespread and controlled by a large number of independent major resistance genes. However, most of these resistances are broken down after a few years of intensive cultivation. *M. grisea* considered as a 'principal model organism' for the study of molecular mechanisms of fungal diseases and host– pathogen interactions in plants. Molecular markers and genetic maps are useful tools for genetic studies such as gene mapping, genome comparison and genetic diversity analysis. Cdc42 is known to be conserved in all eukaryotic organisms, and controls cell polarity through regulating the actin cytoskeleton polarization. Cdc42 is expected to play a prime role in the regulation of morphogenesis of filamentous fungi. It is revealed multiple functions of Cdc42 in filamentous fungi, some of these functions appear in conflict with Cdc42's classical role in regulating polarized growth and deletion of Cdc42 leads to morphological aberration of certain cell types such as conidia, and damage the host pathogenicity.

Keywords: Rice blast, *M. grisea,* Molecular characterization, Diversity analysis, Cdc42

PHYSIOLOGICAL FACTORS OF *Alternaria solani* INDUCING EARLY BLIGHT OF TOMATO AND ITS MANAGEMENT

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ABSTRACT

Early blight of tomato caused by *Alternaria solani* is a disastrous disease of world and Pakistan as well. In physiological parameters, colony growth of *A. solani* was observed at different growth media, oat meal agar (OMA), potato dextrose agar (PDA) and tomato leaf extract agar (TLEA), temperature levels (20, 25, 30 and 35°C) and pH levels (4, 5, 6, and 7) under complete randomized design (CRD). Mycelial growth of *A. solani* was noted maximum at PDA medium (8.5 cm), temperature 25°C (8.5 cm) and pH 7.0 (8.5 cm) after 8 days. *In-vitro* evaluation of five fungicides (Score, Ridomil Gold, Cabrio Top, Topsin-M and Captan) were tested against *Alternaria solani* at 100, 150 and 200 ppm. Cabrio Top gave (77.17, 85.23 and 95.51%) maximum inhibition of the mycelial growth of target pathogen followed by Score (60.11, 71.33 and 83.11%) at 100, 150 and 200 ppm respectively. Least inhibition growth of the pathogen was noted in Captan at required concentrations. During *in vitro* evaluation of fungicides Cabrio Top and Score found to be most effective therefore these were tested in the field experiment under randomized complete block design, maximum disease control (72.31%) was recorded in the Cabrio Top treated plots followed by the (60.11%) in plots sprayed with Score. The findings of the recent studies will be supportive to plan management strategies of early blight of tomato.

Keywords: *Alternaria solani*, Early blight, Tomato**,** Media, Temperature, pH, Fungicides

EFFICACY OF DIFFERENT PLANT EXTRACTS AGAINST *Bipolaris oryzae* CAUSING BROWN LEAF SPOT OF RICE

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ABSTRACT

Rice (*Oryza sativa* L.) is one of the most important staple fruit in the world. Number of diseases attack on it, among them Brown leaf spot of rice caused by *Bipolaris oryzae* is the most devastating disease. Many chemicals are used to control the disease but they have health hazardous effects. There is a dire need to develop ecofriendly methods to control the disease. In present study plant extracts having antifungal activity was selected. Plants extracts from four species i.e. Pomegranate, Thyme, Lemon grass and Barru grass were evaluated. From these plants three concentrations 5%, 10% and 30% of water extracts were prepared. Thyme showed maximum inhibition of fungus (78%) at 30% concentration, followed by lemon grass (67%), pomegranate (56%) and Barru grass (50%) at 30% concentration. Thyme was best at all concentrations. All the treatments significantly inhibited the growth of fungus.

Keywords: Rice, Plant Extracts, *Bipolaris oryzae*

PARASITIC-INDUCED PATHOGENS AND PLANT-RESPONSE: INSIGHTS ON THE VEGETABLE CROPS FROM MORPHOLOGY TO MOLECULAR BIOLOGY

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ABSTRACT

Parasitic plants are present in 20 flowering families, and 4500 species are known to date. Orobanche, Striga spp. and Cuscuta spp. are the major crop pathogens. They have the ability to sense the chemical which is emitted by the nearby host and through haustorium development create the interaction with the host and cause disease in it. It can be reduced by inhibiting germination of parasitic plants and disruption of the volatile host. Parasites live on the resources of host plant which cause stress on its food. Due to the stress, the host plant survival, growth and reproduction come in danger. Because, the host plant tissues damages the biochemical and functional changes, metabolic and physiological disorders which lead to the impairment or death of the host plant. When pathogen attacks plants defend themselves by triggering hypersensitive response, systemic acquired resistance, induced systemic resistance or through type three secretion system. Plants can save themselves from the pathogen attack through innate immunity and its stimuli generated in the responseto the recognition of microbe-associated molecular associated patterns (MAMPs).

Keywords: Metabolism, Molecular biology, Orobanche, Physiology, Vegetable crops

RESPONSE OF PREDATORY BIOLOGICAL CONTROL AGENTS TOWARD *Bt* COTTON TREATED WITH DIFFERENT COMMERCIAL INSECTICIDES AND FERTILIZERS

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ABSTRACT

Current study was carried out to observe the response of predatory biological control agents towards two varieties of *Bt* cotton (single *Bt* 142and double *Bt* cemb 33) treated with commercial insecticides and fertilizers. According to results there was 0.55% *Chrysoperla carnea*, 0.83% predatory spider while 6.0% *C. carnea* and spider for date wise population in single gene *Bt.* At the same time 0.61% *C. carnea*, 0.80% predatory spider, while for date wise population in double gene *Bt* in untreated plot *C. carnea*/spider population was found 6.0%. Radiant (spinetoram) has 0.46% population of *C. carnea* in both varieties. There were 0.23% and 0.31% population of *C. carnea* was observed in plot treated with Oshin (necotinoid) in both varieties respectively. In single *Bt* 0.30% population of spider was observed and 0.49% population of predatory spider was observed by Oshin in double *Bt*., a little bit effects were observed by Commando plus (acephate), Talstar (bifenthrin), and fertilizers Catalyst (liquid potash) and vital (NPK) on response of *C. carnea* and predatory spider in both varieties. No difference observed in date intervals when treatments were applied. Thus, it was concluded that insecticides as well as fertilizers have a little bit effects on bio-control agents.

Keywords: Cotton, Insect pests, Predators, Resistance

INCIDENCE OF APHID ALONG WITH DISEASES AND IMPACT OF SOWING DATES ON DIFFERENT WHEAT CULTIVARS AT DIFFERENT LOCALITIES OF SOUTHERN PUNJAB, PAKISTAN

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ABSTRACT

The study was conducted to evaluated approved recessive cultivars of wheat against leaf and stem rust diseases. The impact of varieties and sowing dates on disease severity was observed at eight locations of selected tehsils of Southern Punjab including Alipur, Jatoi, Muzaffargarh, Khangarh and Kot Addu. Maximum disease incidence (41.19%) was recorded at tehsil Kot Addu followed by Muzaffargarh (37.21%) and Alipur (21.63%). Maximum disease severity was calculated at tehsil Jatoi fields (23.20%) followed by Khangarh (19.10%). Four sowing dates November (1-15), November (16-30), December (1-10) and December (11-20) were observed for the insect pest's incidence and diseases. Lowest disease incidence 39.78% was noticed on wheat, cultivated in November. Four varieties Chakwal-50, Mehraj-2011, Watan and Sahar-06 were cultivated. Sahar-06 showed the minimum disease incidence (27.73%) while Watan showed maximum disease incidence (47.36%). The aphid population was observed maximum at Chakwal-50 (74%) followed by Watan (63%) and Mehraj-2011 (44%). While less population of aphid was recorded on Sahar-06 (57%). It is concluded by the study results that to get the maximum average yield of grains resistant variety should be used and select the suitable time for sowing to reduce the yield losses.

Keywords: Wheat rust, Disease incidence, Disease severity, Sowing dates, Cultivars

PHYLOGENETIC ANALYSIS OF ROOT KNOT NEMATODES SPECIES IN EGGPLANT GROWING AREA OF PUNJAB, PAKISTAN

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ABSTRACT

The aim of current research is to contribute to knowledge of the root knot nematodes (RKN), associated with eggplant growing area of Pakistan by determining the level of genomic diversity. For this purpose various primer sets (TRNAH/MRH106; MORF/MTHIS; 194/195; C2F31108 and some species specific primers) were used for mitochondrial (mt) DNA extraction; similarity of genome sequence; evolutionary relationship of the sample sequences; pair wise identity and then phylogentic analysis of RKN was made by using neighbor joining method, alingning the sequences with MUSCLE, Sequence Demarcation Tool (SDT) and Mega7 softwares respectively. Variation in presence of the restriction enzyme (RE) was obtained by online software (NEBcutter V 2.0 and ORF finder). Haplotype based diagnosis in phylogenetic analyses of mt DNA region revealed that the few Punjab isolate clustal with *M. inornata* a Belgium isolate and *M. haplanaria* clustal with a USA isolate of tomato while one of the sample clustal with *M. luci.*

Keywords: Phylogenetic analysis, Meloidogyne, Mitochondrial, Haplotype, Pakistan

COMPARATIVE EFFICACY OF THREE DIATOMACEOUS EARTH FORMULATIONS AGAINST *Tribolium castaneum* (HERBST) (COLEOPTERA: TENEBRIONIDAE)

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ABSTRACT

Current study was conducted to check the effectiveness of three formulations (Concern®, Organics® and Food Grade®) of Diatomaceous Earth (DE) against red flour beetle, *Tribolium castaneum.* DE formulations were applied at dose rates of 200, 400 and 600 ppm against the target insect. The experiment was conducted on sterilized, crushed wheat grains under optimum laboratory conditions (30±2ºC and 65±5% R.H). Completely Randomized Design (CRD) with three triplicates for each treatment was used. The toxic effects DE formulations were observed after 2,7,14 and 21 days of treatment application. The results of bioassays revealed that the Food Grade® formulation showed better results causing mean mortality 67.77% at the dose rate of 600 ppm after an exposure period of 21 days followed by D.E Concern® and D.E Organics® with 59.98 and 51.11% mortality values at dose rates of 600 and 400 ppm, respectively after an exposure period of 21 days. While least mortality values for each DE formulation were observed at lowest concentration 200 ppm after exposure period of 2 days. The mean percent mortality response of the targeted insect was found time as well as concentration dependent. DEs are eco-friendly insect pest management tactic and can be used for effective management of stored grain insects.

Keywords: *Tribolium castaneum*, Diatomaceous earth, Mortality, Formulations

EFFECT OF ORGANIC MANURES ON POPULATION OF SUCKING INSECT PESTS OF BRINJAL (*Solanum melongena* L.)

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ABSTRACT

Brinjal (*Solanum melongena* L.) is a most vital vegetable in Pakistan. Different sucking insect pests, i.e. whitefly (*Bemisia tabaci* G.), Jassid (*Amrasca biguttula* I.) and aphid (*Aphis gossypii* G.) attack brinjal for the whole growing season. Inorganic fertilizers are well known to enhance vegetative growth of plants and to make them succulent. Thus, these encourage the insect infestation and population build-up. In the present study organic manures from different sources were used to study their effect on the seasonal population dynamics of sucking insect pests of brinjal. The experiment was laid out in a Randomized Complete Block Design having four replications at COMSATS Institute of Information Technology, Vehari. The variety Nirala was used from a Multan progressive grower. Recommended dose of organic manures were applied before soil preparation and ploughed up. Organic manures sources with their doses were Magnet (10 g), Booster Super (7.5 g), V-Compost (62.5 g), Organic 486 (62.5 g) and Urea (125 g) were applied. Plots and replications were separated by one and two meter non-cropped area, respectively. Data was collected throughout the growing season of the crop and sucking insect pests' population was recorded from appearance of insect on the crop to a minimum of six weeks period at weekly intervals. It is concluded that organic fertilizers showed minimum insect pests population as compared to inorganic fertilizers. Magnet showed minimum insect pests population among all organic fertilizers.

Keywords: Sucking insect pests, Inorganic fertilizers, Infestation, Population dynamics

EVALUATION OF PARASITOID POTENTIAL OF A BIO-CONTROL AGENT AGAINST *Callosobruchus chinensis* (BRUCHIDAE: COLEOPTERA)

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ABSTRACT

The current study was carried out to check the parasitism efficiency of *Anisopteromalus calandrae* (Howard) against *Callosobruchus chinensis* population. The populations of beetles was maintained under optimal laboratory conditions (30±2 ºC, 65±5% R.H. and 12:12, L:D). To check the parasitism potential of *A. calandrae*; 5, 10 and 15 pairs (male and female) were released in small plastic jars containing *C. chinensis* on three diets (i.e. mung bean, lentil and chick pea). Data regarding parasitism by *A. calandrae* were recorded after 5, 10, 15 and 20 days of treatment application. Complete randomized design was used to conduct experiment and obtained data were subjected to statistical analysis using statistica-8 software. Findings of parasitism bioassays revealed that highest mean mortality 47.01% was achieved in lentil followed by 41.12% in mung bean, while comparatively least 39.03% was observed in case of chick pea where 15 pairs of *A. calandrae* were released. The parasitism efficacy was found comparative low (3.01%) after 5 days in chick pea at least number of sex pairs of the bio-control agent in three diets, used. Results depicted that mean % parasitism activity was greatly influenced by number of sex pairs and exposure time. Hence, biological control can be effective for the management of stored product insect pests.

Keywords: *Anisopteromalus calandrae, Callosobruchus chinensis,* Parasitism, Pulses

INCIDENCE OF RICE GRAINS MYCOFLORA AT VARYING STORAGE INTERVALS IN DISTRICT SARGODHA, PUNJAB, PAKISTAN

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ABSTRACT

Seeds have a leading part in agriculture but seed-borne pathogens cause seed abortion, rotting and necrosis. In present study, identification and incidence of major seed borne mycoflora associated with rice grains in Sargodha district was assessed. Results revealed that different pathogenic and saprophytic fungal species were found on rice seeds. Maximum percentage incidence showed by *Drechslera oryzae* (33.3%) and *Alternaria* spp (31.3%) while *Penecillium capsulatum* and *Cladosporium* spp showed minimum incidence about 5.8% after the fifteen days. After thirty days, maximum incidence was showed by *F. moniliforme* about 56.8% while *D. carbonum* showed 47% incidence as compared to other fungi. After sixty days of storage, *D. oryzae*, *Alternaria* spp. and *Curvularia lunata* were found to be the highest than other species in blotter paper method. *P. capsulatum* and *Pythium* spp were not found at 60th day of experiment. On the basis of results, it is concluded that many mycoflora attacks on rice seed which directly affects the quality of seeds.

Keywords: Rice, Seed borne pathogens, Incidence, Time interval

GENETIC DIVERSITY OF SOYBEAN CULTIVAR FOR YIELD AND ROOT KNOT NEMATODE RESISTANCE PARAMETERS

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ABSTRACT

These studies were conducted to evaluate the resistance of *Meloidogyne incognita* at different level of inoculums in the soybean (*Glycine Max* L) in green house conditions. Moderately resistant and susceptible cultivars may exhibit the same or very close tolerant limit (T) but show minimum yield, in this way use of several inoculums levels would differentiate various nematode population. Out of fifteen varieties of soybean only six varieties were found resistant in green house trial viz., AGS-109 (V_3), AGS-08 (V_4), NARC-3 (V_{11}), 95086 (V_8), AGS-09 (V_5), and Rawall-I (V_{14}) and rest showed susceptibility to root-knot nematodes. In this study assess the mean performance of plant growth parameters. According to statistical analysis results revealed strong negative correlation between plant growth parameters with different inoculums level of RKN (*M. incognita*). While biochemical analysis showed high contents of total phenol, IAA, chlorogenic acid and Ascorbic acid oxidase in roots of resistant varieties. Marker analysis provides accurate genotypic information, and gives precision which lacks in phenotypic measurements due to environmental interaction and experimental error. The present investigation has been carried out to evaluate the usefulness of molecular markers RAPD for revealing the level of genetic diversity among the *Mi* resistant cultivars of soybean collected from Pakistan and United State soybean germplasm collection USDA. Inferences have been made regarding bioassay and molecular characterization that the most diverse and resistant verities against RKN were AGS-109, AGS-08, NARC-3, 95086, AGS-09, and Rawall-I as compared to the rest of the verities studied and the most effective loci to screen diversity was OPA-20 and OS-14.

Keywords: *Glycine Max*, Pathogenicity, Root-knot nematodes, RAPD, Susceptible, Tolerant

EXPLOITATION OF SOME ENTOMOPATHOGENIC FUNGI AGAINST OKRA MEALY BUG *Phenacoccus solenopsis*

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ABSTRACT

Mealy bug's infestation is very difficult to control because its outer body is covered with white waxy secretions. These white secretions serve as a protective layer which makes pesticides application unfruitful, on one hand and on the other hand the frequent, non-passionate and non-judicious use of pesticides to control these hard pests has not only created resistance in this pest but also polluted our eco-system. Therefore, an attempt has been made to control okra mealy bug through fungal biocontrol agents. Five entomopathogenic fungi viz., *Verticillium lecanii, Paecilomyces lilacinus, Metarhizium anisopliae, Isaria farinosa*and *Beauveria bassiana* were evaluated against different developmental stage of *P. selonopsis* under in-vitro condition. These entomopathogenic fungi greatly reduced the survival of different life stages of *P. solenopsis* as compared to the control. However, their effectiveness was varied with the species used. On 1st instar *P. lilacinus* caused significantly maximum mortality followed by *B. bassiana*, *M. anisopliae* and *V. lecanii*. *B. bassiana* caused 100% mortality on 2nd instar; whereas, *P. lilacinus, V. lecanii,* and *M. anisopliae* caused 90% reduction in mealy bugs. In 3rd instar *M. anisopliae* caused significantly highest mortality of 100% followed by *B. bassiana* (88%) and *P. lilacinus* (86%). Among different entomopathogenic fungi, *B. bassiana* and *M. anisopliae* were highly effective on adult female mealy bug and caused 100% mortality. Present investigation revealed variable LD_{50} values of entomopathogenic fungi against *P. solenopsis.* They are 1.372×10^7 conidia/ml, 7.063×10^6 conidia/ml, 4.173×10^7 conidia/ml, 1.69×10^6 conidia/ml and 6.615×10^6 conidia/ml for *B. bassiana, M. anisopliae,I. farinosa, V. lecanii* and *P. lilacinus*, respectively.

Keywords: Okra, *Phenacoccus solenopsis*, Entomopathogenic fungi

IDENTIFICATION OF INSECT RESISTANCE IN EXOTIC TOMATO CULTIVARS VIA CHOICE BIO-ASSAY AND TRICHOME ANALYSIS IN ARID REGION

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ABSTRACT

Tomato (*Solanum lycopersicum*) is an important growing vegetable across the world. In Pakistan numerous factors are responsible of low tomato production including damages due to insect pests. There is lack of identification of insect pest resistance in Pakistani tomato varieties. The objective of present study was to characterize 22 varieties of tomato on the base of resistance to insects like fruit borer, aphid (adult/nymph) and Shoot fly. Insect resistance was analyzed by using choice Assay. In most of the varieties, Type V and type VI trichomes were abundant but type II were found lesser. Insect infestation data was correlated with trichomes density and Isogenic line Money maker, Balady, Allround, Floradel, M.O.G. 10 and Jaguar showed negative correlation. Preliminary trichomes analysis via choice assay is associated with insect resistance over certain tomato varieties and this can help breeders to develop insect resistant varieties in future.

Keywords: *Solanum lycopersicum*, Trichomes, Semio-chemicals, Resistance, Insect pests

INSECTICIDAL ACTIVITY OF EMAMACTIC BANZOATE AND BOTANICAL EXTRACTS TOWARDS TOMATO FRUIT WORM, *Helicoverpa armigera*

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ABSTRACT

The Experiment was conducted in field on tomato crop grown in the Research area of Department of Agricultural Entomology B.Z.U. at Hafzabad Campus, Layyah during 2016. Investigations on the effect of different botanicals; Neem leaves extracts (2%), Turmeric extracts (2%), Ginger extracts (5%), Tobacco extracts (4%) and a synthetic insecticide (Emamectin benzoate) (5 ppm) against tomato fruit worm, *Helicoverpa armigera*. Lowest mean number of larvae of *H. armigera* (0.49 and 0.57) in Emamectin benzoate and in neem leaves extract and respectively and greater number of larvae was recorded in control plant^{-1} of *H. armigera* (1.19*)*. Fruit damage was less (11.10%) and in neem leaves extracts was 12.50%. Neem leaves extracts based on high yield, lower fruit infestation percentage, eco-friendly and easy to used is most operative source for managing fruitworm larvae. Turmeric, Ginger did not show effective control it.

Keywords: *Helicoverpa armigera*, Botanicals control, Synthetic insecticide

VIRULENCE OF ENTOMO-PATHOGENIC NEMATODES AGAINST FRUIT FLY (*Bactrocera zonata*) LARVAE

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ABSTRACT

Fruit fly (*Bactrocera zonata*) is a very injurious pest to the citrus industry, especially Kinnow variety, which is widely cultivated in Pakistan. At larvae stage, the fruit fly destroys the citrus fruits by interior feeding and result in high economic losses as compared to other citrus insect pests. A virulence assay was run to test the pathogenicity of four entomo-pathogenic nematodes (EPNs) species (*Steinernema asiaticum*, *Heterorhabditis bacteriophora*, *Steinernema pakistansis* and *Steinernema pakistansis*) at 28 ± 2°C temperature and 75 ± 5% relative humidity. The EPNs were applied at three different concentrations viz. 50, 75 and 100 IJs/µL of water, against the third instar larvae of fruit fly placed in sterilized soil containing Petri dishes. The data was recorded at three different time intervals viz. 48, 72, 240 hrs. The results indicated that all the EPNs species were effective at various concentrations for controlling fruit fly as compared to control treatment. The exposure time and EPNs concentrations also had significant influence on the mortality rates of fruit fly. The highest mortality rate was recorded at 72 hrs against 48 hrs. The mean mortality values at 100 IJs/µL were maximum (93.32%) for *S. asiaticum* followed by *H. bacteriophora* (81.66%) and *S. pakistansis* (84.99%). The lowest mortality was achieved in *H. indica* (73.33%). In crux, the use of EPNs to control fruit fly is a novel approach in Pakistan to reduce the fruit fly induced yield losses in citrus.

Keywords: *Bactrocera zonata*, Fruit fly, Entomo-pathogenic nematodes

BASE-LINE SUSCEPTIBILITY OF FIELD POPULATION OF *Tribolium castaneum* (HERBST) AND *Trogoderma granarium* EVERTS TO SPINOSAD IN PUNJAB, PAKISTAN

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ABSTRACT

The potential for development of resistance to spinosad was demonstrated by the existence of resistance in many insect pests of agricultural importance. Toxicity of spinosad was determined for *Tribolium castaneum* and *Trogoderma granarium* in the laboratory studies on kibbled and wheat whole wheat respectively. The impact was evaluated on five distinct populations across Punjab, Pakistan and susceptible laboratory population. The study was aiming to determine the base-line susceptibility of *T. castaneum* and *T. granarium* to spinosad, to provide a basis for future resistance monitoring. Both insects were exposed to a range of spinosad rates, including its current registered rate of 1 mg/kg (1 ppm). Mortality counts were taken after 3, 5 and 7 days post application. The results revealed highest mortality forreference strains followed by RajanPur, D.G. Khan, Multan and Layyah, while lowest was recorded for Muzaffargarh. In conclusion, the results of the present study deliver baseline data on resistance against *T. castaneum* and *T. granarium.*

Keywords: *Tribolium castaneum*, *Trogoderma granarium*, Base-line Susceptibility, Spinosad

MOLECULAR CHARACTERIZATION OF OLD WORLD BEGOMOVIRUS COMPLEX INFESTING A CONGRESS GRASS IN PAKISTAN

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ABSTRACT

During a survey in December 2013, severe viral disease leaf curling was observedin congress grass (*Parthenium hysterophorus*) weed from the vicinity of University of the Punjab, Lahore, Pakistan**.** Genomic DNA was extracted by Doyle and Doyle method then rolling circle amplification (RCA) subjected using phi29 DNA polymerase (Thermo-Scientific). The diluted RCA product was exploited in PCR to amplify whole begomovirus complex. In present study sequenced old world begomovirus genome shared nucleotide sequence identity at 94.2% with *Cherry tomato leaf curl virus* (CToLCV). The alphasatellite shared maximum nucleotide sequence 94.3% to Tobacco curly shoot alphasatellite (TbCSA). The identified betasatellite shared maximum nucleotide sequence identities at 97.5% to Papaya leaf curl betasatellite (PaLCuB). To the best of our knowledge this is a novel begomovirus disease complex infecting *P. hysterophorus* in Pakistan. Furthermore, this is the first report of CToLCV associated with DNA satellites and infecting a weed host in Indo-Pak subcontinent.

Keywords: Old world, Recombination, DNA-satellites

EFFICACY OF DIFFERENT INSECTICIDES AGAINST PINK BOLLWORM (*Pectinophora gossypiella*)

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ABSTRACT

Pink bollworm is one of the major pest of cotton, which causes huge losses in cotton yield and fiber quality of cotton. Since 2015, pink bollworm became a major threat to cotton crop. The study was conducted in the field area of Cotton Research Institute, Multan during 2016 and 2017 following randomized complete block design with three replications to evaluate the efficacy of some new and conventional insecticides against Pink bollworms. Five different insecticides (Triazophos, Bolton, Pointer, Attack and Capital plus) were used against pink bollworm. Data was observed from 25 randomly selected plants per plot before and after 3, 5 and 7 days of pesticide application. The results revealed that maximum mortality against Pink bollworm was given by Bolton (Chlorpyrifos + Gammacyhalothrin) i.e., 46.42% followed by Pointer (Triazophos+ Deltamethrin), Capital plus (Triazophos+ Betacyflathrin) and Attack (Chlorpyrifos+ Fipronil) i.e., 38.00%, 36.09% & 32.00%, respectively. While, minimum mortality against pink bollworm was given by Triazophos i.e., 28.68% after 7 days of pesticide application. Mortality rate Bolton > Pointer > Capital plus > Attack > Triazophos.

Keywords: Pink bollworm, Cotton yield, Conventional insecticides

PERSISTENCE AND EFFICACY OF NEW ENHANCED DIATOMACEOUS EARTH FORMULATIONS AGAINST STORED GRAIN BEETLES AND PSOCID

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ABSTRACT

Three new enhanced Diatomaceous Earth (DE) formulations, Inet PMS, Grain guard and Grain guard natural were evaluated for their effectiveness, persistence and progeny emergence against the red flour beetle *Tribolium castaneum*, the lesser grain borer *Rhyzopertha dominica*, the rusty grain beetle *Cryptolestes ferrugineus* and the psocid *Liposcelis paeta*e. The experiment was carried out at 30±1ºC and 65±5% R.H. in the IPM laboratory, Department of Entomology, University of Agriculture, Faisalabad. Diatomaceous earths were applied as dry dust at the dose rate of 50, 75 and 100 ppm for Inert PMS, 50, 100 and 150 ppm for Grain guard and 100, 200 and 300 ppm for Grain guard natural. Mortality data was recorded after 1, 4 and 7 days for Inert PMS, 4, 7 and 14 days for Grain guard and 7, 14 and 21 days for Grain guard natural on the treated wheat. 100% mortality of Psocid was achieved at the dose rate of 75 ppm and the same level of mortality was achieved at 100 ppm after 4 days of exposure of all insects except red flour beetle. In case of Grain guard 100% mortality was achieved after 14 days of exposure except red flour beetle at the dose rate of 150 ppm. Less mortality was observed in case of Grain guard natural in which mortality did not exceed up to 98%. Psocids were found more susceptible towards all the DEs following by *C. ferrugineus*, *R.dominica*and *T. castaneum.* Progeny emergence of psocids was suppressed by all the DEs and the less progeny production was recordedfor Inert PMS. More persistence was observed in case of Grain guard natural followed by Grain guard and Inert PMS.

Keywords: Diatomaceous earth, Progeny emergence, Mortality, Susceptible

FIRST RECORDS OF TWO SPECIES OF GENUS *Messor* FOREL, 1890 (FORMICIDAE: MYRMECINAE) ALONG WITH TROPHIC ASSOCIATIONS WITH APHIDS FROM PAKISTAN

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ABSTRACT

Members of *Messor* Forel, 1890are considered as micro engineers or soil harvester due to their nest building activities of the soil ecosystem especially in arid regions, and also affecting the surface and subsurface in the rangeland. Harvester ants of this genus perform the activities of seed collection and storage in the galleries of soil chamber. The specimens were collected from district Attock, Jhelum, Bahawalpur (Uch Sharif), Muzaffargarh (Alipur), Layyah, Mansehra (Balakot) and forest areas of Rawalpindi and Islamabad in 2015-2017 by using aspirator and net sweep. Ants were also collected from plants along with their aphid partners and preserved directly in 75% ethanol. Mounting of ant specimens was done using triangular card. Two species of genus *Messor* Forel, 1890, namely *Messor instabilis* (Linnaeus, 1767) and *Messor himalayanus* (Forel, 1902) were identified. They are recorded for the first time from Pakistan. Trophic associations of both species with aphid partners are reported for the first time also. Main identification characters supported with micro-photographs, measurements and distribution are given. A key to both species based on worker has also been given.

Keywords: New records, *Messor*, Hymenoptera, Myrmecinae, Trophic associations

CHEMICAL CONTROL OF ARMY WORM (*Spodotera exigua* H.) ON ALFALFA SEED CROP

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ABSTRACT

The studies were conducted in Rabi 2016-17 at Fodder Research Institute, Sargodha to determine the efficacy of six insecticides viz., spinosad (Spintor 480SC)@ 40 ml, chlorantraniliprole (Coragen 20SC) @ 25 ml, lufeneuron (Marshal 5EC) @ 200 ml, methoxyfenozide (Runner 280SC) @ 100, emamectin benzoate (Emamectin1.9 EC) @ 200 ml, flubendiamide (Belt 48SC) @ 50 ml per acrewith different mode of actions were tested against Army worm (*Spodopteraexigua)*in the field of lucerne crop variety SGD-Lucerne 2002. Plot size was kept 3m × 5m.Experiment was laid out under randomized complete block design (RCBD) with three replications. The data was recorded pre and post (3, 5, 7 and 10 days) treatment. All six insecticides gave excellent results as compared with control. More than 90% mortality was found with the application of spinosad, emamectin benzoate, methoxyfenozide, lufenuron and flubendamide except chlorantraniliprole which provide 85% mortality of *S.exigua* larvae after 7 days of insecticide application.

Keywords: Army worm, Alfalfa, Insecticides

A STUDY TO FIND SAFER INSECTICIDES AGAINST *Trichogramma chilonis*: AN EGG PARASITOID OF SUGARCANE AND COTTON BORERS

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ABSTRACT

The conservation of beneficial organisms like biological control agents is an essential component of any agro-ecosystem. Many insecticides being used for controlling the insect pests in cropping system are causing toxic effects on the non-target organisms present in an agro ecosystem and so there arise a need to use novel groups which have minimum side effects on natural enemies of the pests. These novel groups of chemicals could be effectively incorporated into the integrated pest management program which emphasis on using those insecticides that are compatible with the natural enemies. In this study five commonly used insecticides against cotton and sugarcane borers were laboratory tested for their compatibility with immatures of *Trichogrammma chilonis*. Results revealed that exposure to volume flexi showed minimum emergence, whereas maximum emergence was found in the application of lufenuron, flubendiamide, nitenpyram, pyriproxyfen respectively. Thus lufenuron and flubendiamide, as compare to other insecticides were found safer if used in combination with *Trichogramma chilonis* in an IPM program.

Keywords: Biological control, Toxic effects, IPM, *Trichogrammma chilonis*

PARTICLE BARRIERS AS AN ALTERNATIVE CONTROL STRATEGY AGAINST SELECTED SUBTERRANEAN TERMITES: A REVIEW

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ABSTRACT

Termites are eusocial insects, known as a pest and living in the form of colonies. Subterranean termite's workers are responsible for most of damages in various regions of the world. Due to their complex biology, behavior and hidden attack, chemicals have been the main stay for control, despite of its ill effects. Particle barrier is one of the potential control strategy if developed on scientific basis. Reviewing the available bulky literature concludes that it has the potential of controlling the pest both in laboratory and field conditions. Although particle barrier technology is failed in drawing industrial attention because of some constraints. Knowledge of morphology, particle size and shape, moisture requirement, installation guideline and public awareness are major constraints in adaptation of this technology. Particle size and shape is dependent on the morphology of the pest species along with the other constraints. As concluded in literature a specific particle barrier is effectively controlling a pest specie but failed when the source was attacked by another pest specie. Considering the limitations in installation practice, particle barriers could be an ideal control agent against selected subterranean termites with long lasting results.

Keywords: Subterranean termites, Particle barrier, Constrains, Technology adaptation

EVALUATION OF SYNTHETIC INSECTICIDES AND ESSENTIAL OILS FOR THE MANAGEMENT OF *Phyllocnistis citrella* STAINTON (LEPIDOPTERA: GRACILLARIIDAE)

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ABSTRACT

Citrus leafminer (CLM), *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) is animportant insect pest of citrus and cause extensive damage in both nurseries and mature orchards in Pakistan. The aim of this study was to assess the effectiveness of some synthetic insecticides and essential oils against citrus leafminer larvae by two different bioassay methods; leaf dip bioassay (LDB) and topical bioassay (TB). As seen from results, abamectin through topical application showed greater mortality (63.5%) of CLM larvae. Similarly, the percent mortality of CLM larvae was 53.8% after application of abamectin, when leaf dip bioassay technique was used and the percentage was higher compare to rest of chemcials. However, among tested botanicals, *Azadirachta indica* A. Jussoil showed better results with percent CLM mortality of 35.6%, through topical bioassay and 31.8% through leaf dip bioassay. In the case of *A. indica*, the LC_{50} value was also observed lower (1.88±0.373, 1.73±0.289) in LDB and TB respectively, compared to other botanicals. So, our study suggested that abamectin can effectively suppress the citrus leafminer population. Furthermore, the higher concentration of *A. indica*oil has potential to be tested as a botanical insecticide for the management of CLM larvae in an integrated approach with abamectin.

Keywords: Botanicals, Citrus, Bioassay, Insecticides, *Phyllocnistis citrella*

CONTACT TOXICITY OF FOUR DIFFERENT INSECTICIDES TO HONEYBEES (*Apis dorsata* F.) UNDER LABORATORY CONDITIONS

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ABSTRACT

Contact toxicity of chlorpyrifos, cypermethrin, deltamethrin and endosulfan against captured workers of honeybees, *Apis dorsata* (F.) was conducted under laboratory conditions using surface residual bioassay at 1000 ppm, 500, 250 and 125 ppm under complete randomized design (CRD). No control results showed that mortality of honeybees increased with the increase in concentration and exposure time. The order of toxicity of different insecticides after 24 hrs treatment was chlorpyrifos > cpermethrin > deltamethrin > endosulfan against *A. dorsata* with LC_{50} values of 29.8, 48.5, 84.1 and 88.1 ppm respectively. All the tested insecticides, proved to be highly toxic against *A. dorsata* under laboratory conditions.

Keywords: *Apis dorsata*, Bioassay, Contact toxicity, Insecticides

FIRST RECORD OF *Leptogenys hysterica* FOREL, 1900 (HYMENOPTERA, FORMICIDAE, PONERINAE) FROM MARGALLA HILLS, PAKISTAN

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ABSTRACT

The ant genus *Leptogenys* Roger, 1861 belongs to subfamily Ponerinae and are considered to be one of the most speciose genera throughout tropical and subtropical regions. Individuals of this genus prefer rotten wood, leaf litter, dead wood and under stone surface as habitats, moreover these ants mainly predate on termites and terrestrial isopods. During 2016-17 as a result of extensive surveys, workers of genus *Leptogenys* were collected from Margalla hills, Islamabad, Pakistan. *Leptogenys hysterica* Forel, 1900 based on worker caste is reported here for the first time from Rawalpindi and Islamabad, Pakistan. Description, differential diagnosis, morphometrics and illustrations are provided with notes on distributional range.

Keywords: *Leptogenys hysterica*, Ponerinae, Margalla Hills, Pakistan

NEED FOR DEVELOPMENT OF SHORT DURATION COTTON WITH SPECIAL REFERENCE TO SUSTAINABLE MANAGEMENT OF PINK BOLLWORM IN THE CHANGING CLIMATE

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ABSTRACT

Pink bollworm (*Pectinophora gossypiella*) is recognized as an important pest of cotton and can damage flowers and bolls of both *Bt* and non-*Bt* cultivars. Cry-1Ac in *Bt* cultivars is considered very effective in controlling lepidopterous larvae; therefore, the present study was carried out to investigate the impact of Cry1-Ac and the earliness index on the natural incidence of *P. gossypiella* at the Cotton Research Institute, Faisalabad. During 2015–2016, ten cultivars were used to determine the incidence of pink boll-worm infestation. The experiment was repeated for 2 years. Population of *P. gossypiella*, Cry1-Ac and earliness traits of selected cultivars was observed on advanced cultivars of cotton were observed to determine their impact on pink bollworm. Correlation coefficient results regarding days to first flower (R value = 0.66) as well as the earliness index (R value = − 0.62) exhibited a strong association with pink bollworm, but Cry1-Ac had a weak association (R value = − 0.058) with pink bollworm. The coefficient of determination (R^2) explained that variability of pink boll-worm due to Cry1-Ac, the earliness index, and days to first flower was 18.0, 38.5, and 43.5%, respectively. Principal component analysis results showed that the first two PCs expressed 87% of the total variability. Clusters made on the basis of the studied parameters revealed that clusters 2 and 3 comprised the cotton cultivars possessing earliness traits compared with cluster 1. Therefore, it can be concluded that the earliness index/short duration trait in cotton is an important component for the sustainable management of pink bollworm infestation the need for which is endless to evade the pink bollworm problem in the era of climate change.

Keywords: Earliness index, Transgenic cotton, *P. gossypiella*, Insecticidal protein

ENTOMOPATHOGENIC EFFICACY OF *Beauvaria bassiana* AND *Bacillus thuringiensis* AGAINST *Aphis gossypii* AND *Amrasca biguttula* biguttula ON OKRA UNDER FIELD CONDITIONS

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ABSTRACT

A field trial was undertaken to evaluate the potential of endophytic impact of *Beauvaria bassiana* and *Bacillus thuringiensis* for the management of insect pests of okra *Abelmoschus esculentus* (L) in the field. The insect pests include aphid species *Aphis gossypii* and jassid species, *Amrasca biguttula biguttula*. The experiment was conducted in the experimental field area of University of Agriculture Faisalabad. The okra growers used chemical insecticide for the management of insect pests of okra, but as the pesticides have their adverse effect and their adverse effect prompted us the need to identify alternate method to manage insect pests. An attractive alternative tool to control these insect pests is the use of entomopathogenic fungi and bacteria, due to their eco-friendly characteristics. Therefore, *Beauvaria bassiana* and *Bacillus thuringiensis* were used against aphids and jassids on okra. Three replications for each treatment were used. The rate of concentrations was (10^8-10^9 conidia ml^{-1}) of *Beauveria bassiana* and (10^8-10^9 spores ml^{-1}) *Bacillus thuringiensis* were applied as foliar spray. The results indicate that both combine application and as well as separately of both *B.thuringiensis* and *B. bassiana* reduced the population of aphid and jassids significantly as compare to control plot. In combine application maximum mortality were (79.57%) and (50.52%) against aphid and jassids respectively. Similarly separate application of *B. thuringiensis* and *B. bassiana* reduced the population of both aphid and jassids significantly. On the basis of present results both *B. thuringiensis* and *B. bassiana* can be used for the management of *A. gossypii* and *A. biguttula biguttula* in the field on okra crop.

Keywords: Endophytic impact, Entomopathogenic fungi and bacteria, Eco-friendly

POPULATION DYNAMICS OF CITRUS PSYLLA KUWAYAMA (PSYLLIDAE: HOMOPTERA) IN CITRUS ORCHARDS OF DISTRICT SARGODHA AND ITS CONTROL WITH FEW BOTANICAL INSECTICIDES

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ABSTRACT

Diaphornia citri is a severe pest of citrus plants throughout the world. This pest causes citrus greening disease through harsh feeding. The population increases two times during summer and spring season, when citrus trees are flushing. Different synthetic insecticides have been used to decrease its infestation but this pest has been developed the resistance against the insecticides. The present study was done to check the population dynamics of *D. citri* from Sargodha during March, April and May 2017. Data was collected from five selected orchards i.e. 40 NB, 95SB, UOS orchard, 55NB and 70NB.collection was done from those orchards having minimum area of one acre. Maximum population was recorded during mid of April to mid of May. These significant variations are due to the environmental factors specially temperature and relative humidity. On average maximum number of *D. citri* population was recorded during May (37.77/p, 30 °C, R.H. = 25%.) The minimum population was recorded during March (2.62/p, 18°C, R.H = 51%). For the control of *D. citri* 7 botanicals i.e., Neem, Dahtura, Mint, Tobacco, Lemon, Eucalyptus, Bathu and AK were applied by leaf dip method underlaboratory condition. Three concentrations of each botanical 25%, 12.5%, and 6.25% were prepared in the laboratory. Each treatment was replicated for three times. Mortality rate was recorded after 12, 24, 48, and 72 hours. Mortality was increased by increasing concentration and time after releasing of insect. Maximum mortality 48% was recorded by Neem extracted which is very effective against citrus psylla. But minimum mortality was recorded by Mint extract which was 2%.

Keywords: Population dynamics, *D. citri*, Botanicals, Mortality rate

PRELIMINARY STUDIES ON THEBLACK SCAVENGER FLIES (DIPTERA: SEPSIDAE) FROM POONCH DISTRICT, AZAD KASHMIR, PAKISTAN

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ABSTRACT

Black scavenger flies (Diptera: Sepsidae) belong to the superfamily Sciomyzoidea, are easily attracted towards the dung of various mammals, carrion, decaying organic matters, and so can easily be collected from these habitats. During our surveys, thirteen species of five genera of Sepsidae are recorded from Poonch district, Azad Kashmir, Pakistan. Of them, genus *Meroplius* Rondani, 1874 and four species viz., *Meroplius minutus* (Wiedemann, 1830), *Dicranosepsis parva* Iwasa, 1984, *Sepsis coprophila* De Meijere, 1906 and *Sepsis indica* Wiedemann, 1824 are the new records for Pakistan. An illustrated key to the local genera and species along with their diagnostic characters, distributional notes and remarks are provided.

Keywords: Preliminary, Sepsidae, Poonch, Azad Kashmir, Pakistan

EFFECT OF PUPAL DISTURBANCE ON THE ADULT EMERGENCE AND EXPLOITING BIO-PESTICIDES DETERRENCE ON THE OVIPOSITION OF *Bactrocera zonata* UNDER LABORATORY CONDITIONS

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ABSTRACT

Fruit flies are the most damaging pests of fruit and vegetables due to its high rate of reproduction, host searching ability and having the characteristic of sudden outbreaks which need proper management strategies. The aim of the study was to explore the proper handling time of pupae for mass production, biological control and to work out the environmentally safe bio-pesticides as ovipositional deterrence. These studies were carried out under laboratory conditions to determine earlier periods during pupal maturation with minimum handling damage of mechanically sorting pupae for mass rearing of fruit flies *B. zonata* needed for the surveillance, collection and production of pupal parasitoids. The sifting of pupae from saw dust had significant effect on the adult emergence of fruit fly. Results revealed that 4th or 5th day pupae when sieved from substrate gave maximum number of normal adults with good fliers. However first day and second day sifted pupae resulted into increased number of non-emerged, half emerged or deformed adults. In the ovipositon deterrence trials, it is concluded that neem seed oil gave maximum egg-laying inhibition on glass substrates as well as on fruits. While the peppermint oil gave good results on glass substrates. The present preliminary studies were carried out under laboratory conditions, so it needs repetition and after confirming the results it should be tested under field conditions.

Keywords: Fruit flies, Rearing, Pupal disturbance, Oviposition deterrence

FIELD SURVEY AND CONTROL OF CITRUS PSYLLIDS, *Diaphorina citri* KUWAYAMA (HIMPTERA: PSYLLIDAE) BY GROUND AND FOLIAR APPLICATION OF PESTICIDES

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ABSTRACT

Citrus psyllid *Diaphorina citri* infestation was monitored at a total of 28 sites in two citrus growing provinces; Khyber Pukhtonkhwa (KP), Punjab and federal capital (Islamabad) in Islamic Republic of Pakistan. Selected pesticides were also tested as ground and foliar application for their efficacy against *Diaphorina citri* nymphs and adults. The mean number of citrus psyllids ranged from 1.75 to 32.75 per leaf at nine sites in the KP province. At Islamabad the number of citrus nymphs and adults ranged 0.19 to 30.75 adults/leaf, while this number was low (0.42 to 7.75 psyllids/leaf) in the main citrus growing area (Bhalwal and Kotmomin) of Punjab province. Ground application of Imadicloprid and Temik pesticides did not show reduction in the psyllids population. Foliar application of diptrix, imadicloprid and deltamethrin kept the nymphs, and adult population of *D. citri* at minimum level for at least 30 days.

Keywords: Citrus, Control, Pakistan, Pesticides, Psyllids, Survey

EFFECT OF ALTITUDINAL CLINES OVER DISTRIBUTION OF ODONATA

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ABSTRACT

Comprehensive surveys were carried out in 27 localities for three years (2014-16) to explore Odonata fauna in tribal area of Pakistan. A total number of 438 specimens were collected resulting 26 species under 15 genera and 04 families. To check effect of altitudinal variations of species distribution the visited areas were divided in to three categories. The first category was kept less than 4000 feet while the second category ranges between 4000-6000 ft. However the third category was kept greater than 6000ft. In these categories the second category showed maximum number of 14 species. While minimum number (03 species) falls under last category. The results show a clear trend that number of species decreases on increasing elevation from sea level after a certain level. It can also be seen that most preferable altitudinal range for most of the odonates was 4000-5000ft with maximum number of family, genera as well as species represented.

Keywords: Odonata, Altitudinal clines, Tribal area, Khyber Pakhtunkhwa, Pakistan

BIOLOGICAL CONTROL OF POST HARVEST DISEASES OF FRUITS AND VEGETABLES BY USING ANTAGONISTIC MICROORGANISMS

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ABSTRACT

Post-harvest decay of fruits and vegetables accounts for significant level of postharvest diseases. About 20-25% of the harvested vegetables and fruits decay during postharvest handling. Although it is very hard to find out, the full extent of post harvests losses due to diseases during transportation and storage. Fungicides are the primary source of controlling post harvest decay. The recent trend shifting toward safer and more co-friendly alternatives for the control of post harvest decays. Different biological approaches and the use of antagonistic organisms become accepted throughout the world. Several postharvest diseases can now be controlled by microbial antagonist. Mechanism by which microbial antagonists suppress postharvest diseases is still unknown; competition for nutrients and space is widely accepted. Mixed culture of microbial antagonists appears to provide batter control of postharvest diseases over individual culture or strain. Efficacy of microbial antagonists can be enhanced by using with low concentration of fungicides and physical treatment with hot water etc but at the international level different microbial antagonist like *Debaryomyces Hansen ii* Lodder & Krejer-Van Rij, *Cryp-tococcus laurentii* kufferath & Skinner, *Bacillus subtilis*, and *Tricoderma harzianum* are being used. The result of this technique is encouraging; several factors indicate that postharvest biological control with the use of artificially introduced antagonists may prove to be an affective technology. We need to continue to explore potential uses on commercial scale.

Keywords: Antagonists, Fungicides, Biological control

EVALUATION OF PLANT EXTRACTS AGAINST *Ralstonia solanacearum*

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ABSTRACT

Ralstonia solanacearum is posing serious threat to many crops especially solanaceae vegetables around the world. In this study we have used plant extracts to inhibit the growth of *R. solanacearum*. The antibacterial activity of botanical extracts of Datura, Neem, turmeric and garlic were evaluated in different concentrations i.e. 1%, 3%, 5%, 7% and 10%. Agar diffusion method was used to test the antibacterial activity. Highest antibacterial activity was recorded with garlic at 10% concentration i.e. 5.6 cm diameter which successively reduced with decreasing the concentration. Similar trend was observed with other extracts and overall trend observed in terms of antibacterial activity was garlic > neem > turmeric > Datura. *In vivo* application of these extracts also significantly reduced the disease incidence. The potential of these plant extracts can be exploited to mimic the bacterial wilt pathogen.

Keywords: *Ralstonia solanacearum*, Plant extracts, Antagonism

BIOINFORMATICAL ANALYSIS OF PECTATE LYASES FROM DIFFERENT SPECIES OF PHYTOPARASITIC CYST NEMATODES

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ABSTRACT

Plant parasitic nematodes (PPNs) which are also known as 'the hidden enemies of plants' are well known for their considerable losses to the crop plants worldwide. They use different cell wall degradation and modifying enzymes to establish their feeding sites on the plant roots. It is very important to discover and characterize these chemical weapons used by PPNs to overcome losses by incurred by them. Pectate lyases (PLs) are one of the important catagories of cell wall degrading enzymes used by the PPNs to invade the plant tissue. By keeping these facts and importance of PLs for compatible plant-nematode interactions, present study was designed to characterized 35 different pectate lyases from different species of cyst forming PPNs using some bioinformatical tools. For this purpose, pI, GRAVY, ScL and signal peptide cleavage sites were determined to characterize the protein features of the PLs. Moreover, the protein sequence of PLs from different species were subjected to conserved motifs analysis, phylogenetic analysis, tertiary protein structure prediction and ligand based binding site prediction as well. The results depicted enormous sequence similarities for PLs in closely related nematode species. Phylogenetic analysis of protein sequences clustered 50 PLs into 4 main groups. Tertiary structure prediction analysis of 7 PLs from H. glycines species disclosed the more β- sheets than α-helix in the protein sequence of PLs. Motif analsysis resulted in 10 highly conserved motifs in the protein sequences of various PLs. Molecular operating environment (MOE) software led to the prediction of different sites involved in the interaction with pectin to induce degradation in cell wall. These results could pave the way about bioinformatical analysis of different nematode protein family to generate and enhance our understanding at the molecular basis and functioning of pectate lyases.

Keywords: Pectate lyases, Cyst nematodes, Phylogenetic analysis, Molecular docking

A COMPARATIVE ASSESSMENT OF THE FEEDING PREFERENCE OF FRUIT FLY SPECIES ON BER

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ABSTRACT

Fruit fly, *Bactrocera* spp. (Tephritidae: Dipetra) are the anxious pest of different vegetable crops and fruit orchards. *B. zonata* and *B. dorsalis* are the most abundant and serious pest of fruit orchards among the other fruit fly, species in the world. It attacks fruit like mango, guava, citrus, peach, apricot, apple and fig etc. According to an estimate loss in fruits without management have been recorded at upto 24% to cucurbits in Pakistan. Seasonal monitoring of fruit fly infestation has become the need of time so that its survival during different months can be recorded to develop a module for effective management. Monitoring was carried out under Multan conditions during 2017 on ber fruit tree. Data of fruit fly larval infestation on fruit and adult fruit fly species were recorded from different three ber varieties viz., Desi, Umeri, Kheeri, and also observed different places of pupation near the ber orchard. It was recorded that maximum population of fruit flies larvae was observed from Kheeri variety (1.09%) followed by Umeri (0.86%) and Desi (0.09%). Highest population of *B. zonata* was recorded on ber fruit while the lowest population *B. dorsalis* and no population of *Carpomyia Vesuviana* observed during whole season. Data of preference pupation place was observed and recorded that maximum population of pupa was near stem having mud (2.67%) and under tree canopy (1%).

Keywords: *Bactrocera* spp., Cucurbits, Fruit flies larvae

FIRST RECORD OF *Nothoserphus mirabilis* BRUES, 1940 (HYMENOPTERA: SERPHIDAE) FROM POTHWAR, PAKISTAN

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ABSTRACT

Nothoserphus mirabilis Brues, 1940 (Hymenoptera: Serphidae) is recorded for the first time as larval parasitoid of *Coccinella septempunctata* and *Menochilus sexmaculata* from various areas of Pothwar. Main identification characters supported with measurements and illustrations are provided with notes on distributional range.

Keywords: *Nothoserphus mirabilis*, Serphidae, Pothwar

ODONATA FAUNA OF KURRAM AGENCY (FATA), KHYBER PAKHTUNKHWA – PAKISTAN

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ABSTRACT

Odonata fauna of Kurram Agency was surveyed for the first time during 2014-2016. This area remained un-explored since birth of Pakistan (in 1947) because of uncertain ground conditions. The area represents an important ecology by having unlimited water bodies in different forms. It holds an important geographical position as well, by having Afghanistan at its North West border which is it-self very poorly known for Odonata fauna. A total of 438 dragonflies and damselflies were recorded during three successive summer seasons. More surveys are further suggested to unveil additional important species from the area.

Keywords: Odonata, Distribution, Kurram agency, FATA, Pakistan

IN VITRO EVALUATION OF FUNGICIDES AGAINST ALBUGO CANDIDA CAUSING WHITE RUST OF BRASSICA

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ABSTRACT

The oil seed Brassicas are the world third most important source of vegetable oils. In Pakistan they were grown on an area of 238861, hectares but still Pakistan has been chronically deficient in its production due to some biotic and abiotic factors that may cause reduction in yield, one of the most important biotic factors is White rust disease which also results in heavy losses. So in order to minimize losses due to white rust disease the present study was conducted at plant pathology laboratory, University of Agriculture Faisalabad, Pakistan during February 2017 to evaluate fungicides against white rust of brassica disease caused by *Albugo candida*. The five different fungicides *viz.,* Score (Difenoconazole 25% EC), Captan (50% WP), Nativo (Tebuconazole 50% EC), Amistar top (Azoxystrobin 25% + Difenoconazole 12.5% SC) and Mancozeb (Ethylene bisdithiocarbamate 37% WP) were tested at three different concentrations of 50, 100 and 150 ppm by using the poisoned food technique. Among the five different fungicides, highest percent inhibition of mycelial growth of fungus was recorded in Azoxystrobin + Difenoconazole (25%+ 12.5%) SC (97.50, 99.90 and 99.95) at all the concentrations tested with mean 99.11 percent followed by score (Difenoconazole 25%EC) with the inhibition of 97.73, 99.90 and 99.90% respectively with mean of 99.18%. Minimum inhibition was observed in Mancozeb (Ethylene bisdithiocarbamate 37% WP) with 55.83, 63.62 and 70.52% inhibition at 50, 100 and 150 ppm concentration respectively with a mean of 63.66%. In general, inhibition of radial growth of fungus increased with increase in concentration of each fungicide.

Keywords: *Albugo candida,* Fungicides, Poison food technique, Mycelial growth, Inhibition

INSECTICIDAL POTENTIAL OF AQUEOUS EXTRACTS OF NEEM AND DATURA ON *Trogoderma granarium*

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ABSTRACT

Khapra beetle (*Trogoderma granarium* Everts) (Coleoptera: Dermestidae) is recorded to be the most damaging and destructive pest of stored grains throughout the world. Present study was conducted to check the insecticidal activity of Neem and Datura extract on *Trogoderma granarium*. Different concentrations of both Neem and Datura were accessed for mortality and repellency effects viz., 1.5%, 3%, 6% and 12% respectively. Data was recorded after 24, 48, 72 and 96 hours of application. While the better result of repellency was observed in Datura. Maximum mortality percentage (43.33±0.3 & 69.67±1.14%; $p \leq 0.05$) was observed in Neem at 12% concentration after 72 and 96 hours' interval. Whereas Datura depicted less mortality (36.67±0.44 and 51.67±0.13%) at 12% after 72 and 96 hour's interval. Moreover, Datura extract showed more repellent effect than toxicity as compared to Neem extract. These results suggest that the plant extracts evaluated in this study may be useful in repellent and toxicant formulations against *T. granarium*.

Keywords: Aqueous extract, Concentration, Mortality, Repellency

EVALUATION OF DIFFERENT BIO-PESTICIDES AGAINST RICE LEAF FOLDER WITH DNA QUANTIFICATION AS PESTICIDES EVALUATING TOOL

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ABSTRACT

Studies were carried out to check the efficacy of different bio pesticides at equal concentration against *Cnaphalocrocis medinalis* (Guenee) (Lepidoptera: Pyralidae) in the Institute of Agriculture Science University of the Punjab, Lahore. In this study DNA quantification was used as pesticide screening and evaluating tool for plant genome health. Different botanicals crude extracts i.e. *Azadirachta indica, Melia azedarach, Eucalyptus globulus* and one microbial insecticide *Bt* was used in this experiment for control of rice leaf folder under Randomized Complete Block Design (RCBD) with 3 replications. The neem crude extract and microbial insecticides (Bt) gave excellent results with lowest post treated increase in leaf infestation (2.76% , 3.07% 6.60% and 4.48%, 6.06% 9.33% after 3, 9 and 16 days of application respectively) caused by *Cnaphalocrocis medinalis*. On the other hand, *Melia azedarach* and *Eucalyptus* also control the *Cnaphalcocrocis medinals* but with least efficacy. Maximum leaf folder infestation was observed in control plots. Different bio pesticides were used instead of chemical pesticides that harmful to the plant (cause genotoxicity) and checked it may bond or not with plant genome. Rice samples treated with different bio pesticides along with control were collected and extracted the DNA by using CTAB method. All the samples were on gel electrophoresis for further confirmation and quantification DNA using spectrophotometer. The bio pesticide treated rice samples showed DNA quantification value i.e. 34.45 µg/ml, 33.65 µg/ml, 31.05 µg/ml, 34.55 µg/ml, 33.88 for control, Bt, Eucalyptus, Darek and Neem respectively. The main objective of the study was to check the genotoxicity effect of bio pesticide treated rice and concluded that no harmful effect of bio pesticides on rice plant structure and cause no genotoxicity of plant genome.

Keywords: Bio-pesticide, Rice leaf folder, DNA, Treatments, Genotypes

AGE-STAGE, TWO-SEX LIFE TABLES OF THE LADY BEETLE (COLEOPTERA: COCCINELLIDAE) FEEDING ON DIFFERENT APHID SPECIES

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ABSTRACT

Life table data were collected for *Coccinella septempunctata* Linnaeus (Coleoptera: Coccinellidae) feeding on three different host aphid species, *Aphis craccivora* Koch (Hemiptera: Aphididae), *Lipaphis erysimi* Kaltenbach (Hemiptera: Aphididae) and *Myzus persicae* Sulzer (Hemiptera: Aphididae),under laboratory conditions, using age-stage, two-sex life table. The pre-adult developmental period of *C. septempunctata* was the shortest on *M. persicae* (21.12 d) and the longest on *A. craccivora* (28.81 d). Net reproductive rate (R_0) ranged from 77.31 offspring per individual on *A. craccivora* to 165.97 offspring per individual on *M. persicae*. Mean generation time (T) ranged from 39.10 d on *M. persicae* to 51.96 d on *L. erysimi*. Values of the intrinsic rate of increase (r) decreased in the order *M. persicae*, *A. craccivora* and *L. erysimi* (0.1302, 0.0864 and 0.0848 d^{-1}, respectively). The highest finite rate of increase (λ) was observed on *M. persicae* (1.1391 d^{-1}) and the lowest was observed on *A. craccivora* and *L. erysimi* (1.0903 and 1.0885 d^{-1}, respectively). This information will be useful in relation to the mass rearing of *C. septempunctata* in biological control systems.

Keywords: *Coccinella septempunctata*, Life table, Population parameters, Aphid species

IDENTIFICATION OF RICE MYCOFLORA AND MANAGEMENT OF *Drechslera oryzae*

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ABSTRACT

Among the cereals, rice has great importance as it is the leading food source for mankind. In Pakistan, rice is the 2nd major crop subsequent to wheat. Rice seeds were highly infested by various seed borne fungi which contribute in low yield causing economic losses. Among different diseases of rice, Brown leaf spot is caused by *Drechslera oryzae* which is a seed-borne pathogenic fungus, is a major threat to rice. The following research was planned to study the seed pathogenic mycoflora of rice. In this context, mycoflora of rice were studied by using standard blotter paper method. Rice seed samples were collected from Rice Research Institute, Kala Shah Kaku. After the identification of different seed borne mycoflora of rice, *D. oryzae* was isolated and purified for further studies. Effect of different fungicides was also tested on *D. oryzae* by using poison food technique as well as by seed treatment *in vitro* to find the proper chemical control against *D. oryzae*. The fungicides used for this purpose were Precure combi, Topsin M, Dithane M 45, Cabrio top and Hallonil.

Keywords: Chemical control, Rice, Seed-borne mycoflora, *Drechslera oryzae*

HOST DENSITIES, *Brevicoryne brassicae* LINNAEUS (HEMIPTERA: APHIDIDAE) ALTERS BIOTIC POTENTIAL OF APHID PARASITOID, *Diaeretiella rapae* (HYMENOPTERA: BRACONIDAE: APHIDIINAE)

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ABSTRACT

Parasitoids are most widely used group of natural enemies in biological control program of insect pest especially for aphid species. Among the aphid parasitoids, the *Diaeretiella rapae* is one of the important to parasitize the aphid specie, *Brevicoryne brassicae.* The present study was done under laboratory condition (25±2 ºC temperature and 65-70% R.H.) to assess the impact of biotic potential of *D. rapae* on *B. brassicae*. In this study we used different host densities containing; 10, 20, 40, 80 and 120 aphids. For each host density only two pairs of *D. rapae* were released. Our results showed that highest parasitism (40.95%) was observed at low host density (10 Aphids) while minimum parasitism (23.41%) was observed from highest host density (120 Aphids). The percent parasitism of 36.08%, 33.63% and 31.76% was observed in host densities of 20 aphids, 40 aphids and 80 aphids, respectively. As like parasitism the percent emergence of adult *D. rapae* from each host density 10, 20, 40, 80 and 120 aphids of about 81.17%, 69.44%, 63.34%, 48.42% and 44.76%, respectively. The coefficient of determination (R^2) values for percent parasitism and adult emergence are 91.95% and 90.24%, respectively. This indicates that regression line is perfectly fit to data which is closely related to host densities and parasitoid population. Our findings revealed that increase in host densities decreased the parasitic potential as well as percent emergence.

Keywords: *Diaeretiella rapae*, Host density, Percent parasitism, Adult emergence

IDENTIFICATION OF MULTIPLE SOURCES OF RESISTANCE IN LENTIL AGAINST SOME POTENTIAL FUNGAL DISEASES

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ABSTRACT

Four hundred-sixty-six lentil genotypes were evaluated to identify the potential sources of resistance against 4 major fungal diseases namely; Fusarium wilt (FW), collar rot (CR), botrytis grey mould (BGM) and Lentil rust (LR). Screening of germplasm was performed at hotspots under high inoculum pressure at Sialkot and Faisalabad regions during 2012-14. Most of the genotypes were susceptible to highly susceptible against all diseases. One genotype LPP 12089 was found highly resistant against FW disease while LPP 11002 was found highly resistant against BGM and LR diseases. However, 23 genotypes were found having resistance against more than one diseases. One genotype LPP 12012 was found to be resistant against all four diseases; 3 genotypes (LPP 11001, LPP 11002 and LPP 12040) were identified as best sources of multiple disease resistance for traditional lentil growing regions of Pakistan whereas 12 genotypes showing resistance against FW and CR were identified as best sources of multiple disease resistance for the regions other than traditional areas of Pakistan. These identified sources of resistance can either be used directly as resistant varieties after verifying their agronomic traits or can be used in lentil breeding programs for the evolution of multiple disease resistant varieties for commercial cultivation.

Keywords: Lentil wilt, Collar rot, Botrytis grey mold, Rust, Multiple resistance

PREDICTIVE MODEL FOR THE DEVELOPMENT OF FUSARIUM WILT OF CHILLI BASED UPON SOIL AND ENVIRONMENTAL FACTORS

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ABSTRACT

Fusarium wilt is the most destructive disease of chilli pepper in all chilli growing areas of the world. Soil and environmental factors play a crucial role in the development of disease. Knowledge of soil and environmental factors and identification of resistant sources within available germplasm against Fusarium wilt disease is very necessary. In current study, the impact of various soil and environmental factors namely maximum and minimum soil and air temperature, soil moisture, relative humidity, wind speed and rainfall was evaluated for the development of Fusarium wilt of chilli pepper. Disease predictive model based upon two years soil and environmental data was developed which explained 82.7% variability in disease development. Regression estimates of path model expressed that maximum and minimum soil temperature and maximum air temperature played significant role for the development of Fusarium wilt of chilli pepper with C.R value of 6.525, 3.078 and 14.077 respectively. Regression models on five varieties/ advanced line (Desi, Skyline, Sanam, Maxi and10553 were developed, which were in close conformity with observed values of disease incidence during two years models. It was concluded that comprehensive knowledge of soil and environmental factors is much pivotal for an apt management of Fusarium wilt of chilli pepper. Appropriate précised information of soil and environmental factors facilitates to accomplish disease by applying minimum quantity of fungicides/chemicals which consequently protect environmental pollution.

Keywords: Chilli pepper, Fusarium wilt, Soil/environmental factors, Multiple regression

EVALUATION OF PYRETHROIDS AGAINST ASIAN CITRUS PSYLLID, *Diaphorina citri* (HOMOPTERA: PSYLLIDAE) UNDER LABORATORY CONDITIONS

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ABSTRACT

The Asian citrus psyllid, *Diaphorina citri* Kuwayama (Homoptera: Psyllidae), is one of the most important pest of citrus orchards. A laboratory study was conducted to determine the toxicity of pyrethroids (Politrin-C®, Talstar®, Confidor® and Cymbush®) against *D. citri* at different concentrations through leaf dip bioassay. After 24 hour exposure period, the maximum mortality (71.15%) was recorded for Politrin-C® (Profenofos + Cypermethrin) followed by (65.05%) for Talstar® (Bifenthrin), (53.40%) for Confidor® (Imidacloprid) and (45.10%) for Cymbush® (Cypermethrin). This study can be helpful for desingning IPM program of *D. citri* in Citrus orchards.

Keywords: Citrus psyllid, Pyrethroids, Toxicity, Mortality

THE POTENTIAL IMPECT OF CLIMATIC CHANGE ONAGRICULTURAL INSECT PESTS

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ABSTRACT

Climate and weather can substantially influence the development and distribution of insects. Climatic change arising from increasing levels of atmospheric greenhouse gases would, therefore, be likely to have a significant effect on agricultural insect pests. Current best estimates of changes in climate indicate an increase in global mean annual temperatures of l °C by 2025 and 3°C by the end of the next century. Changes in climate may result in changes in geographical distribution, increased overwintering, changes in population growth rates, increases in the number of generations, extension of the development season, changes in crop-pest synchrony, changes in interspecific interactions and increased risk of invasion by migrant pests. Insects are cold-blooded organisms the temperature of their bodies is approximately the same as that of the environment. Therefore, temperature is probably the single most important environmental factor influencing insect behavior, distribution, development, survival and reproduction. Some researchers believe that the effect of temperature on insects largely overwhelms the effects of other environmental factors. The climate change induced challenges that the crop growers have to face in near future in managing harmful insect pests of their crops along with its socio-economic impacts on farming community. We feel it is timely and important that further studies pertaining to climate change driven changes in serious insect-pests of crops and planning and development of adaptive strategies needs to be undertaken to lessen the yield losses and safeguard the food security of nation.

Keywords: Climate change, Agriculture, Insect pests

RICHNESS, ABUNDANCE AND DISTRIBUTION OF ODONATA FAUNA IN KURRAM AGENCY

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ABSTRACT

Extensive field surveys were carried out first time in the history to collect Odonata fauna of Kurram Agency during the years 2014-2016. A total of 438 samples were collected yielding four families, 15 genera and 26 species. Family Libellulidae represented 19 species and found dominant followed by Coenagrionidae with five species. From this ecologically rich area new records need to be explored by conducting thorough field surveys. A checklist along with distribution is provided.

Keywords: Odonata, Checklist, Distribution, Kurram Agency, Khyber Pakhtunkhwa, Pakistan

EVALUATION OF RICE GERMPLASM FOR RESISTANCE AGAINST *Pyricularia oryzae* THE CAUSE OF RICE LEAF BLAST

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ABSTRACT

Rice is the major food crop worldwide especially of the most Asian countries like Pakistan, China and Bangladesh. It is the third largest crop of Pakistan and covers about 10% cultivated area. Rice crop is attacked by many diseases but the most lethal disease is leaf blast of rice. Rice blast caused by *Pyricularia oryzae* is one of the most important diseases in rice growing areas of the world. The use of resistance source is the most economic and effective means of reducing yield losses caused by this disease. For this purpose nursery of twenty two rice genotype including one susceptible check, Basmati C-622, was established during kharif 2017 to determine the source of resistance in rice germplasm against *P. oryzae*, the cause of rice blast disease at Ayub Agriculture Research Institute, Faisalabad by artificial inoculum with aqueous spore suspension of the pathogen. The test genotypes were evaluated against leaf blast by following the standard evaluation system for rice introduced by the International Rice Research Institute Philippines. Diversity of 22 genotypes was also assessed based on blast symptoms. Moderately resistant reactions were observed with genotype ARI-1, ARI-4, ARI-5, PK-8663, PK-3810, ARI-6, ARI-7 and ARI-8. The 22 genotypes were grouped in 4 clusters. The growing of some genotype in the same cluster is based on their similar reaction against leaf blast. The results of this study can be useful for selecting suitable genotypes for the development of blast resistant varieties through hybridization.

Keywords: Moderately resistant, Rice blast, cluster, Diversity, *Pyricularia oryzae*

THE STUDY FOR SCREENING OF DIFFERENT VARIETIES OF AUBERGINE (*Solanum melongena* L.) AGAINST COTTON JASSID (*Amrasca biguttula biguttula*)

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ABSTRACT

The aubergine is important and popular vegetable in Pakistan and jassid is a major pest of aubergine. The experiment was conducted to study the different genotypes of aubergine against jassid. The main aim of study was to find out the resistance verities for organic vegetables productions. The five different genotypes (Purple long, Green long, Round black, Black pearl and Nirala were produced to study the jassid. The experiment was conducted at institute of Agriculture sciences, university of the Punjab Lahore All the recommended agronomic practices were adopted during the experiment. RCBD was used in the experimental field with the four replications. No any plant protection procedures were applied and genotypes were selected under natural condition of insect pests' pressure. The variety Nirala showed the maximum jassid population (4.22/leaf) while other genotypes significantly differ with from the all other recorded varieties of aubergine are following i.e. green long (2.08), Round black (2.98) and black pearl (2.36). The minimum jassid population where noted on the Purple long (1.46/leaf).

Keywords: *Solanum melongena*, Aubergine resistance, Jassid, Ishida

HAEMOLYMPH ASSAY OF SILKWORM (*Bombyx mori*) L. INFECTED WITH *Bacillus thuringiensis*

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ABSTRACT

Sericulture is a distinctive field of agriculture where silkworms are reared on wide range to produce the silk. The silkworm, *Bombyx mori* is a fragile lepidopteron insect, which has been reared for silk production. Silk produce by this silk worm, it is easy to wear, comfortable and good for health so called as "Queen of Textile". Sericulture has become as an important cash crop in several regions of the world. Silkworm is very sensitive to various pathogenic diseases. There are no any silkworm species, which claimed as to diseases free or pests free. Among the bacterial diseases of *B. mori*, flacherie is very common disease which is caused by *Bacillus thuringiensis.* By this disease a huge loss is occur like weight loss of larva, reduction in cocoon quality and quantity and infestation for healthy larva. In present study, the silkworm larvae ware fed on mulberry leaves treated with *B. thuringienses*. Mulberry leaves were contaminated by spraying the Bt by hand spryer. After infection the colour of infected larva also changed from whitish to blackish brown and body fluid discharged from the midgut by rupturing the integument of silkworm. Treated leaves were fed to 4th instar. 100% mortality was recorded after 3 days. The effect of BT was calculated by measuring total haemocyte count in the haemolymhp by haemocyto meter. First and second days THC was increased like 5128/ml, 5704/ml respectively but third and fourth days THC was decreased like 1928/ml, 344/ml respectively. Result showed that the bacterial infection on silkworm was decreased 90% on 4th days as compare to normal values. The present observation indicated that due to physiological weakness of silkworm larvae become susceptible to various pathogenic diseases due to loss of immunity.

Keywords: Haemocyte, *Bombyx mori,* Mulberry leaves, Pathogenic diseases

SPATIO-TEMPORAL POPULATION VARIATIONS OF MOSQUITO LARVAE IN DISTRICT MUZAFFARGARH, PAKISTAN

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ABSTRACT

Mosquitoes are famous to transmit epidemic diseases in human and animals. Female mosquitoes feed on human and animal blood to lay their eggs. At the same time, they transmit diseases. Dengue, malaria and chickungunya are important diseases, transmitted by mosquitoes. Pakistan has favorable environment for the breeding of mosquitoes. In southern Punjab, every year, the cases of mosquito borne diseases have been reported. So, there is a need to identify the mosquito species present in district Muzaffargarh, Punjab Pakistan, and factors affecting changes in their populations. So for, dengue vectors have not been confirmed from the area under study. The study was helped us to confirm the existence of *Aedes* mosquitoes in district Muzaffargarh. Mosquito larvae were collected from various potential habitats in the district Muzaffargarh and biotic and abiotic parameters were also been recorded. Some of larvae were also collected, boiled and preserved in ethylalchol where as few of them used for rearing in laboratory so that further identification should be done. It was concluded that the population of mosquito was high near vegetation and the water quality were also affect the population of mosquito. The maximum population was recorded in month of july-september where as minimum population was present in October and November. There were no any mosquitos present in air water cooler and in tyers which contains water. The populations of mosquito were present in sewerage water placed in open place near garbage. Further study for identification will be done later.

Keywords: Mosquitoes, Epidemic diseases, Dengue, Malaria, Muzaffargarh

RESPONSE OF SOIL-INHABITING MITES (ACARI: ORIBATIDA) AS A BIOINDICATOR TOENVIRONMENTAL VARIATIONS AND AGRICULTURAL PRACTICES: REVIEW

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ABSTRACT

Oribatid mites poorly explored from Pakistan which play important rule for the benefits of agricultural soils along with other soil-inhabiting microorganisms. Most of oribatid mites inside soil feed on the organic material, fungi while some shows the predatory and scavenger like behavior. Previous evidences show that climatic changes and land used practices effect the soil-inhabiting animals. Environmental factors play important role for the building of soil mites communities by giving the food resource competition and environmental filtering as well as limitation of their dispersal. Orbited mites show, their extreme reaction against the change in soil moisture, temperature, heavy metal accumulation and organic matter content with in soil along some agricultural practices. Oribatid mites, responses towards different environmental variations and agricultural practices worth to study. Now, we have a lot research knowledge related to the said mites communities formation against different factors. The aim of this review to answer the environmental and agricultural problems by using oribatid mitesas a detector by taking only one sample from a specific area.

Keywords: Acari, Oribatid mites, Bioindications, Environmental variations

EFFECT OF MICROWAVE RADIATIONS FOR THE APPROPRIATE CONTROL OF STORED GRAIN INSECTS AND PESTS

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ABSTRATCT

Globally a valuable part of the stored products are being loss due to harmful stored grains. Currently in the whole world for the management of stored grains, various chemicals are being used excessively.These chemicals leave carcinogenic toxins on the treated food. To avoid this problem there are many ways to minimize the loss due to stored grains. Microwave radiation is also a good strategy to control the harmful insects and pests of stored products. The use ofmicrowave radiations by the application of "Magnetron" had shown brilliant results. Technique is used excessively worldwide especially for quarantine measures. Recently different stored grain pests like *Sitophilus zeamais, Tribolium castaneum and Plodia interpunctella* are controlled at power levels of 300, 400, 500 and 600 W with the exposure times of 14 and 28 s. Complete mortality of *S. zeamais* and *T. castaneum* larvae and adults was attained at 600 W for 14 s or at 500 W for 28 s, whereas for *P. interpunctella* larvae and adults, one hundred percent mortality was obtained at 500 W for 14 s or at 400 W for 28 s. The effect of microwave radiations was studied on two stored products insects, *Tribolium confusum* and *Callosobruchus maculatus* in wheat flour and cowpea seed respectively. All experiments were conducted at five exposure times of 5, 10, 15, 20 and 25 secs at power level of 400 W. Complete mortality of *T. confusum* adults was obtained at 25 secs, whereas 98.8% mortality was obtained the same exposure time for *C. maculatus* adults. So the application of microwave radiations for the control of stored grain pests could be better than pesticide application. But the technique is not popular enough because of its some limitation like non-uniform heating, grain quality damage and lack of technical labor that can be handled by further research and implementation.

Keywords: Pest control, Microwave radiation, Stored grains insects, Application

ANTIFUNGAL POTENTIAL OF DIFFERENT BIOCONTROL AGENTS AGAINST *Alternaria solani* CAUSING EARLY BLIGHT OF TOMATO

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ABSTRACT

Tomato is most important vegetable crop in Pakistan. It is attacked by number of diseases which directly reduced its production. Early blight caused by *Alternaria solani* is most destructive disease of tomato. Different fungicides have been used for its management but their continuous use develop resistance in pathogen and also cause human health hazards. In present study, four different biocontrol agents namely, *Bacillus subtilis*, *Trichoderma asperellum*, *Trichoderma viride* and *Trichoderma harzianum* were assessed by using dual culture, volatile and nonvolatile metabolites assay against *A. solani*. Results showed that all tested biocontrol agents significantly inhibited the mycelial growth of targeted pathogen under laboratory conditions. In dual culture assay, maximum inhibition of pathogen was showed by *T. asperellum* (79.3%) followed by *B. subtilis* (74.6%), *T. harzianum* (71.7%) while minimum inhibition was showed by *T. viride* (62.1%). Among metabolites, nonvolatile metabolites showed highest growth inhibition as compared to volatile metabolites. Nonvolatile metabolites of *T. asperellum* showed maximum inhibition about 72% and minimum inhibition (46.9%) was recorded by *T. viride* as compared to other tested treatments. While volatile metabolites of *T. asperellum* showed maximum inhibition percentage about 64.2% and minimum inhibition was showed by *B. subtilis* (35.5%) as compared to other tested treatments. On the basis of results, it is concluded that biocontrol agents have great potential for effective management of early blight disease.

Keywords: Tomato, Early blight, Biocontrol agents, Antagonism, Metabolites

SUSCEPTIBILITY STATUS OF SUNFLOWER HYBRIDS AGAINST WHITEFLY, JASSID AND HEAD MOTH UNDER NATURAL FIELD CONDITIONS IN PAKISTAN

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ABSTRACT

Insect pests are tremendously decreasing the yield of sunflower so the current research was conducted to screen the sunflower hybrid against insect pests under natural field conditions at Oilseeds Research Institute, AARI Faisalabad, Pakistan. Nineteen sunflower hybrids were screened to evaluate their susceptibility to major insect pests during the year 2017 with three replications by adopting Randomized Complete Block Design (RCBD) at experimental research area of Institute. Results represent that screened sunflower hybrids showed significant variation regarding the insect susceptibility. It is concluded that sunflower hybrids namely, FH-666 and FH-675 expressed resistant response against whitefly and head moth. Potential of these hybrids is further needed to be explored to make them resistant against Jassid and strengthen their existing resistance capability against Whitefly and Head Moth.

Keywords: Screening, Resistance source, Sunflower, Whitefly, Jassid, Head moth

BIODIVERSITY AND TAXONOMIC STUDY OF ORDER ODONATA FROM DISTRICT MULTAN, PUNJAB, PAKISTAN

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ABSTRACT

Economically odanata is very important predator of wetland and agro ecosystem because they feed on larvae of mosquito. Few years before observe that the population of odonata decrease very rapidly due to excessive use of chemical on pounds and other hydrological places for the control of mosquito and housefly population. Reductions of these populations have huge effects on the beneficial insect like odonata population. The main diet of adult odonata is a immature of diptera. Dragonflies are predator of both stages of dipteral order first aquatic larval stage, as nymphs or naiads, and as well as adults. They are fast, agile fliers, sometimes migrating across oceans, and are often found near water. Some odonates species live several years beneath the water surface and feed on small animal, tadpoles, small fish, and other invertebrates. Biodiversity and taxonomic study plays an important role in the species identifications and classification for specific insects in a specific area. For this purpose the survey tours were conducted in different localities of district Multan. Data was collected on daily basis with the help of arial net. After collection specimens were killed in potassium cyanide jar. Later on specimens were spread and preserved in wooden boxes. The samples were identified up to species level with the help of available literature, keys and internet source. As the result 20 species were identified on the base of morphology and physiology. These were also cross checked from NARC Islamabad. The identification keys, Photography of adults and wings were also provided.

Keywords: Biodiversity, Odonata, South Punjab

COMPARATIVE EFFICACY OF COMMERCIAL FUNGICIDES AND *Trichoderma harzianum* AGAINST FUSARIUM WILT IN STRAWBERRY

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ABSTRACT

Cultivation of strawberry (*Fragaria ananassa*) is surging among Pakistani famers due to its profit ratio as compared to other traditional crops. This crop has been attacked by various pathogens responsible for low yield. The objective of this study was to identify better approach to manage Fusarium wilt caused by *Fusarium oxysporum* f. sp. *fragariae* (Schlecht) in the field. Firstly efficacy of eight fungicides was evaluated by the poison agar technique against colony growth of *F. oxysporum* f. sp *fragariae* in-vitro. Among tested chemicals, four (Score, Topsin-M, Avito and Carbendazim) were found significantly effective to inhibit pathogen growth compared with control. Later, effectiveness of four different isolates of *Trichoderma harzianum* was also evaluated through dual culture technique against *F. oxysporum* f.sp *fragaria*e. However only one isolate of *T. harzianum* was found efficient to suppress pathogen growth. Subsequently four fungicides and an isolate of *T. harzianum* were evaluated in the greenhouse and later three chemical (Score, Topsin-M and Carbendazim)along with biocontrol isolate were subjected to field evaluation using artificial inoculation in randomized complete block design (RCBD). All three chemicals controlled wilt disease with varying degree of success. The mean results of field trials indicated that Topsin-M gave 88.0%, *T. harzianum* 80.0% while Carbendazim and Score showed 72.0% of protection in the field after 42 days. Topsin-M was found most effective followed by *T. harzianum* and can be applied for management of Fusarium wilt of strawberry in Pakistan.

Keywords: Biocontrol, Chemical Control, Dual culture, Fungicides, Inoculation, Poison agar

EVALUATION OF DIFFERENT PLANT EXTRACTS TO CONTROL PATHOGENS ASSOCIATED WITH STEM END ROT DISEASE DEVELOPMENT IN SAMAR BAHISHT CHAUNSA

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ABSTRACT

Mango is one of the world's most important fruit crop. It is the major growing fruit crop in Pakistan. At all stages of its life it suffers from a number of diseases. The main post-harvest disease of mango is stem end rot which is caused by *Lasiodiplodia theobromae.* Other pathogens associated with disease are viz *Colletotrichum gloeosporiodes, Alternaria alternata, Aspergillus niger* and *Botrytis cineria.* It causes severe losses in storage and market. The investigation was done at mango cultivar Samar Bahisht Chaunsa. The mature mango fruits were collected from the selected orchards. The samples were stored at ambient temperature (25 ^{o}C) and cold storage (12 ^{o}C). The diseased fruits were removed and the associated pathogens were isolated, identified and frequency is calculated. *L. theobromae* was most devastating fungus. At ambient temperature maximum percentage of *L. theobromae* with mean value was 47.31% followed by *C. gloeosporioides* with mean frequency of 20.84%, *A. niger* 15.03% *B. cineria* 10%, and *A. alternata* showed least mean frequency 6.81%. At cold storage *L. theobromae* was maximum having the frequency 49.25% followed by *C. gloeosporioides* with mean frequency of (20.75%), *B. cineria* (14.03%), *A. alternata* (11.89%) and *A. niger* showed least mean frequency 4.23%. Different plant extracts viz, *D. stramonium, A. sativum, A.indica* and *C. intybus* were used. The maximum inhibition of *C. gloeosporioides* and *A. niger* was shown by *A. sativm.* In case of *A. alternata* maximum inhibition was shown by *D. stramonium* and *A. indica* showed the maximum inhibition of *B. cineria* and *L. theobromae.*

Keywords: Post-harvest disease, Stem end rot, Fungus, Inhibition

EFFECT OF DIFFERENT CHEMICALS AND FUNGICIDES TO INDUCE FLOWERING AND CONTROL OF INFLORESCENCE DISEASES IN MANGO CULTIVAR-CHAUNSA SUMMER BAHISHT

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ABSTRACT

Mangoes (*Mangifera indica* L.) are universally regarded as superb fruit and one of significant fruit crop in tropical and subtropical areas of the world. Mango is prone to various diseases throughout its development stages but diseases at flowering stages of mango cause more losses and directly affect the productivity. Flowering in mango from one season to the next is unreliable because the environmental signals for flower initiation are often inconsistent. During the current research we find out the most promising synthetic chemical of laboratory grade, chemical fungicide or their possible combination which not only promote the flower development but also induce flowering and to combat inflorescence diseases which are the main reason to lessen the yield. The filed trail was performed for this research with various treatments. maximum flowering/ flower emergence was observed with the treatment KNO_3 (8.67) followed by $CaNO_3$ (7.33) and KNO_3 with the combination of champion (6.66) and $KNO_3$with the combination of cabrio top (5.33) was calculated as compared to control. Minimum flowering occurred on the plants treated with the fungicides alone i.e., Contaf plus with 3.33 as compared to control which was recorded only 1.33. Among all the chemicals Contaf plus gave best control for all the inflorescence disease in the field. Maximum disease incidence was 42.90% of BB followed by 39.00% with AN, 17.70% with MM and minimum 0.40% was recorded with powdery mildew. To induce flowering and flower setting KNO_3+ $Cu(OH)_2$ treatment showed best response in the field on mango inflorescences when used in combination while KNO_3 and $CaNO_3$ also proved to be the best for the induction of flowers when applied separately on the mango trees. Current research is amazing and tremendous regarding the induction of flowering and suppression of flower disease by the application of the chemicals either singly or in combination with one another.

Keywords: *Mangifera indica*, *Ceratocystis fimbriata*, Fungicides, Sudden death, Field

POPULATION DYNAMICS OF MEALYBUG IN CITRUS ORCHARDS OF SARGODHA AND ITS CONTROL WITH FEW BOTANICAL INSECTICIDES

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ABSTRACT

Citrus is very important crops in Sargodha region and produce orange, lemon, grapefruit, pomelo and limes. Sucking and chewing insect pest attack on citrus and cause severe loss. Among these pests mealy bug is the serious pest of citrus plants and cause 50 to 60% loss. Couple of year's mealy bug has been gained the resistance against insecticides. Insecticide also polluted our environment, so there is huge need to replace the insecticides with botanicals. Present study was conducted to check the population dynamics and control of mealy bug by plant extracts. The experiment was done in five selected locations of Sargodha region i.e. Chak#55NB, Chak#40NB, Chak#91SB, UCA field and Chak#70NB. From this region only mango mealy bug (*Drosicha mangifera*) recorded from these areas. For Calculation of population fluctuation from these areas, 5 plants were selected from each location and calculated the mealy bug 10 branches on each plant and data revised after15 days. Maximum Nymph population was recorded during the month of February and March. But adult population reached maximum level in the month of May. After collection of mealy bug from selected localities then 7 Plant extract *Azadirachta indica* (Neem), *Datura stramonium* (Dhatura), Mentha (Mint), Lemon, *palizin* (Eucalyptus), Bathu, Tobacco and Ak were applied. 6.25%, 12.5% and 25% solutions of all extract were used on mealy bug. Mortality was recorded after 24, 48 and 72 hours. Plant extracts Neem, Dhatura, Bathu, Ak, Lemon, Eucalyptus, and Mint. Maximum mortality was recorded by neem followed by Dhatura and Bathu respectively but other extracts have low rate of mortality. The percentages of results are as 44, 33, 29, 11, 3, 7 and 0.

Keywords: Plant extracts, Mealy bug, Population dynamics, Mortality rate

EFFECT OF *Pythium aphanidermatum* ON DIFFERENT VEGETABLES CROPS AND ITS INOCULUM INTENSITY

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ABSTRACT

Diseases are the primary concern in vegetable production, as they attacked by several destructive plant pathogens including the soil-borne infectious fungi. *Pythium* diseases of vegetables and field crops are considered important limitations in successful cultivation of crop plants throughout the world. The genus *Pythium* belongs to the kingdom Straminopila; phylum Oomycota; class Oomycetes; subclass Peronosporomycetidae; order Pythiales and family Pythiaceae (Alexopoulos *et al.* 1996; Dick *et al.* 1999). Among the *Pythium* species, *P. aphanidermatum* is cosmopolitan in distribution and one of the most common plant parasitic pathogen of a number of different crop plants in warmer parts of the world. Keeping in view the scarcity of information about the subject, the present studies therefore plan to determine the pathogenicity, host range and extent of losses caused by *P. aphanidermatum* to different cropsespecially the vegetables. Four isolates of *P. aphanidermatum* was isolated in very high frequency from different locations of district Hyderabad of Sindh province and from various sources from different vegetables. For confirmation of its host range pathogenicity test was conducted on chili, okra, tomato, brinjal, cluster bean, ride gourd, bottle gourd, round gourd, cauliflower, sweet paper, cucumber, coriander, radish, turnip, spinach and carrot. The all four isolates of *P. aphanidermatum* were reduced all tested vegetables plant weight, plant length and germination percentage however increased plant mortality rate. The inoculum density (10^1 to 10^6 cfu/g^{-1}soil) of all tested isolates of *P. aphanidermatum* on chili plant. The plant mortality gradually increased with each increasing inoculum level and became maximum at 106 cfu /g soil. The highest mortality of 69% and 72% observed with 10^5 and 10^6 cfu/g^{-1} soil, respectively.

Keywords: *Pythium aphanidermatum*, Vegetables, Pythium, Inoculum density, Host range

SCREENING OF SELECTED OKRA CULTIVARS AGAINST DEVELOPMENT OF ROOT-KNOT NEMATODES (*Meloidogyne incognita*)

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ABSTRACT

Okra is a valuable vegetable crop of Pakistan. It is predominantly hosted by pathogens that reduce its yield and quality. Among these yield reducing agents, root knot nematodes are very important due to their board host rang. Because of root knot nematode infestation, huge yield losses are caused by *Meloidogyne incognita.* Chemical control for this important pathogen is expensive, causes pollution problems is not environmental friendly, so present study was planned to evaluate the level of resistance among different available varieties of okra against *M. incognita* under the field conditions in experimental field area of Department of plant pathology, University of agriculture, Faisalabad during 2014-15. The selected field was already infested with *M. incognita* randomized complete block design. Data was recorded on various plant growth parameters nematode development parameters. Data was recorded after sixty days on, No. of galls per root system, nematode per root system, No. of egg masses per root system, No. of females per root system, No. of juveniles per root system, No. of leaves per plant, root length root, shoot and fruit weight. This experiment was repeated in the next growing season also. Results indicated that for various nematode population and plant growth attributes all the cultivars significantly differed with the Sabz pari 2001 and Sabz pari X Ramakrishna having best performance on over all yield by showing moderately resistant response but no variety was resistant against *M. incognita.* On over all basis and yield attributes it is recommended that Sabz pari 2001 and Sabz pari X Ramakrishna are moderately resistant to nematode infestation and should be recommended to formers in root knot nematode infested soils of Pakistan. Data was analyzed by using Statistix 8.1 statistical package.

Keywords: Pathogens, Root knot nematodes, *Meloidogyne incognita*

EMERGING RESISTANCE IN *Ceratocystis fimbriata* AGAINST COMMONLY USED FUNGICIDES IN PAKISTAN

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ABSTRACT

Ceratocystis fimbriata is the fungus causing Mango Sudden Death Disease (MSDD) in wide range of Mango orchards in Pakistan. To evaluate the efficacy of currently used fungicides, twelve systemic fungicides were evaluated in laboratory against *C. fimbriata.* Further, the best control showing fungicides were further tested in the field. Fungicides were tested in laboratory by recording mycelial growth of the fungus through poison food technique. Laboratory tests showed that Topsin-M was superior to all the other fungicides with mean mycelial growth 1.44 cm mycelial growth at 100 ppm with 86.67% growth reduction, followed by Score with 1.93 cm mycelial growth and 77.67% growth reduction. Then, two top fungicides i.e. Topsin-M and Score were tested in the field conditions. Topsin-M gave the bet response with 59.41 suppression of diseases severity and 19.65% decrease over control followed by Score with 61.09 suppression of disease severity and 16.59% decrease over control. These results, conclude that *C. fimriata* has developed resistance against most of the fungicides.

Keywords: *Ceratocystis fimbriata*, Mango sudden death disease, Fungicides, Resistance

POPULATION TRENDS OF RICE LEAF FOLDER, *Cnaphalocrocis medinalis*, ON RICE CROP IN DISTRICT JHANG, PAKISTAN

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ABSTRACT

Rice leaf folder, *Cnaphalocrocis medinalis* has attained the status of the major pest in all the rice growing areas of Punjab, Pakistan. Current trial was conducted to determine the population trends as well as to know the effect of abiotic factors on the population of *C. medinalis* on rice crop during kharif season of 2015 and 2016. Rice crop (Basmati super variety) the field was monitored for leaf-folder infestation at weekly intervals from first week of August to second week of October for evaluating the population dynamics of *C. medinalis* on rice crop. During 2015, the population peak of *C. medinalis* (1.96/plant) was observed during 4th week of September. While the population peak of *C. medinalis* (2.46/plant) was recorded during 2nd week of September during 2016. This information can be helpful for implementation of rice leaf folder control program in rice growing areas.

Keywords: Population dynamic, Rice leaf folder, Infestation, Time period

EFFECT OF SALINITY (NaCl) ON FUSARIUM WILT OF CHILLI CAUSED BY *Fusarium oxysporum* f. sp. CAPSICI

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ABSTRACT

Water salinity effect on wilt of chilli caused by *Fusarium oxysporum f. sp.* capsici. *In-vitro* six salt treatment were tested resulted considerable effect on fungal mycelia growth but at highest dose of NaCl (5 and 7 g/L) increased in sporulation were recorded. Disease severity increase with increase in dose of NaCl (2.5 to 7 g/L) applying on chilli plant significant results were recorded on (LDI) leaf damage index from 30-60 DPP. LDI were recorded at highest salt stress (NaCL) 5 and 7 g/L from 50-55% compared with control LDI. Salinity level at 2-20 g/L in water (without *FOC*) results recorded decreased in plant height from 8.7 and 30%. After inculcation of *FOC* similar effect was recorded. Increase in concentration of NaCl lower the weight of dry aerial part of plant; salt treatments (NaCl) tested 5 and 7 g/L parameters reduced from 40-45% and 30-35% compared with control. Decrease in weight of root fresh and dry from 15 to 77 and 14 to 68%, when compared unstressed plant with salinity (NaCl) levels from 2 and 7 g/L weight of fresh fruit also effected at high dose of NaCl 5 and 7 g/L tested reduced by 45 and 75%, compared with control.

Keywords: Wilt of chilli, *Fusarium oxysporum*, Fungal mycelia growth, Salinity

PRECOOLING AND POSTHARVEST FUNGICIDAL TREATMENTS INFLUENCE DISEASE DEVELOPMENT AND FRUIT QUALITY ATTRIBUTES IN SUFAID CHAUNSA

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ABSTRACT

Postharvest disease incidence along the supply chains does limit the shipment potential of mango fruit around the globe. This study was targeted to study the impact of precooling and efficacy of postharvest fungicide 'Tecto' (a.i. Thiabendazole-500 g/L) at different concentrations alone and in combination with Sportak (postharvest fungicide) (a.i. Prochloraz-450 g/L) for postharvest disease management in a commercial mango cultivar (Sufaid Chaunsa) of Pakistan. The fruit subjected to on-farm forced air-cooling and storage under low temperature conditions (11°C; 80-85% RH) had significantly lesser disease and better fruit quality along with more shelf life and higher marketability index as compared to non-precooled and traditionally transported mangoes. Moreover, non-precooled fruit had significantly higher rate of respiration (CO_2 liberation) and more weight loss as compared to the precooled fruit. Among the tested fungicidal combinations, combined application of Tecto @ 2000 ppm with Sportak @ 0.5ml/L (Tank mix; HWT-52°C; 5 min) performed better with significant disease control (i.e. stem end rot, side rot and anthracnose) and more marketability during storage and ripening. The tested alone concentrations of Tecto (1000, 1500 and 2000 ppm) could not perform well in this regard. However, the effect of "Tecto" 2000 ppm was relatively better (but non-significant) in terms of marketable fruit followed by Tecto-1500 ppm than other Tecto concentrations, Carbendazim and Mancozeb. In conclusion, precooling was helpful in increasing the shelf life of mangoes by reducing postharvest disease development, physiological weight loss and rate of respiration. Among the fungicidal treatments, 'Tecto' was not commercially effective for postharvest disease control whereas 'Sportak' exhibited significant potential in this regard.

Keywords: *Mangifera indica*, Precooling, Fungicide, Storability, Marketability, Quality

COMPARISON OF SEED HEALTH TESTING TECHNIQUES FOR DETECTION OF EARLY BLIGHT IN TOMATO SEED STOCKS AND EVALUATION OF VARIOUS TREATMENTS FOR ITS CONTROL

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ABSTRACT

Early blight is an emerging problem of tomato, a major vegetable crop in Pakistan. The current study was carried out to detect the presence of *Alternaria solani* in tomato seed stocks collected from Khyber Pakhtunkhawa and Azad Jammu & Kashmir. This research work also included the comparative study of International Seed Testing Association techniques for detection of seed-borne inoculum of *A. solani* in tomato. A random sample of 400 seeds of different varieties obtained from local market and research stations of KP and AJ&K was drawn in order to evaluate their germination and seed infection by *A. solani* using potato dextrose agar, standard blotter and deep freezing methods. The assessment results showed that among various techniques, blotter method was found to be the most effective in revealing 6.20% seed infection as compared to deep freezing method (3.18%) and PDA (0%) in detecting *A. solani* in tomato seeds collected from AJ&K. A similar trend was observed for detection of the pathogen in seeds collected from KP showing 8.22% seed infection in blotter, 3.77% in Deep freezing method and 0% in PDA. Blotter method is therefore recommended for routine seed health testing of tomato for early blight infection. Amongst locations, the samples from local market of Peshawar and Agriculture Research Station D.I Khan showed the highest infection of up to 18.58 and 13.87%, respectively, whereas seed samples from Agriculture Research Institute Mingora had the lowest seed infection (2.72%). Among varieties, Bombino (19%), Early Stone (19%), Gala (18.50%), Roma (18.25%) and Pooja (17.25%) had the highest percentage of infection whereas variety Ontario (1.16%) exhibited the least infection. In a screen house experiment conducted to determine the efficacy of fungicides and botanical extracts on disease severity and plant growth parameters, fungicides, Definite and Cobox and botanical extracts from Caralluma and Mint had a significant effect in minimizing the disease severity. Area under disease progress curve was significantly less for treated plants than inoculated control. Among fungicides, Definite (difenoconazole) gave promising results while extracts from caralluma were equally effective. A similar trend was evident for plant growth parameters. Therefore, botanical extracts should be integrated into the fungicide spray schedule to reduce resistance buildup of the pathogen against fungicides and to minimize the excessive use of fungicides.

Keyword: Early blight, *Alternaria solani*, Seed infection, Fungicides, Botanical extracts

POPULATION TREND OF APHID (*Aphis gossypii* G.) ON DIFFERENT VARIETIES OF BRINJAL UNDER FIELD CONDITIONS

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ABSTRACT

The study was carried out in the field at Multan, Pakistan to investigate the population trend of aphid, *Aphis gossypii* G. on brinjal, *Solanum melongena* during 2014-15 and 2015-16 crop seasons. Brinjal varieties Round Black, Dilnasheen, Black Beauty, Hybrid Shilpa, Bemisal and Nirala were used in the experiment. Number of aphid was recorded at weekly interval from October 15 to March 1 during both years. Aphid number was recorded on three leaves per plant from four plants per plot. Population of ladybeetle was recorded from whole plant by sampling three plants per plot. Seasonal mean number of aphid per leaf was maximum on the variety Black Beauty and lowest on Nirala during 2014-15 growing season. During 2015-16 season maximum number of aphid per leaf were recorded on the variety Round Black and lowest on Nirala. When sampling dates (pooled over varieties) were compared highest and lowest number of aphids per leaf was noted on February 1 and March 1, respectively during 2013-14. However, maximum and minimum number was recorded on February 1 and January 1, respectively during 2015-16.

Keywords: *Aphis gossypii*, *Coccinella septempunctata*, Population, *Solanum melongena*

ECO-FRIENDLY MANAGEMENT OF BACTERIAL WILT OF TOMATO USING DRIED POWDER OF *Withania coagulan*

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ABSTRACT

Thepotential of dried powders of *Withania coagulans* to control bacterial wilt (BW) of tomato was explored both, under in-vitro and in-vivo conditions. The aqueous extract (20%, w/v) of dried powder of leaves produced the maximum (20.8 mm) zones of inhibition (ZI), followed by the same concentration of succulent shoot (19.2 mm, ZI) while the minimum growth inhibition (11.2 mm, ZI) was achieved by the aqueous extracts of 5% (w/v) stem powder. Consistent with the *in-vitro* results, the higher dose (30 g kg^{-1} soil) of dried powder of leaves, under in-vivo conditions, also out-performed other treatments; it reduced the area under disease progress curve (AUDPC) by 37.54%, pathogen population g^{-1} of infested soil by 45.04%, enhanced shoot length by 37.45%, root length by 63.36%, and plant fresh biomass by 38.62% as compared to untreated inoculated control plants. The leaves powder treatment was followed by the dried powder (30 g kg^{-1} soil) of succulent shoots (tender shoots plus leaves). Among the four powder doses tested, the higher dose (30 g/kg soil) of dried powders of all parts of the medicinal plant consistently gave better results. Similarly, application of the powders 20 days before transplanting (DBT) was found to be better than the other application times. The combination of 30 g kg^{-1} soil and 10 DBT was found to be the second best treatment in terms of disease control and enhancement of yield-contributing plant growth characters. The treatment combination of 15 g/kg soil applied 0 DBT proved to be the least effective treatment. Therefore, it is concluded that dried powder of leaves and succulent shoots of *W. coagulans* applied at the rate of 30 g kg^{-1} soil, 20 DBT, can be included as an effective component of integrated disease management (IDM) against BW.

Keywords: Bacterial wilt, *Withania coagulans*, Tomato, IDM

MOLECULAR IDENTIFICATION OF CITRUS GREENING FROM PAKISTAN BY DIFFERENT MOLECULAR METHODS

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ABSTRACT

Huanglongbing (HLB) also known as citrus greening, is an important disease in Asia and has destroyed 100 million citrus trees worldwide during the last century. In recent years the presence of HLB was suspected in different citrus growing regions of Pakistan. Surveys conducted in citrus groves of Punjab, Pakistan, citrus samples exhibiting symptoms of HLB were collected. The aim of this study was to investigate the presence and the genetic diversity of CLas in Pakistan. A PCR method using specific primers allowed the detection of CLas in citrus leaves by amplification of a 1160-bp fragment from the 16S rDNA. These samples were also tested by q-PCR. All the samples which were detected positive from standard PCR also showed positive FAM/ct value with q-PCR. We further used an anti-OmpA polyclonal antibody based direct tissue blot immune assay to localize CLas in different citrus tissues. In citrus petioles, CLas was unevenly distributed in the phloem sieve tubes, and tended to colonize in phloem sieve tubes on the underside of petioles in preference to the upper side of petioles. These samples were then sequenced and phylogenetic analysis was drawn. These samples were phylogenetically related with other sequences from the rest of the world with varying degree of similarity. This is the first report of characterization of HLB from Pakistan using different molecular method.

Keywords: Citrus greening, rDNA, Tissue blot immune assay, Phylogenetically

A STUDY ON MANAGEMENT STRATEGIES ADOPTED BY VEGETABLE GROWING FARMERS AGAINST DIFFERENT DISEASES OF SUMMER VEGETABLES IN TEHSIL ZAFARWAL, DISTRICT NAROWAL

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ABSTRACT

Vegetable production has grown widely especially on a per capitabasis, which increased 60% over the last 20 years. This trend is predominantly strong in developing countries. Out of World total agricultural area, vegetables cover about 1.1% with the region of Central Asia and Europe contributing with 12% of the total global area. Vegetables being the rich source of vitamins, carbohydrates, proteins, salts and dietary fibers play an important role in maintaining human health. According to WHO (2002) recommendations for per capita consumption of vegetable should be 300-400 gm/day. In spite of the fact that nature has gifted Pakistan with diverse kinds of soil, geography, and climate which favour cultivation of various kinds of vegetables throughout the country, the area under cultivation of vegetables is 1170 thousand acres with total production of 17402 thousand tones, at contributes to maintain vegetable consumption of only 80-100 gm/day/person. The study was conducted in Tehsil Zafarwal District Narowal. Tehsil Zafarwal has 15 union councils. 8 rural union councils were selected and from each selected UC 2 villages were selected proposively where maximum vegetable farmers were available. Sample size was 131 with confidence level 95% and confidence interval 5 calculated by using www.surveysystem.com. An interview schedule technique was developed for data collection. The data obtained by this research method were analysed through a standard computer programme known as Statistical Package for Social Sciences (SPSS) for drawing conclusions and formulating the recommendations. During kharif 86.7% of them were growing cucumber, 18.9% of them were growing okra and only 11.1% of the respondents were growing cabbage in their fields. A great majority (80.0%) of the respondents was growing chilies, 65.6% tomatoes in tunnel and 11.1% were growing other vegetables. Majority of the respondents had adopted recommended disease management practices. The awareness level regarding cucumber and bitter guard was 97.8% and 100.0% of the respondents respectively. While adoption level was 64.4% and 71.2
%. Majority of the farmer's awareness level was high about the occurrence of the crops listed in the research instrument and adoption level of the practices was also founded good in almost all the summer vegetables listed in the research instruments. Mostly farmers were growing crops management practices were also significant in order to improve productivity.

Keywords: Awareness, Adoption, Management strategies, Summer vegetables

INHIBITORY EFFECT OF SOME PLANT EXTRACTS AGAINST *Alternaria alternata*

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ABSTRACT

Alternaria alternata is an important fungal pathogen of many plant species. In present study, aqueous leaf extracts of five different plants (Sisal, Chili, Datura, Parthenium and Lemon) were evaluated against *A. alternata* at three different concentrations (10%, 20%, 30%) by using food poison technique. Results showed that all extracts showed antifungal activity against *A. alternata*. Datura extract showed maximum inhibition of pathogen about 87% followed by parthenium (83.6%), sisal (76.9%), chili (68.2%) and lemon (61%) at 30% concentration as compared to other concentration. Datura and sisal extract also showed best inhibition at 10% concentration as compared to others. On the basis of results, it is confirmed that plant extracts also have antifungal potential and will be used as alternatives to chemical fungicides.

Keywords: *Alternaria alternate*, Plant extracts, Antifungal activity, Inhibition

INTEGRATION OF ENTOMOPATHOGENIC FUNGI AND ECO-FRIENDLY INSECTICIDES FOR MANAGEMENT OF *Rhynchophorus ferrugineus* (OLIVIER)

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ABSTRACT

Rhynchophorus ferrugineus is the most important destructive pest of Date palm (*Phoenix dactylifera* L.) in the world. Pakistan is the sixth largest producer and exporter of dates in the world. Losses to date palm plantations in Pakistan sometime surpass 10-20%. Most of traditional management strategies used by farmers are found insignificant to combat this voracious insect pest. The entomopathogenic fungi *Beauveria bassiana* [Bb-1, Bb-2], biorational insecticides; Lufenuron [Match 50EC) and Nitenpyram (Active 10% SL) [Ins-1 and Ins-2] respectively were applied to larval (2^{nd}, 4^{th} and 6^{th} instar), pupal and adult stages. Alone and combined effect of *B. bassiana* and insecticides were observed. The highest mortality (100%) was recorded in 2^{nd} instar larvae when exposed to combination of both agents [Bb-2+Ins-1]. Contrarily lowest mortality (67.24%) was recorded in 2^{nd} instar larvae when treated with lowest concentration of Bb (Bb-1) 20 days after treatment. The maximum pupal and adult mortality remained 88.37% and 84.58% respectively after treatment with Bb-2+Ins-1. The combination of *B. bassiana* at higher concentration whereas Nitenpyram at lower dose (Bb-2+Ins-1) was found more lethal to larval, pupal and adult stages of *R. ferrugineus*. This signifies the need of combining *B. bassiana* and biorational insecticides that can reduce the cost of management with least harm to environment and natural enemies.

Keywords: *Rhynchophorus ferrugineus*, Date palm, Entomopathogenic fungi, Mortality

EXPERIMENTAL EVALUATION OF DIFFERENT BOTANICALS AND ANTIOXIDANTS AGAINST *Bipolaris oryzae*, THE CAUSAL AGENT OF BROWN LEAF SPOT OF RICE *IN VITRO*

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ABSTRACT

Rice (*Oryzae sativa L.*) is the world's second most important cereal crop following only corn than 33% of the total populace. Nearly 482 million metric tons of rice was produced in the last harvesting year worldwide. Traditionally, countries in Asia have the largest share in world rice production. According to the most recent official data with a production volume of over 210 million metric tons in 2017. Rice is involved up to 11% of the aggregate developed territory in Pakistan (IRRI, 2016-17) creating 3.8 million metric ton yield every year. Affected grains devoured by the human can be very perilous for their wellbeing. Rice is generally affected by various pathogens as microorganisms and infection; however a large area of the noteworthy pathogens of rice trim is growths causing an enormous loss of yield of the harvest. The most important disease of rice is as darker leaf spot of rice caused by the *Bipolaris oryzae* making 52% misfortunes (yearly study 2016-17) in Pakistan. To control this disease, chemotherapeutic procedures i.e. utilization of different botanicals and plant concentrates assumed a noteworthy part to control of infection. These antifungal movement substance were practiced under vitro, plant concentrates of Neem, lemon and Aloevera @1ml, 2ml and 3ml were likewise tried under vitro conditions. From every one of these fixations, 3ml of plant gel of Neem was more powerful against the contagious development. Under vitro conditions, two antioxidants were utilized as 3mM 5mM and 9mM. From these two hostile Antioxidants, salicylic corrosive @ 9Mm restrain the development of parasite up to 95% under vitro conditions. Yet, in field, 20mM had a critical decrease in disease severity (DS) and disease incidence (DI). Notwithstanding control the ailment, utilization of phenolic mixes had incredible impact in expanding the aggregate grain yield.

Keywords: Rice, Microorganisms, Infection, Antioxidants, Yield

EFFICACY OF FOLIAR APPLICATION OF SYSTEMIC INDUCED ELICITORS TO CONTROL CITRUS LEAF MINER, *Phyllocnistis citrella* STAINTON ON ROUGH LEMON IN NURSERY

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ABSTRACT

Citrus leaf miner is one of devastating insect pest of all citrus varieties and can be controlled by different methods systemic induced resistance is one of the most effective methods to control leaf miner. Several elicitors are used to control them. Nursery of one year old plants of rough lemon was established according to RCBD randomized complete block design with 3 replications. The plants were treated with three levels of concentrations which were 3%, 5% and 7%. There were 4 treatments (Neem extacts, Garlic extract, Hydrogen peroxide, and control). Foliar application of elicitor was applied with hand sprayer on 15 days of interval by using 300ml of solution. Total three applications were applied with interval of 15 days. Data were collected on weakly basis. Maximum damage on treated plants were usually observed in control in all chemicals while minimum damage was observed at 7% in neem extract and hydrogen peroxide while Garlic extract gave minimum damage at 3 and 5%. High dose of neem extract and hydrogen peroxide gave excellent results as compared to other doses.

Keywords: Citrus leaf miner, Rough lemon, Treatments, Damage

NEW NOCTUID'S SPECIES OF THE GENUS *Leucania* OCHSENHEIMER (HADENINAE: NOCTUIDAE) FROM DISTRICT MUZZAFARGHAR

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ABSTRACT

Adults and immatures of the genus *Leucania* are serious threat to the different crops, fruits and vegetables by feeding on different portions of plants leaves. Adult are mostlypale yellow coloured. Palpi obliquely upturned where the second joint roughly scaled, and prominent, short, naked and depressed third joint. Proboscis well developed. Eyes hairy. Antennae minutely ciliated in male. Head not deeply retracted into the thorax, which is smoothly scaled. Tibia and tarsi with short hairs. Caterpillars eat the leaves of cane. Bare leaf midribs are all that remain after heavy attack. Immature of this genus mainly damages the leaves but in some cases it also affects fruits. Therefore the taxonomic study plays an important role in the species identifications and to check their biodiversity for specific insects in specific area. For this purpose collection of this genus was done with the help of light traps from the different localities of Jatoi town, District Muzzafarghar and collected specimens were killed immediately in potassium cyanide bottle jar, for the study of male and female genitalia the abdomen of collected specimens were detached and dipped in 10% KOH solution for 24 hours. Dissection of abdomen was done with the help of fine forceps and needles under stereo microscope. Genitalia were treated with 50, 60 and 70% concentrations of alcohols to make genitalia more clear. To study the wing venation both wings were detached from the body and dipped in sodium hypochlorite solution 15 to 20 minutes for descaling then washed wings with distal water 2 to 3 time to remove sodium hypochlorite. Permanent slides were made with the help of Canada balsam. Specimens were identified up to species level with the help of available literature and internet source. As the result one new species for example *Leucania iqbali* was described for the first time from Jatoi town, district Muzzafarghar. A key of identification and classification has been provided. Additional photographs of adult, wings male and female genitalia attributes were also provided.

Keywords: Taxonomic study, Muzzafarghar, Crop damage, *Leucania iqbali*

ANTIFUNGAL POTENTIAL OF FUNGICIDES AGAINST *Colletotrichum capsici* (Syd.) BUTLER AND BISBY, CAUSING ANTHRACNOSE OF CHILLI PEPPER IN PAKISTAN

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ABSTRACT

This work was conducted to evaluate in-vitro efficacy of various fungicides against *Colletotrichum capsici*. In present research, six treatments (T) viz. Carbendazim, Benomyl, Topsin-M, Antracol, Nativo, and Alliete along with control, various concentrations (C), days (D), and their interactions, i.e., (T × C), (T × D), (C × D), and (T × C × D) were exploited in a laboratory through food poison technique. Carbendazim expressed maximum colony growth (1.91 cm) as compared to all other fungicides with respect to control. Interaction between treatments and concentration (T × C) exhibited maximum colony growth of all treatments (Carbendazim, Benomyl, Topsin-M, Antracol, Nativo, and Alliete), i.e., 0.23, 0.74, 1.70, 2.14, 2.48, and 2.87 cm at 300 ppm as compared to 400 ppm and 500 ppm concentrations, respectively. Similar trend was also observed concerning interaction between (fungicides × days) and (tested concentrations × days). Results of the present study revealed that among tested fungicides, Carbendazim at 500 ppm expressed highly significant reduction in fungal growth.

Keywords: Fungicides, Food poisoned technique, Chilli, Anthracnose

RESPONSE OF ONION GERMPLASM AGAINST PURPLE BLOTCH DISEASE (*Alternaria porii*) AND ITS INTEGRATED MANAGEMENT

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ABSTRACT

Infected leaf sample were collected and then pathogen was isolated and identified. Nursery was obtained from Monsanto Pakistan and local variety and was transplanted to field for screening of the resistant genotypes against PLB and out of total eight varieties, Nasa Puri (local variety) was found highly susceptible and X-P Red (Monsanto hybrid) was found resistant towards disease. In Management trial six fungicides were used and azoxystrobin at 1% concentration gives statistically significant results by reducing the disease (10.67%) as compared to control (61.1%). Among the four plant extracts used, Neem at 15% concentration gives statistically significant results by reducing disease (31%) as compare to control (68%). The experiment was carried out under randomize complete block design (RCBD).

Keywords: Purple blotch, *Alternaria porri*, Hybrids, Fungicides, Plant extract

PCR DETECTION OF BEGOMOVIRUSES FROM CHILLIES, THEIR ASSOCIATED WEEDS IN MULTAN, REGION

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ABSTRACT

Chilli (*Capsicum annuum* L.) has its unique place in the world diet in its green fruits (as vegetable) as well as a ripe dried form (as a spice). Begomoviruses are a serious constraint causing leaf curl diseases in the cultivation of several crops in the Indian subcontinent. Leaf curl disease of chilliis now a serious problem in Pakistan. Survey was conducted in chilli field areas of Southern Punjab for identification and prevalence of Begomoviruses. The incidence of these distressing pathogens has created leaf curl diseases with causing huge losses. Leaves samples of chilies showing yellowing, vein thickening and leaf curling symptoms were collected. Weeds were also collected from these fields. Detection of pathogen was done by using PCR technique. Cotton samples infected by CLCuV were used as positive. DNA was extracted by using DNA kit. A pair of abutting oligonucleotide primers (Beg1/Beg2) was used for amplification. Total reaction mixture of 25 ul containing 5 uM Master mix, 17 uM water, 1 uM each primers and 1uM DNA template. Amplification conditions utilized were typically 35 cycles of melting at 94°C for 1 min, annealing at 50°C for 1 min and extension for 1.5 min at 72°C. All collected samples of chillies were detected positive by PCR which are badly infected. While detection of Begomoviruse was not detected from *Digeria muricata*, *Dactylotenium aegyptium, Echino chloacolonum, Horse purslane* but was detected from samples of *Amaranthus viridis* and *Chenopodium murale*. PCR products result from amplifications with primers Beg1 and Beg2 was seen on ethidium bromide stained agarose gel. Samples were the results of amplifications from nucleic acids extracted from chillies and weeds infected with Begomoviruses.

Keywords: Chilli, Begomoviruses, Leaf curl disease, CLCuV, Oligonucleotide primers

SCREENING OF TOMATO VARIETIES AGAINST BACTERIAL WILT AND ITS MANAGEMENT BY MEDCINAL PLANT *Peganum harmala*

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ABSTRACT

The study was conducted to find out resistant varieties of tomato against bacterial wilt and to evaluate the in-vitro and in-vivo antibacterial activity of medicinal plant *Peganum harmala.* For in-vitro study three different concentrations of plant parts (leaves and stem) were investigated and for in-vivo study three different doses of plant parts (leaves and stem) were evaluated in green house condition. Different concentrations of plant parts (leaves and roots) of *Peganum harmala* were tested for the in-vitro growth inhibition of the BW pathogen. For in-vivo studies, two different application methods (mixing and mulching) and three different doses viz. 0 g, 15 g and 30 g kg^{-1} soil of whole plant powder of *Peganum harmala* were tested. The experimental material was comprised of 6 varieties of tomato and a medicinal plant i.e. *Peganum harmala*. The experiment was laid out in Complete Randomized design with three replications in factorial arrangement. Among the varieties tested SAHEL F1 proved highly resistant whereas RIOGRANDE, T1359, XICO, AX831554 and NAQEEB were recorded as moderately resistant (MR) in glass house conditions. Sahel F1 took longer duration (33 days) to produce 50% wilting followed by variety AX831554 which took 15 days for the same treatment. Similarly 9 days were taken by variety Riogrande to produce 50% wilt symptoms upon inoculation with *Ralstonia solanacearum.* A fast pathogenesis by *R. solanacearum* was observed in Riogrand variety which took 9 days to show 50% wilting after inoculation. In *in-vitro* study higher concentration of leaves (18%) gave maximum zone of inhibition (ZI) value than the higher concentration of root extract. The lowest ZI was observed for 6% concentration of root-powder. Among two different application methods used for phytobiocidal management, mixing is found to be superior over mulching. All growth parameters values were higher in case of mixing of plant powder in soil than of mulching on soil surface. The lower AUDPC value and population dynamic were calculated for mixing than simply mulching on soil. While in case of doses higher dose i.e. 30 g kg^{-1} soil gave the batter control over lower doses. Hence it is concluded that 30 g succulent shoot powder of *Peganum harmala* applied through mixing could be considered as one of the component of integrated disease management (IDM) against BW.

Keywords: *Peganum harmala,* Mulching , Phytobiocidal , Tomato, *Ralstonia*, IDM

ASSESSMENT OF HEALTH STATUS OF STORED SEEDS OF OKRA *(Abelmoschus esculentus*) AT FAISALABAD AND TOBA TEK SINGH

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ABSTRACT

Okra *(Abelmoschus esculentus)* is a crop of warm season originated from *India.* Okra plant and okra seeds are prone to different diseases but the fungal diseases have significance importance. It was direly needed to conduct a comprehensive study foe she assessment of seed borne mycoflora associated with okra seeds and their management by some effective seed treatments. For this purpose survey was conducted of different localities in Faisalabad, Samundari, Gojra, Tofaa Tek Singh and Kamalia. On the *basis* of visual observations three, samples were collected from unhealthy seed lots. Okra seeds collected from 5 locations of district Faisalabad and Toba Tek Singh were examined for myco flora prevalence adopting blotter paper method and PDA medium method. Four different fimgi namely *Aspergillus nigcr, Aspergillus flavus, Fusarium oxysporum* and *Aliemaria ahernata* were predominantly detected. Identification was carried out on the basis of morphological characteristics and standardized protocols. Infection frequency of associated pathogens was calculated. Maximum frequency of okra seed associated myco flora was found in samples collected from Gojra (90.89%) and Samundari (93%). Germination rate (%), root length and shoot length was also measured to calculate the seedling vigor index. The maximum vigor index (1110) was observed in sample # 3 collected from Kamalia while it was minimum in sample # 1 collected from Gojra. Evaluation of three chemically different fungicides containing active ingredient viz; Imedacloprid-Taboconazole (Hombere), Cymoxanil+Mancozeb (Curzate) and Shinkar *in-vitro* through dipping method was done as chemical management. Curzate completely inhibited *Fusariitm oxysporum, Aspergillus flavus***,** *Aspergillus niger*and *Altemaria altemata.*

Keywords: Okra, Fungal diseases, Seed borne mycoflora, Management, Infection

DETECTION OF SEED BORNE MYCOFLORA ASSOCIATED WITH CHICK PEA AND ITS MANAGEMENT

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ABSTRACT

Legume is one of the most vital plants and is worldwide used for local consumption and exportation. Chickpea (*Cicer arietinum* L.) is a significant pulse crop grown and used globally, especially in the Asian countries. Chickpea contains a good source of protein and carbohydrates. Seed borne diseases are well known serious global threats and among those seeds Chickpea (Gram) is also a potential source. In Pakistan, these seed borne fungi are responsible for many pre or post-emergence field diseases which cause reduction in plant population and ultimately present yield losses. *In vitro* experiment was conducted to identify the mycoflora associated with 12 varieties of chickpea and used by International seed Testing Association (ISTA) techniques followed under Complete Randomized Design (CRD) in seed health testing Lab. Department of Plant Pathology, UAF. Deep-freezing, standard blotter paper and Agar plate technique were used. Efficacy of different fungicides and in different concentrations was checked within the lab conditions against seed borne fungal pathogens. *Allernaria alternata* showed the higher percentage than the other species while *Arabiei* showed lowest percent incidence on seeds of chickpea. In management, seeds are treated with Hombre giving maximum seed germination (90%) and minimum recovery of fungi (28%) as compared to control germination (61%) and other seed treated chemicals.

Keywords: Legume, Chickpea, Seed borne diseases, *Allernaria alternata*

MANAGEMENT OF SESAME CHARCOAL ROT INCITED BY *Macrophomina phaseolina* BY USING RESISTANT CULTIVARS, SOIL AND SEED TREATMENTS

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ABSTRACT

Sesame is the most important crop of the world due to its high protein contents. It suffers from several diseases but among them charcoal rot is most destructive disease caused by *Macrophomina phaseolina*. The present study was designed for management of charcoal rot of sesame by using screening trials of available germplasm, soil amendments and seed treatment through different chemicals. Eight varieties/lines (Black Till, 20011, 40009, 87002, 87008, 95002, TH-6 and TS-3) were collected from Ayub Agricultural Research Institute, Faisalabad. Screening trial was conducted in 'Research area of Department of Plant Pathology, University of Agriculture, Faisalabad. Data was recorded by using disease rating scale of (Dinkaran *et al*., 1996). Among Eight varieties/lines one variety (Black Till) showed resistant behavior. One line (20011) showed moderately resistant behavior, while three lines (40009, 87008 and 95002) showed susceptibility and one line (87002) and two varieties (TH-6, TS-3) showed highly susceptible against test pathogen. The efficacy of different fungicides at various concentrations was evaluated against test pathogen through pot culture assay in green house conditions. Among five fungicides (Hombre, Copper oxychloride, Topsin-M, Carbendazim, Metallaxyl+Mancozeb) evaluated Carbendazim gave maximum disease reduction (55.74%) at 150 ppm concentration as compared to control under greenhouse conditions, when used as seed treatment. Minimum disease reduction was given by Copper oxychloride, (43.24%) at 150 ppm concentration when used as seed treatment. Among five fungicides (Hombre, Copper oxychloride, Topsin-M, Carbendazim, Metallaxyl+Mancozeb) evaluated Topsin M gave maximum disease reduction (58.21) at 150 ppm as compared to control when used as soil treatment. Minimum disease reduction was given by Copper oxychloride, (43.65%) at 150 ppm concentration when used as soil treatment.

Keywords: Sesame, Charcoal rot, Resistant cultivars, Seed, Soil treatment

ESTIMATION OF FUNGAL POST-HARVEST ROTS PROBLEMSAS POTENTIAL THREAT FOR CITRUS COLD STORAGE AND PROCESSING INDUSTRIES

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ABSTRACT

Pakistan stands at 13th position regarding citrus production in the world. Yield losses occur in field have their own importance but post-harvest problems also cause significant losses in citrus production, harvesting, transportation and processing. The present study was designed to assess the post-harvest losses due to different fungal isolates. For this purpose diseased samples of the citrus cultivars (Sweet orange, Lemon, Musambi, Fruiter early and Grape fruit) were collected from different fruit markets and cold storage houses during September-March 2013-14 with different time intervals. These properly labeled and sealed in polythene bags brought to Seed Health Testing Lab. of Department of Plant Pathology. Different fungal species were isolated and identified from diseased fruit samples. *Penicillium digitatum* was isolated from all collected cultivars where as *Penicillium italicum* was isolated from four varieties (Sweet orange, Lemon, Musambi, Fruiter early) and *Aspergillus niger* was isolated only from two cultivars (Lemon and Sweet orange). In pathogenicity trails *P. digitatum* attained paramount importance regarding rotting of all artificially tested citrus cultivars which stored at 25°C in incubator for one week time period. Only grape fruit showed some resistant response where the diameter of covered area of *P. digitatum* colony growth was recorded as only 2cm while Musambi exhibit highly susceptible response against *P. digitatum* with 13cmcovered area and remaining cultivars showed intermediate response. *P. italicum* and *A. niger* fungal isolated found to be less virulence regarding the citrus fruit rotting ability of different cultivars. Only Musambi and Lemon showed maximum rotting effect with colony covered area of 3-5 cm after the one week of inoculation.

Keywords: Citrus, Post-harvest, Fugal rots, Potential threat

SEED BORNE MYCOFLORA ASSOCIATED WITH LENTIL (*Lens culinaris*. MEDIK) AND ITS INTEGRATED MANAGEMENT

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ABSTRACT

Leguminosae, the pulses is one of the most significant plant family, having the potential to make readily available protein, inexpensive source of simple carbohydrate and vitamins compared to some additional food product for both animals and human consumption. Among aforementioned biotic factors, playing a significant role in lesser production of lentil, are plant pathogenic microbes. As integral unit of crop production is seed so a healthy seed, free of pathogens, is obligatory for healthy crop; hence also good plant produce. Seed borne pathogens are among the prime hurdles in achieving these two goals. Seed borne mycoflora of lentil are one of major problems in lentil production. Numerous fungi are serious parasites of seed primordia; and of course, maturing and stored seeds of lentil. The present research work had been laid out to detect the seed associated fungi of lentil, their effect on seed health, vigor and germination. For the detection of seed-borne mycoflora, International Seed Testing Association (ISTA) techniques followed under Complete Randomized Design (CRD) in seed health testing laboratory in Department of Plant Pathology at University of Agriculture, Faisalabad. The fungi isolated and identified from different seed samples of lentil are of following species of; *Alternaria alternata, Ascochyta lentis, Aspergillus flavus, Aspergilus niger, Fusarium oxysporum, Penicillium* spp and *Rhizopus* spp. Minor traces of *Chaetomium* spp, *Macrophomina* spp and *Mucor* spp also appeared. After macro colonial expression on PDA pure culturing plates, the aforementioned fungal pathogens of lentil seed brought under integrated management through plant extracts and chemical control by application of various fungicides. Seed treatment with Curzate M8 and Mencozeb gave the best results in reducing the incidence and recovery (% age) of different mention pathogenic fungi and also enhance the germination of lentil seeds. Among extracts used, Neem extract gave the best results in reducing the recovery (% age) and enhanced the germination of lentil as compared to other extracts and control.

Keywords: Leguminosae, Seed primordial, Seed-borne mycoflora, Stored seeds

AN ECO-FRIENDLY MANAGEMENT OF PULSE BEETLE, (*Callosobruchus chinensis*) USING PLANTS FORMULATIONS ON CHICKPEA

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ABSTRACT

Granules pulses (*Cicer arietinum*) are grown on different 180 million hectare which is 12 to 15% of the Earth's arable soil and they reported for 27% of the world's major yield creation, among granule pulses only giving 33% of the nutritional protein Nitrogen (N) require of human being. Grams position 3rd amongst legumes on worldwide base, including 88% of the precipitation growing scheme and singly contribution almost 3rd, 4th of the legumes cultivate in Pakistan. It is an assault through numerous pest vermin to including pulse beetle, since its harsh and major insect and reason 55-60% failure in storage space, in kernel mass and 45.50-66.30% failure in quartnery structure of protein substance owing toward its harm and legume pit become ailing for human being utilization since healthy when for sowing. The persistent use of these insecticides in granaries of small-scale farmers has led to a number of problems such as killing of non-mark species, user hazards, and toxic residues in food, development of genetic resistance in the treated pest, increased cost of application and the destruction of the balance of the ecosystem. While the plant family unit Euphorbiaceae is a big family unit of blossoming plant life among three hundred genus's and about 7,500 diversities and having medicinal properties and are also reported to have insecticidal activity. Four botanicals, viz., *Azadirachta indica* (Neem), two edible seed oils viz., *Brassica juncea* (Mustard), *Linum usitatissimum* (linseed), and two inert materials, such as wood ash and sand were used for the experiment. Data was taken, analyzed and resulted that Mustard oil revealed the bare minimum time of 5.06, 5.63 and 6.64 to hundred percent fatality at its relevance charge of 1.5, 1 and 0.5 g, correspondingly, which were considerably improved to examine the Neem kernel residue, timber dust, linseed oil and sand at their every application charge. Mustard oil and sand every appliance charge were the mainly efficient in reducing offspring of PB. Mustard and linseed oil was known the smallest holes per granule at every one their appliance charge comparison to every new treatment counting the power.

Keywords: Pulses, Pulse beetle, *Azadirachta indica*, *Brassica juncea*, *Linum usitatissimum*

EFFICIENCY OF DIFFERENT INSECTICIDES ON SUCKING PEST OF Bt-COTTON

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ABSTRACT

Studies on "Efficiency of different insecticides on sucking pest of *Bt*-Cotton**"** were undertaken during Rabi 2015-2016 at farmer field of Retra Union Council Tehsil Taunsa Sharif District Dera Ghazi Khan Punjab, Pakistan. The incidence of sucking pests i.e. thrips, jassid and whiteflies was observed throughout the crop growth period in cotton. Initially, the incidence of thrips was observed from 10 days after sowing while it was from 15 DAS onwards for whiteflies. The peak incidence of thrips was observed during 5th standard week (64 DAS) with a population of 8.26 thrips/trifoliate leaf/plant. All the weather parameters together accounted for 83.23% significant variation in thrips population (R2=0.8323) and maximum and minimum temperatures, morning and evening relative humidity's also could independently affect changes in thrips population. The activity of whiteflies was observed from 50th standard week till the end of the crop season. The peak incidence of whitefly population was observed during 5th standard week (64 DAS) with a population of 1.4 nymphs/trifoliate leaf/plant. The multiple linear regression analysis revealed that all the weather factors together were responsible for 53.93% (R2 value) of total variation in whitefly population though it was non-significant. Among all the insecticides evaluated as foliar sprays, spinosad 45 SC 0.0135% was found significantly superior in reducing the thrips population followed by fipronil 5 SC 0.005%. Whereas, spiromesifen 240 SC 0.096% was found highly effective against whiteflies followed by buprofezin 10 EC 0.01%, with high percent reduction in population over control, among the neonicotiniods tested, imidacloprid 200 SL 0.06% and thiamethoxam 25 WG 0.005% were found promising against thrips, while acetamiprid 20 SP 0.004% and thiacloprid 21.7 SC 0.027% proved better against whiteflies with moderate efficacy. The seed yield of cotton was highest from spiromesifen 240 SC 0.096% (1188 kg/ha) followed by buprofezin 10 EC 0.01% (1146 kg/ha). However, all the treatments were found significantly superior over the untreated control in terms of pest' suppression and seed yield in cotton.

Keywords: Insecticides, Sucking pest, Neonicotiniods, Reduction in population

EFFECT OF MORPHO-PHYSIO CHEMICAL PLANT FACTORS ON UTILIZATION BY *Lasioderma serricorne* (F.) (COLEOPTERA: ANOBIIDAE) IN FOUR TYPES OF TOBACCO

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ABSTRACT

Flue-cured Virginia (FCV), Sun-cured Rustica (SCR), Dark Air-cured (DAC) and Air-cured Burley (ACB) were evaluated for utilization by larvae and adults of *Lasiodermaserricorne*. Leaf thickness (LT), moisture content (MC), nicotine, total sugars (TS), starch, chlorides and potassium contents were determined and the impact of these factors on utilization was worked out. Maximum utilization (6.81mg) by larvae was observed on Flue-cured Virginia (FCV) followed by Sun-cured Rustica (SCR), Dark Air-cured (DAC) and Air-cured Burley (ACB) as 5.37, 4.27 and 2.23mg respectively. Adult had utilized dark air-cured tobacco at the maximum (3.07mg). The utilization of Sun-cured Rustica (SCR) (2.58mg) and Flue-cured Virginia (FCV) (2.51mg) did not differ significantly from each other. Least utilized type of tobacco by adult stage was Air-cured Burley (ACB) (1.31mg). Hence, Dark Air-cured (DAC) was mostly utilized while Air-cured Burley (ACB) was the least utilized type. Correlation analyses revealed a positive relationship between utilization by larvae of *L. serricorne* and moisture content with correlation (r) value of 0.525. Leaf thickness had no-significant correlation (r = 0.045) with consumption by larval stage of *L. serricorne*. Adult *L. serricorne* had no correlation with moisture content (r = 0.244) and leaf thickness (r = 0.025). Larval stage of *L. serricorne* had significantly positive interaction with total sugars (r = 0.554) and starch (r = 0.588) while nicotine (r = -0.155), chlorides (r = 0.204) and potassium (r = -0.359) were no-significantly correlated with *L. serricorne* larvae. The results revealed that adult utilization had significant positive association with chlorides (r = 0.480) and no-significant relationship with nicotine (r = -0.199), total sugars (r = 0.078), starch (r = 0.219) and potassium (r = 0.052).

Keywords: Cigarette beetle, *Lasioderma serricorne*, Utilization, Nicotine, Total sugars, Starch

REPELLENT EFFECT OF *Ricinus communis* (L.) AND *Citrus paradise* (MACF.) LEAF EXTRACTS AGAINST TWO STORED GRAIN INSECT PESTS

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ABSTRACT

The present study was aimed to evaluate the repellent potential of two plant extracts against *Tribolium castaneum* (Herbst) and *Rhyzopertha dominica* (Fabricius). Plant materials were extracted using methanol and petroleum ether. Periodic analysis for the repellent effects was carried by impregnating each filter paper (half-disc of filter papers) with micropipette at concentrations (5, 10 and15%) of each of the plant extract. The repellence was recorded after 24, 48 and 72hrs of the treatments application. The findings of experimental trials presented significant mean repellency 79.21% of *T. castaneum* followed by 56.12% of *R. dominica* at 15% of methanolic extract of *Ricinus communis* after 24 hrs. Comparatively low mean repellency (48.13%) and (39.24%) was observed in case of petroleum ether extract of *Citrus paradise*.Least repellency (28.17%) was given by *R. dominica* at 5% concentration of petroleum ether based extract of *C. paradise* after exposure period of 72 hr. Overall results showed that methanolic extracts were more effective than ethanol based and extract of *R. communis* was found comparatively more effective than *C. paradise*. Hence, these findings underlined the potential repellent effects of both plant extracts and highlighted their efficient use as ecofriendly stored food protectantsinstead of hazardous synthetic pesticides.

Keywords: Stored grain pests, Repellent potential, Methanolic, Petroleum ether

C. SOIL AND ENVIRONMENT

EFFECT OF AMENDMENTS ON LEAD AND COPPER IMMOBILIZATION AND PHYTOAVAILABILITY FOR RAPESEED (*Brassica napus* L.) AND CONTINUOUS TOMATO (*Lycopersicon esculentum*) IN CONTAMINATED SOIL

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ABSTRACT

Soil contamination with heavy metals has become a global environmental-health concern. Pot trials were conducted to investigate the effects of biochar (BC), rice straw (RS), multiwall carbon nanotubes (MWCNT) and single superphosphate (SSP) on Pb/Cu immobilization and leaching by means of sequential extraction (BCR) and Total characteristics leaching procedure (TCLP), and phytoavailability of metals was assessed with rapeseed in co-contaminated soil. Moreover, the residual effect of applied amendments on Pb and Cu pyhtoavailability in promoting tomato were also observed. Results disclosed that BC was found more effective among all applied amendments, and prominently modified the distribution of Pb and Cu from acid soluble phase (less bioavailable) to residuals fractionation (nontoxic) and increased the geochemical stability in acidic soil. Metals concentrations in second grown tomato shoot treated with BC 6% were below the permissible limit set by world health organization. While, SSP was effective to reduce only TCLP-Pb to 0.2 mg L^{-1} in polluted soil, which was also below critical limit (5 mg L^{-1}). SSP was more effective for Pb immobilization, while, the bioavailability of Cu increased with increasing SSP addition. It should be careful to evaluate the impact of SSP on Cu remediation in co-contaminated soil.

The low effectiveness of MWCNT on the immobilization of Pb and Cu in soil might be due to lesser amount of MWCNT applied and could be low pH of soil. So, addition of BC could increase the immobilization of Pb and Cu and has the potential to reduce their hazard and bioavailability in two cropping patterns in co-contaminated soil.

Keywords: Immobilization, Heavy metals, Biochar, Rice straw, Multiwall carbon nanotube

EFFECT OF RHIZOBIAL CONSORTIUM ON MAIZE (ZEA MAYS L) AT GERMINATION AND EARLY SEEDLING STAGE UNDER SALINE CONDITIONS

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ABSTRACT

Germination of a seed under saline conditions is of great importance for the survival and continual growth of many plant species. Different strategies are opted to induce the salinity tolerance in crops. Inoculating the legume crops with rhizobia under saline condition is common. However, recently, rhizobial inoculation for inducing the salinity tolerance in non-legumes is also being explored. Therefore, in the present experiment, effect of rhizobial strains and their combination was studied in maize at germination and early seedling growth under variant NaCl concentrations (control, 4 and 8 dS m^{-1}). Results revealed that increasing salt concentration significantly affected the germination and growth of seedlings. However, rhizobial inoculation significantly improved all the attributes regarding germination and seedling growth. Moreover, better improvement following rhizobial consortium in the germination % (37%), germination speed (13%), germination rate (39%), mean germination time (18%) and mean daily germination (20%), vigor index (2.76 times), coleoptile length (15%), plumule length (26%), radical length (76%) length of seedlings (26%) and salt tolerance index (117%) was observed at 8 dS m^{-1} in comparison of respective un-inoculated control.

Keywords: Maize, Germination, Rhizobial consortium, Salinity stress, Salt tolerance index

GROWTH AND YIELD PERFORMANCE OF 25 GUAR (*Cyamopsis tetragonoloba* L.) GENOTYPES UNDER SALINE-WATER IRRIGATION

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ABSTRACT

Water scarcity and salinity are the major challenges faced by arid regions such as Thar Desert in Pakistan. Developing appropriate salt tolerant genotypes and salinity management practices are necessary to ensure long-term viability of agriculture in these stressed environments. This study evaluated growth and seed yield of 25 different guar genotypes under irrigation with salinity waters (3, 6 and 9 dS m^{-1}) using harvested rainwater as control under field conditions. Results indicated salinity levels had significant influence on growth and yield of guar crop. At the highest salinity level of 9 dS m^{-1}, out of 26 genotypes three genotypes (S-6005, S-8885 and 2/1) showed less than 20% reduction in plant height, one genotype (BR 90) had 15% reduction in number of branches and two genotypes (S-6049 and S-5611) produced 70% of the branches compared to control. Seed yields of genotypes ranged from 0.94 to 1.82 tons ha^{-1} under control salinity but at 9 dS $m^{-1,}$ it ranged from 0.28 to 0.89 tons ha^{-1} with genotype BR-99 producing highest seed yield under both control and highest salinity levels. Straw yield ranged from 0.89 to 3.34 tons ha^{-1} under control and the range was reduced to 0.57 to 1.4 tons ha^{-1} at 9 dS m^{-1}. Sodium concentration increased whereas K concentration and K^+/Na^+ ratio decreased with increasing salinity levels in both straw and seed samples of all the guar genotypes evaluated in this study. Based on salinity tolerance index (STI) and geometric mean productivity (GMP), out of 25 guar genotypes only four (BR-99, S-5608, 2/1, S-5615 and S-8885) were considered as tolerant. Results of our study indicated that guar can be potential commercial crop for water scarce and salt affected arid regions of the world.

Keywords: Water scarcity, Salinity, Guar, K^+/Na^+ ratio

AGRICULTURAL SUSTAINABILITY UNDER CLIMATE CHANGE: A REVIEW

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ABSTRACT

Climate change has imposed unpredictable effects on agriculture and forested lands. In some regions of the World, climate has become favorable for the cultivation but in most of the regions climate has been changed to a terrible level. Meteorological variables have also been affected due to the high magnitude of anthropogenic activities. Urbanization and industrialization have been considered as threat for productive lands. From past few decades, modern agriculture has been adversely affecting the environment due to uncontrolled use of chemical fertilizers and pesticides which are adversely affecting the biodiversity, soil and water. Organic agriculture products' demand leads to future non-climatic changes. No doubt, population pressure is a great challenge for agriculture and forestry because of providing healthy food, clean water and fresh air to breathe. Need of the time is to reduce the use of toxic and hazardous chemicals in agriculture sector by promoting apt programs i.e. climate smart & precision agriculture, re-use of agricultural, recycling of paper products etc. There is need to enhance innovation and investment activities to strengthen organic agriculture farming. Agro-forestry and urban-forestry projects should be promoted for supporting sustainability regimes. Environmentally safer and sustainability based objectives will surely lead to achieve agriculture & food and environmental security goals. Vital role of experts (in the fields of agriculture, forestry, Soil & environment and extension) will be helpful in this regard.

Keywords: Sustainable organic agriculture, Climate change, Food security

ENVIRONMENTAL AND SEASONAL VARIATIONS ON BIOACTIVE AND NUTRIENT COMPOUNDS IN RUBUS BERRIES

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ABSTRACT

This study examined the influence of seasonal (time of harvest) and environmental variation on the phytochemical composition and post-harvest shelf-life of raspberries cultivated in greenhouse (GH), high tunnels (HT) and open field (OF) cultures. Significant differences were found for different years, times of harvest, and their interactions with storage time. The content of total sugars increased from early to late harvest by 16% and 62% in the two investigated years in GH production, and by 24% and 48% in OF production, though it decreased by 30% and 15% in HT production. Generally during storage, the content of glucose and fructose increased, while the content of sucrose decreased, and often the smallest changes during storage were found at the end of the season. The highest values for titratable acidity were found at the late harvest in GH and HT production. Anthocyanin content varied significantly with time of harvest, though no consistent pattern was found, and it increased in general during storage. The content of total phenolics in the OF raspberries was twice in one of the investigated years as compared with the other, while smaller differences between years were found in GH and HT production. The ellagic acid content in general decreased from early to late harvest time in all production systems, while the vitamin C content was lower in HT and OF raspberries at the end of the season. In average for both years, no changes during storage were found in the content of vitamin C, total phenolics and ellagic acid. In conclusion, the sugar concentrations showed the greatest variability, with differences between years, within season, and during storage. Time of harvest seemed often to influence the size of the changes in sugar content during storage. Storage led to sweeter fruit with higher colour, and in general with no negative consequences on the content of bioactive compounds.

Keywords: Time of harvest, Cultivation methods, HPLC, Bioactive compounds, Quality

EFFECT OF COPPER TOXICITY ON SEED EMERGENCE, STAND ESTABLISHMENT AND COPPER ACCUMULATION OF SOYBEAN AND ITS ALLEVIATION THROUGH BIOGAS SLURRY

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ABSTRACT

The present study was aimed at investigating the toxic effect of copper on seed emergence, seedling growth, chlorophyll contents and copper concentration in different parts of soybean. Four soybean cultivars viz Walliam-82, NARC-2, Rawal-1 and Ajmeri-2104 were stressed with six Cu concentrations i.e., 50, 100, 150, 200, 250 and 300 mg Cu L-1 in two factor factorial completely randomized design with three replications. It was noted that shoot and root weights decreased gradually as the concentration of Cu increased for all cultivars especially Rawal-1 while Ajmeri-2014 was found as the most tolerant. Moreover, with the increase in the concentration of Cu, the drastic effect on growth and chlorophyll contents was recorded in Rawal-1 followed by NARC-2 > William-82 while Ajmeri-2014 showed tolerance under Cu toxic impacts. The addition of biogas slurry (BGS) improved plant growth, total chlorophyll contents and Cu concentration in soybean seedlings. Different levels of BGS (0, 2, 3, 4, and 5%) were applied but 4% significantly mitigated the adverse effect of Cu stress. It was concluded that Rawal-1 was more sensitive to Cu stress followed by Walliam-82, NARC-2 and Ajmeri-2104. Among all cultivars, Ajmeri-2014 is a suitable cultivar for Cu affected soils and BGS could be used an amendment under Cu contaminated soil to relieve the stress in soybean.

Keywords: Copper stress, Soybean, Emergence, Growth, Chlorophyll contents, Biogas slurry

GROWTH RESPONSE OF *Tamarix aphylla* IN RELATION TO WATER USE EFFICIENCY

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ABSTRACT

Today, climate change is one of the most important environmental issues in the world. It has remarkable results on plant production, water use and transport patterns. These results reflect the water use efficiency of plants, communities, and ecosystems, and finally, in vegetation distribution pattern, species composition, and ecosystem structure. Water use efficiency of plants, helps in the understanding and forecasting the responses of terrestrial vegetation to global climate change, and the adoption strategies. Water use efficiency in trees is an indication about ratio of carbon absorption to the ratio of transpiration. In agricultural research, the question of drought tolerance by increased water use efficiency has been well studied. For forest trees, this question is less clearly understood. This study underscores the beneficial impacts of water use efficiency on the growth of selected plant. The main aim of this study was to check the growth behavior of *Tamarix aphylla* at regular, average and extreme volume of water application. The research was conducted in the experimental area of the department of Forestry and Range Management, University of Agriculture Faisalabad. Seedlings of above mentioned tree species were collected from the nursery area of the department of Forestry and Range Management. Along with control level, there were four treatments. Randomized Complete Design (RCBD) was used for conducting the experiment. The sprouting potential of the said species was observed in response to water use efficiency at early development stages. Seedlings were raised in pots by irrigating at different frequencies i.e. Daily (T0), 4 days (T1), 8 days (T2), 12 days (T3), and 16 days (T4) to check the sprouting percentage and morphological parameters, at different levels of irrigation. Data regarding various morphological parameters showed variations in their performance after analysis. The impact of all the treatments on the plant height was significant. It was quite clear that the growth of *T. aphylla* was much better by increasing the water use efficiency.

Keywords: Water use efficiency, Global climate change, Drought tolerance, *Tamarix aphylla*

PROTEOMIC RESPONSE TO COLD STRESS IN DIFFERENT SILICON - ACCUMULATOR RICE (*Oryza sativa* L.)

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ABSTRACT

In rice (*Oryza sativa*) plant, silicon accumulation is directly involved in broad spectrum stress alleviation. Aim of this study is to elucidate the role of *Lsi1* gene (silicon accumulator) overexpression in response to cold stress in rice crop. Presently, two rice lines; LSD and HSD responses were studied under chilling stress (12°C/10°C; D/N). Physiological responses were detected through RWC % and REL % measurement. Molecular responses were detected through comparative 2- DE and qPCR. Enhnanced Si uptake protected leaf cells from excessive water loss as RWC% in HSD leaves remained within 80%-95% while in LSD leaf tissues it reduced up to 50%; and also kept REL% below toxic. Among 93 leaf reproducible, differential proteins; 57 proteins up regulated and 36 down regulated respectively based on ≧1.5 (up regulation) and ≦0.5 (down regulation) parameter. On the basis of MapMan functional Gene Ontology (GO), these proteins were found to be involved in thirteen important groups ; Photosynthesis (23%), Stress defense response (5%), Redox defense response (10%), Signaling proteins (2%), Carbohydrate metabolism (4%), Amino acid metabolism (5%), Secondary metabolism(4%), Nucleotide metabolism (6%), RNA regulation (4%), TCA (4%), Protein metabolism (16%), Development (2%) and Unknown functional annotation (4%). qPCR depicted coincidence with proteomics findings. Conclusively, *LSi1* overexpression enhanced Si induced cell,[s] physiological and molecular defense through insoluble silica gel deposition as well as the bioactively soluble silica form with the enzymes to trigger chilling defense pathway.

Keywords: Primary/Secondary chilling response cascade, RWC, Electrolyte leakage

COMPARISON OF CARBON SEQUESTRATION POTENTIAL AMONG DIFFERENT AGROFORESTRY TREE SPECIES AFTER TWO YEARS OF PLANTING

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ABSTRACT

Fast growing trees are cheap and efficient source of carbon sequestration and carbon stocks in environment and can be called farm friends. Potential of carbon sequestration depends upon several factors and varies according to trees species. A study was conducted for the determination of carbon sequestration and carbon storage variations among different trees species at the early stages. Along with, physio-chemical properties of soils related to treated trees. Under same set of soil and climatic conditions, 15 widely trees were planted in seedling stage. Utilizing tree biomass, carbon sequestration and stocks were measured after 2 years (2014-2016) of planting. Soil samples were employed with two different depths (0-15, 16-30 cm) from each planted tree for determination of physio-chemical characteristics of soils i.e. EC, pH, C, N, P, K and organic matter. It was resulted that *Populus deltoides* were high in carbon stocks (7.21± 1.31 kg C) with highest rate of carbon sequestration (13.21± 0.84 kg C/year as compared to others remaining trees. Carbon (mg/kg) and organic matter % were also higher in soil sample of *P. deltoids* (3.8±0.2 and 2.29±0.42) respectively than others. But nitrogen compounds were maximum in *D. sissoo* (0.063±0.04) and less in *Acacia nilotica* (0.058±0.008), similar to *Albizia lebbeck*. This research improved the better understanding related to carbon sequestration and stocks in different trees and related soils.

Keywords: Agroforestry, Carbon sequestration, Carbon stock

IMPACT OF SULPHATE AND POTASSIUM IONS UPTAKE ON GROWTH OF SUNFLOWER IN SALINE-SODIC SOIL

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ABSTRACT

Nutrients imbalance and lesser availability to crop plants is a major growth retarding factor in salt affected soils. Sulphur being the 4th essential macro nutrient improves plant growth synergistically with potassium ion by decreasing the injurious effects of salt stress under saline environment. Sulphur is taken as sulphate ion by roots of plants. To evaluate the effect of SO_4^{2-} and K^+ uptake on growth of sunflower hybrids viz. SMH-9706 and PARSUN-3 besides impact on Na^+/K^+ ratio, a study was conducted in a saline- sodic soil (ECe = 6.5 dS m^{-1} , pH = 7.7, SAR = 17), in triplicates using CRD under optimum conditions of greenhouse of LRRI, NARC, Islamabad, Pakistan. Potassium sulphate was applied @ 50 mg kg^{-1} of the soil in pots. After 35 days of germination and seedlings emergence, both the hybrids responded significantly (P = 0.01) for growth and ionic parameters. Fresh and dry mass of PARSUN-3 was higher 17 and 12% respectively than that of SMH-9706. sulphate and potassium ions uptakes were higher 6 and 8% respectively in PARSUN-3 than SMH-9706. Sulphur and potassium decreased Na^+/K^+ ratio in both the hybrids. However, this decline was higher in PARSUN-3 than SMH-9706. This study identified the way to evaluate promising genotypes of crop plants for growth and production with sulphur and potassium nutrition under saline sodic environmental conditions.

Keywords: Sunflower hybrids, Saline-sodic soil, Bio-mass, Potassium sulphate, Na^+/K^+ ratio

STRATEGIES TO ENHANCE N FERTILIZER USE EFFICIENCY IN RICE-WHEAT CROPPING SYSTEM UNDER CHANGING SCENEARIO OF CLIMATE IN PUNJAB, PAKISTAN

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ABSTRACT

Nitrous oxide among greenhouse gases is a very important gas and a main causal agent that cause global warming. Flat planting method with flood irrigation is commonly used for growing of wheat and rice, but results in inefficient use of applied nitrogen fertilizer due to poor aeration, leaching and volatilization. However, planting of wheat and rice on beds not only saves water but also improves the efficiency of nitrogen use. The objective of this study was to compare the efficacy of nitrogen use of wheat and rice crops planted on beds and flat land. The results showed that 15.02 and 16.0% higher nitrogen use efficiencies were recorded in bed planted wheat and rice crop than traditional flat method at same nitrogen level, respectively. Thus bed planting methods increased nitrogen use efficiency and indirectly reduces nitrous oxide emissions from applied nitrogenous fertilizers in wheat and rice crop fields.

Keywords: Rice-wheat system, NUE, Climate change, Bed planting

EFFECTS OF INORGANIC AND ORGANIC FERTILIZERS ON SUGARCANE PRODUCTION AND JUICE QUALITY

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ABSTRACT

Integrated use of inorganic and organic fertilizers improved the fertilizer use efficiency and ultimately reduces the emission of greenhouse gases. Impact of Humic Acid (Granular 40%) @20 kg ha^{-1}, Press Mud @20 t ha^{-1} and Bio-Fertilizer (BOP 20%) @ 250 kg ha^{-1} application under two NPK fertilizer levels (F1=100% & F2=75% of standard dose) was compared with NPK alone on sugarcane variety CPF-248 with respect to yield and quality parameters in field conditions. The results showed that germination & tillers per plant were statistically significant while the cane count, cane yield, CCS and Sugar Recovery were non-significant. Maximum cane yield (102.51 & 94.59 t ha^{-1}) in case of both the fertilizer levels (F1 & F2) respectively was recorded in the treatment (T4) of Bio-Fertilizer. The humic acid treatment (T2) performed next close to it. Maximum CCS (14.30 & 13.75%) and Sugar Recovery (13.45 & 12.93%) were recorded in (F1 & F2) levels respectively in the same treatment (T4) followed by (T2). From the study it was concluded that application of all the organic sources (Humic Acid, Press Mud and Bio-Fertilizer) gave better cane yields and sugar recovery along with 100% recommended NPK fertilizer dose i.e. @ 168-112-112 kg ha^{-1} as compared to 75% NPK fertilizer dose i.e. @126-84-84 kg ha^{-1} and control i.e. NPK fertilizer alone. Among the organic sources Humic Acid (Granular 40%) @ 20 kg ha^{-1} and Bio-Fertilizer (BOP 20%) @ 250 kg ha^{-1} performed equally better than the Press Mud @ 20 t ha^{-1} treatment as compared to control. This study depicted that integrated nutrient management should be encourage to adopt climate change.

Keywords: CPF-248, Humic acid, Press mud, CSS%

CLIMATE CHANGE SCENARIOS AND ITS IMPACTS ON AGRICULTURE SECTOR OF PAKISTAN

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ABSTRACT

Pakistan is one of the most affected countries in South Asia by climate change. An increasing emphasis on food security and the regional impacts has come to beginning of the scientific community to think about the impact of climate change. Observed changes have seen on rice, wheat and cotton crops due to temperature and precipitation in Pakistan especially in the province of Punjab. The purpose of this study is to explore the changes in climatic variables (temperature, precipitation & floods) on three major crops namely; wheat, rice and cotton in the Punjab province of Pakistan. There is a positive impact of precipitation on wheat while it is negatively affected by temperature rise. Both temperature and precipitation negatively effects the cotton production. For rice production precipitation has no effect while temperature has both positive and negative effects. Through review of different articles, we analyzed that climate change have remarkable impact on growth, productivity, yield of Rabi& Kharif crops of Pakistan.

Keywords: Wheat, Rice, Cotton, Precipitation, Climate change

ISOLATION AND SCREENING OF RHIZOBIA FOR IMPROVING GROWTH AND YIELD OF MUNG BEAN (*Vigna radiata* L.) UNDER AXENIC CONDITION

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ABSTRACT

Nitrogen is the most frequently deficient nutrient in almost all soils of the Pakistan and it is one of the macro-nutrients required in the highest amount to the plant. Application of nitrogen through fertilizers has many environmental reservations. Mung bean have ability to make symbiotic relationship with nitrogen fixing bacteria (*Rhizobium*) that are present in soil and can fix atmospheric nitrogen (N_2) into its readily available (NH_4^+) form. This symbiotic relationship between legumes and *Rhizobium* is highly specific, only specific strains can cause nodulation of mung bean. *Rhizobia* for this experiment were isolated from the root nodules of mung bean growing at different locations of Faisalabad and isolated *Rhizobia* were characterized for P-solubilization, HCN production, EPS production, Oxidase, and catalase activity. Results showed that 66, 8, 54, 52 and 47% *Rhizobium* isolates were positive in respective test. Growth promotion experiment was conducted in sand jars, in the growth room of Soil Microbiology and Biochemistry Lab. Institute of Soil and Environmental Sciences to check their effect on growth promotion and nodulation of mung bean under control conditions. Selected *Rhizobium* isolates were inoculated on mung bean seed and then inoculated seeds were sown in sand jars. Nitrogen free half strength Hoagland solution was applied for water and nutrient requirements. Data regarding growth parameters was collected after four weeks. Data was analysed statistically by using completely randomized design with three replications. Results depicted a significant increase in plant biomass, shoot length, root length, shoot fresh weight, root fresh weight and root nodulation by 110%, 46%, 98%, 97%, 130% and 3 folds, respectively as compared to (un-inoculated) control. Hence, we can conclude, on the basis of the above mentioned results that growth and nodulation of mung bean can be significantly improved by the inoculation with *Rhizobium*.

Keywords: Rhizobial inoculation, Mung bean, Oxidase, Catalase, EPS production

PHYTOSOCIOLOGICAL STUDIES AROUND THE INDUSTRIAL POLLUTED & NON-POLLUTED AREAS

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ABSTRACT

Phytosociological survey was conducted around Sindh Industrial Trading Estate (S.I.T.E.) and University Campus in order to compare the vegetation of both areas. Sampling was carried out by Point Centered Quarter Method (PCQM) in University Campus and Industrial area. Total 80 and 50 plant species were recorded in 30 and 10 observed stands in industrial area and University Campus, respectively. Different plant communities were identified in both areas (Control & Polluted) based on first dominant species. Distribution pattern of plant communities in polluted area was different than that of the University Campus. In polluted area *Abutilon fruticosum* and *Prosopis juliflora* were prominent in most of the investigated stands while in the University Campus, *Aerva javanica* and *Prosopis juliflora* showed their dominance. There were 7 common species which observed in both areas. Some important attributes of plant communities which include the total importance value index (IVI), presence class, occurrence in observed stand and their leading dominance is determined in both areas. Industrial areas vegetation was more disturbed due to industrial waste as compared to University Campus.

Keywords: Dominant species, Industrial pollution, Phytosociology, Plant communities

BIOFORTIFICATION OF MAIZE THROUGH ZINC SOLUBILIZING PLANT GROWTH PROMOTING RHIZOBACTERIA

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ABSTRACT

Bioaugmentation of Zn solubilizing rhizobacteria could be a sustainable intervention to increase bioavailability of Zn in soil which can be helpful in mitigation of yield loss and malnutrition of Zn accompanied by various direct and indirect mechanisms. In the present study, a number of pure rhizobacterial colonies were isolated from maize rhizosphere and screened for their ability to solubilize zinc oxide. These strains were screened on the basis of phosphate solubilization, production of IAA, ammonia, hydrogen cyanide, siderophores, exopolysaccharides, and the activity of urease, protease, lipase, catalase, oxidase, and utilization of citrate. Most of the selected strains showed multi-growth promoting attributes. These strains were evaluated in a jar trial for their ability to promote the growth of maize seedlings. Results revealed that inoculation of Zn solubilizing strains improved the growth of maize. In comparison, strains ZM20, ZM31, ZM63 and S10 were best in stimulating the growth attributes of maize. These strains were identified as *Bacillus* sp. (ZM20), *Bacillus aryabhattai* (ZM31 and S10) and *Bacillus subtilis* (ZM63) through 16S rRNA sequencing. The identified strains were further evaluated in pot and field trials and the results revealed that zinc solubilizing strains significantly improved the activity of antioxidant enzymes, plant growth, yield attributes and successfully biofortified the maize grains. Among treatments, co-inoculation with *Bacillus aryabhattai* (ZM31) × *Bacillus subtilis* (ZM63) demonstrated best results in all observed attributes. Zinc solubilization activity of *Bacillus* spp. strains was associated with drop in pH due to production of organic acids. The UPLC and GC-MS analysis reported seven different kinds of organic acids e.g. lactic, acetic, citric, succinic, formic, isobutyric and isovaleric acids from the cultures. Such bacteria could be very effective as bio-inoculants to improve growth, and yield of maize under nutrient deficient soil conditions and also for biofortification of minerals in cereals for human consumption to overcome the problems of malnutrition.

Keywords: Zn solubilizing rhizobacteria, Maize, Phosphate solubilization, Siderophores

FOLIAR APPLIED SALICYLIC ACID IN THE PRSESNCE OF BAGASS REDUCED DELETERIOUS EFFECTS OF SALINITY ON WHEAT

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ABSTRACT

Presence of high salts in root zone independently changes the water relationship of plant with soil and dependently increases toxicity of salts to the plant. Under this abiotic stress, the production of oxidative stress in different cellular compartments increases the accumulation of reactive oxygen species (ROS) in chloroplasts and peroxisomes. The apoplastic oxidative stress activates the signals for salicylic acid (SA) production to play its role as antioxidant. But dependent effects of salts reduce the signals for SA production which affect the plant growth. This study aimed to evaluate the comparative effects of soil and foliar applied SA on the wheat grown in the presence of organic matter (OM) in saline soil. Here we used bagass as OM, and SA was applied at the rate of 50µM. The bagass was mixed with artificially developed saline soil (EC 12 dSm^{-1}). Results showed that the chlorophyll contents of plants were higher in foliar applied SA (i.e. 13.2%) than soil applied SA (i.e. 7.3%) under saline soil conditions. In addition, seed germination, plant shoot and root lengths, leaf area, fresh and dry biomasses, and number of tillers per plant were significantly higher in the foliar applied SA treatment than that of soil applied SA under saline conditions. Interestingly, reverse behavior was observed under the normal soil conditions. The difference between growth behaviors is probably because of the salts in the root zone which reduces the availability of nutrients to the plants. Under salt stress condition, the production of reactive oxygen species (ROS) may enhance its degenerative effects on cells. The foliar application of SA at this stage may alleviate the plants by its direct availability and reduce the ROS effect on plants. At the same stage, soil applied SA showed the minor effect because of its competition with salts near the root zone; however, more SA availability in normal soil was the evidence of weak competition with salts. Here, our findings suggest that foliar application of SA could be more effective in reducing salt stresses on plants in soil.

Keywords: Salinity, Wheat, Salicylic acid, Foliar application, Soil application

CHANGES IN SOIL ORGANIC CARBON FRACTIONS WITH SOIL DEVELOPMENT IN LOESS DERIVED SOILS

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ABSTRACT

As an essential indicator of soil quality soil organic carbon and its fractions play an important role in improving soil chemical, physical and biological conditions. Soil organic carbon fractions may vary with soil development and soil genesis controls its vertical distribution. Objectives of this study were to determine organic carbon fractions in soil derived from Loess parent material and role of relief in its vertical distribution. Five soil pedons were selected along a loess toposequence and sampled at genetic horizon level. Each soil sample characterized for soil texture, pH, calcium carbonate and organic carbon fractions including total and dissolved organic carbon, particulate organic carbon, HCl insoluble organic carbon and density fractions. Total organic carbon content significantly differed with soil type and depth within each soil. Particulate organic carbon ranged from 0.09 to 0.40 g kg^{-1} soil. Udic Haplustalfs and Typic Haplustalfs had highest particulate organic carbon while Typic Ustorthents had lowest. Dissolved organic carbon ranged from 0.02 to 0.11 g kg^{-1} soil and greater in the Udic Calciustepts followed by Udic Haplustalfs, Typic Ustorthents, Typic Calciustepts and Typic Haplustalfs soil profiles, and distribution remains uniform throughout the profiles depth. Insoluble C fraction extracted with HCl ranged from 2.14 to 0.63 g kg^{-1} soil and greater in Udic Haplustalfs profiles followed by Typic Ustorthents, Typic Calciustepts, Udic Calciustepts dic Haplustepts and Typic Haplustalfs soil profiles. Light fraction in the soil samples ranged from 0.02 to 0.08 g kg^{-1} soil, and heavy fraction ranged from 1.18 to 2.98 g kg^{-1} soil. The Udic Haplustalfs soil profiles had highest content of both light and heavy fraction. Total organic carbon had little correlation with clay. Particulate organic carbon, dissolved organic carbon and HCl-insoluble organic carbon had significant correlation with total organic carbon. The heavy fraction had the strongest correlation with total organic carbon while light fraction had negative correlation. It is apparent that most organic carbon occurs as heavy fraction in these soils.

Keywords: Soil Genesis, Carbon fractions, Soil properties, Total organic carbon

TEMPORAL CHANGES IN SOIL CARBON STORAGE ALONG A CHRONOSEQUENCE OF *Pinus massoniana* PLANTATIONS IN SOUTHERN SICHUAN – CHINA

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ABSTRACT

The short term changes of soil carbon storage in forest plantations were not studied. To gain an understanding on the roles of Masson pine(Pinus massoniana) plantations in squestrating carbon, changes in soil organic carbon (SOC) and total nitrogen (TN) in two soil layers (0-30 and 30-60cm) were investigated along a chronosequence of masson pine plantations. The percentage change in the content and stock of SOC increased with soil depth whereas the change in the TN content and stock decreased, and the change was more pronounced on the SOC and TN contents compared to their stocks. Stand age and soil depth are the dominant biotic factors manipulating the soil C and N storage but has no effects on their spatial changes. The recalcitrant compounds of C and N are neither accumulated nor lost in a relatively shorter period of time. The results of this study, provides some information onsoil carbon management in even-aged plantated forests and improves knowledge of environmental managers on the roles played by stand ages in carbon and nitrogen reserved in terrestrial ecosystems. Hence, long term studies are required on the effects of forest age on soil C and N reserved in this masson pine plantations.

Keywords: *Pinus massoniana* plantations, Stand age, Soil organic carbon, Soil total nitrogen

MITIGATING THE EFFECT OF NaCl STRESS ON MAIZE BY ELEVATED POTASSIUM FERTILIZATION UNDER HYDROPONIC CONDITION

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ABSTRACT

Salt affected soils are characterized by excessive amount of soluble salts or exchangeable sodium in the root zone. Maize is a salt sensitive crop grown on wide range of climatic zones and soils. Generally, salinization causes high osmotic stress and sodication (exchangeable Na+) cause ion toxicity or especially nutrient imbalance of potassium (K^+) uptake and transport affect plant growth in arid and semi-arid zone. Potassium (K) is an essential macro-element for plants with significant role in enzyme activation, osmoregulation and charge balance. Elevated level of Na may decrease K^+ uptake in plants. Unbalanced K^+/Na^+ ratio in plant tissue alter the normal metabolic and physiological process. In present study, two maize varieties (Syngenta 8441 and FH 15) were grown for 35 days in hydroponic system. Salinity levels (i.e. 1, 30 and 60 m*M*) were developed with application of NaCl. Three potassium levels (i.e. K_2SO_4 @ 2, 4 and 6 m*M*) were applied in standard nutrient medium. Different parameters i.e. plant growth, antioxidant activities, membrane stability index (MSI) and K^+/Na^+ ratio were studied in both maize varieties. Maize growth was significantly reduced due to salt stress, but potassium application with higher levels significantly improve maize growth by improving K^+/Na^+ ratio, chlorophyll contents and antioxidant activity According to results, potassium fertilization in some extent also mitigate harmful effect of salinity and decrease oxidative damage by enhancing defense mechanism and enhance maize growth in both varieties under salt stress. Proper use of nutrient and their management may improve maize growth successfully under salt stress.

Keywords: Maize, Salinity, Potassium fertilization, Hydroponic

EFFECT OF FARM YARD MANURE COUPLED WITH LIME STONE, LIGNITE AND BIOCHAR FOR CADMIUM DECONTAMINATION DURING WHEAT CULTIVATION

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ABSTRACT

Industrialization in every walk of life is an obligatory concept for the whole world. With the beauties of this industrialization, we are bound to face the curse. Metal contamination especially cadmium (Cd) contamination has raised soil and water pollution manifolds and thus, is a great threat for food chain contamination. In recent era, Cd is at the peak of conversation because of its toxicity ventures even at very low concentration and high mobility in soil. Wheat is the staple food of more than half population of the whole world but have great vulnerability to accumulate Cd into its various parts. In fact, very little increase in Cd content in grain could cause harmful effects on consumer's health. So, in order to ensure food safety and mitigate Cd contamination, a field experiment was conducted in the vicinity of Multan, Pakistan. Farm yard manure was applied individually and in combined form with lime stone, lignite and biochar for Cd decontamination coupled with wheat cultivation. Results revealed that maximum increase in straw (19.19%) and grain (27.72%) yield of wheat crops was observed with combined application of farm yard manure + lime stone as compared to control. Surprisingly no Cd concentration was recorded in the wheat grains. However, maximum decrease in straw Cd of wheat (78.5%) was also observed with the combined application of farm yard manure + lime stone. Moreover, it was also observed that significant decrease in soil Cd was noted with the combined application of farm yard manure and lime stone. Therefore, it can be concluded that combination of organic (such as farm yard manure) and inorganic (such as lime stone) amendments can increase their proved efficiency for Cd stress mitigation and cultivation of secure food from these health risks alarming soils.

Keywords: Farm yard manure, Lime stone, Lignite, Biochar, Wheat, Cadmium

SILICON ALLEVIATES IMPACT OF SALINITY ON RICE IN SALT AFFECTED SOIL

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ABSTRACT

Silicon has widely been reported as a beneficial nutrient for plant growth and development. However, its effect on improving plant tolerance to salinity stress has not been explored well. The mechanisms of silicon in mediating salt stress responses are poorly understood. Rice is classified as a silicon accumulator and is relatively sensitive to salinity stress. The present study investigated the effect of silicon on sodium transport in rice plant from roots to above ground plant parts i.e., shoot and seeds under saline conditions. In the absence of silicon, root uptake of Na and subsequent transport to shoot and seeds increased many folds with increase in the level of salinity stress from original (2.85 dS m^{-1}) to 5.28 and 7.57 dS m^{-1} that resulted into severe reduction in growth and yield of rice. However, application of silicon at 50, 75 and 100 mg/kg soil significantly decreased the root uptake and transport of Na to shoot and seeds, and increased the mineral concentration of potassium, phosphorus and silicon in root, shoot and seeds under saline stress. Silicon application at 100 mg kg^{-1} soil was found promising for improving growth and yield parameters of rice, increasing mineral uptake of P, K and Si, and decreasing uptake of Na under all levels of salinity stress in comparison with control treatment. It can be concluded that silicon application could be useful strategy for improving the rice production in salt-affected soils.

Keywords: Rice, Salinity, Silicon, Sodium, Nutrition

EFFECT OF CADMIUM ON GROWTH AND PHYSIOLOGICAL ATTRIBUTES OF *Triticum aestivum* L. IN SOLUTION CULTURE

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ABSTRACT

Cadmium (Cd) is biologically non-essential heavy metal hindering plant growth and physiological characteristics even at low concentrations. To explore the effect of applied Cd on growth and gas-exchange attributes of wheat, a solution culture experiment was accomplished in glass house of Institute of Soil and Environmental Sciences, University of Agriculture Faisalabad Pakistan. Wheat seedlings were grown in acid washed sand and were shifted to foam plugged holes in thermo pore sheet floating on plastic tubs (8 L) containing Hoagland's nutrient solution. Four Cd levels (0, 5, 10 and 15 μM) with four replicates were applied after one week of seedlings transplantation. Our results showed that highest level of applied Cd produced minimum growth and physiological attributes relative to control. Shoot and root length was recorded as lowest (33 and 14 cm) in 15 μM Cd treated plant compared to 0 μM Cd (42 and 22 cm). Similarly, plants grown in 15 μM Cd containing solution showed 44 and 28% reduction in shoot and root dry weight respectively relative to control. Total chlorophyll and gas-exchange parameters *viz*. photosynthetic rate, transpiration rate, stomatal conductance and sub-stomatal CO_2 concentration were decreased by 30%, 81%, 56%, 68% and 39% respectively in Cd (15 μM) stressed plants compared to unstressed plants. The membrane stability index and leaf relative water contents were linearly decreased by increasing Cd levels in rooting solution. The results clearly indicated that Cd even at lower levels negatively affect physiological functions which ultimately minimize the dry biomass of wheat.

Keywords: Cadmium, growth, Chlorophyll contents, Gas-exchange parameters, Wheat

EFFECT OF VARIOUS AMENDMENTS AND PHOSPHATIC FERTILIZERS IN CD STABILIZATION IN ARTIFICIALLY SPIKED SOIL

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ABSTRACT

An experiment was conducted to study the effect of different organic and inorganic amendments on the photo-availability of Cd in artificially spiked soil grown with Sesbania (*Susbania grandiflora*) for 90 days in pots. Treatments including Farmyard manure (FYM), press mud (PM) and Biochar (BC) were added to soil at 10 g kg^{-1} while humic acid (HA) at 5 mg kg^{-1} and SSP and DAP both at 45 mg P ka^{-1} soil. These treatments along with one control were added to pots containing 6 kg soil already spiked with Cd (5 mg Cd kg^{-1}) and arranged in Completely Randomized Design with three replications. The pots were grown each with 5 seeds of the crop which were then thinned to two plants after establishment. During growth of the plant no additional fertilizers were applied and they were irrigated with tap water as per requirement of the crop. Data on plant height, biomass, plant Cd, P and K concentration and uptake and postharvest soil pH, EC, OM and AB-DTPA ext. Cd, P and K were taken. The results showed that all organic amendment had higher plant height and total dry biomass as compared to phosphatic fertilizer (SSP and DAP) which could be attributed to improvement in soil conditions and supply of additional nutrients along with P as from phosphatic fertilizer. Organic amendments had higher soil Cd but lower plant Cd and uptake as compared to phosphatic fertilizer and control suggesting its phyto-stabilizing role in Cd contaminated soil. Postharvest soil pH and EC were higher for PM and BC treated soil as other amendments which could be attributed to their soluble organic fractions and formation of OH ions. These results suggested that the test all organic amendments (FYM, BC, PM and HA) can play role in Cd phyto-stabilization while on the other hand the phosphatic fertilizer increase their plant uptake which needs further verification and assessment.

Keywords: Sesbania, Farmyard manure, Press mud, Biochar, Cd phyto-stabilization

REDUCTION OF NITROGEN LOSSES THROUGH BIOLOGICAL AND CHEMICAL AMENDMENTS IN WHEAT CROP

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ABSTRACT

Nitrogen (N) loss from applied fertilizer to soil is a serious concern in the agricultural system. Use of inhibitors is one of the best options to reduce losses of applied nitrogen. A variety of inhibitors are available to control the N losses. A pot experiment was conducted at National Agricultural Research Center (NARC) to investigate the effect of urease inhibitors [N-(n-butyl) thiophosphoric triamide (NBPT)], nitrification inhibitors [dicyandiamide (DCD)] and sulfur oxidizing bacteria (SOB) on mitigating N losses. The objective of this study is to quantify the efficacy of urease inhibitor, nitrification inhibitor and SOB for improving nitrogen use efficiency (NUE) and crop yield. Experiment was composed of ten treatments: Control, Recommended N kg soil, 75% Rec. N, 75% Rec. N+NBPT (0.5% w/w of N), 75% Rec. N+DCD (5% w/w of N), 75% Rec. N+SOB (25 µL/ kg of soil), 75% Rec. N+NBPT+ DCD, 75% of Rec. N+NBPT+SOB, 75% of Rec. N+DCD+SOB, 75% of Rec. N+NBPT+DCD+SOB. The maximum wheat grain yield was obtained with recommended N dose followed by 75% of the rec. N+DCD, the yield differences between these two treatments were non-significant. Whereas, the use of nitrogen is 25% less as compared to recommended N applied. Nitrogen recovery efficiencies obtained were statistically higher where 75% N fertilizer was amended with DCD and NBPT being the maximum with 75% N+DCD.

Keywords: Inhibitors, DCD, NBPT, SOB, Nitrogen use efficiency, Nitrogen losses

STRATEGIES TO UPLIFT THE WHEAT CROP PRODUCTIVITY BY THE SOLE AND COMBINED APPLICATION OF RECLAIMING AGENTS UNDER SALINE-SODIC CONDITIONS

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ABSTRACT

Soil salinity and sodicity are among vital factors influencing the productivity of farms for better utilizing of available resources. A number of reclaiming agents were applied in sole and combined phases in current experiment to improve the physico-chemical properties of saline-sodic soils and enhance wheat crop productivity. For this purpose, a field experiment was conducted at Government Reclamation Farm 112/15 L. Mian Channu, Khanewal with sixteen treatment and three replicates following randomized complete block design (RCBD). Soil samples were collected randomly at 0-15 and 15-30 cm depth and were analyzed for physico-chemical properties of soil. Treatments applied were Control, Bacterial inoculants (B.I), Farmyard manure (FYM), Sulphuric Acid (H_2SO_4), Gypsum, B.I + FYM, H_2SO_4 + FYM, H_2SO_4 + B.I + FYM, H_2SO_4 + B.I, H_2SO_4 + Gypsum, H_2SO_4 + B.I + Gypsum, H_2SO_4 + FYM + Gypsum, H_2SO_4 + FYM + B.I + Gypsum, Gypsum + FYM + B.I, Gypsum + FYM, and Gypsum + B.I. Reclaiming agents were applied in the field 15 days prior to wheat cultivation. The crop was harvested at maturity and productivity parameters were studied, which indicated the treatment with (sulfuric acid + bacterial inoculants + farm yard manure + gypsum) resulted in maximum production including: plant height (103.51 cm), fertile tillers (246.67), spike length (17.25 cm), 1000-grain weight (43.71 g), straw yield (5080.0 kg ha^{-1}), grain yield (3777.7 kg ha^{-1}) and harvest index (43.29%) while the minimum quantities 68.82 cm, 153.33, 12.65 cm, 3540.0 kg ha^{-1}, 2329.7 kg ha^{-1} and 39.74% respectively were found in control. The physico-chemical properties of soils including pHs, ECe, were significantly decreased while, organic matter, available potash and available phosphors were improved by the same treatment. So, combined application of reclaiming agents is concluded as better tool to maximize crop production under saline-sodic conditions as compared to their sole application or control.

Keywords: Wheat productivity, Salinity-sodicity, Bacterial inoculants, Gypsum

EARTHWORMS INFLUENCE NITROGEN MINERALIZATION AND CROP N UPTAKE FROM ORGANIC WASTES AFTER THEIR SOIL APPLICATION

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ABSTRACT

Application of organic wastes to the soil and its effects on changes in soil properties and nutrient stock is of the great interest for sustainable crop production. Soil biota drive the decomposition and mineralization of the waste that resulted in release of nutrients i.e. nitrogen (N) which is useful for crop growth and yield. Therefore, the main objective of the current study was to assess the effects of earthworms on nitrogen mineralization and crop N uptake after soil application of organic wastes. To explore this objective, an outdoor pot experiment was conducted at COMSATS Institute of Information technology, Vehari. Earthworms were inoculated in organic wastes amended (wheat straw, maize straw, compost, farmyard manure and slurry) pots that were filled with 9 kg of soil. Similarly, suitable controls were also maintained in such pots. Thereafter, autumn maize crop was sown in these pots. At the start and the end of experiment, soil samples were collected and analyzed for mineral nitrogen. Maize plants were harvested at physiological maturity stage to estimate N mineralization, crop dry matter yield, N uptake, and crop N recovery. Addition of earthworms in all organic amendments increased DM yield, N uptake and total N recovery especially in manure, compost and slurry treatments. The respective increment by earthworms in total N recovery was 543%, 105% and 109% from aforementioned treatments of the total N applied in soil by organic amendment, about 14%, 8%, 6% and 2% was recovered from manure, slurry, compost and maize straw, respectively by maize plants. Sole application of organic wastes tended to increase maize crop dry matter yield and N uptake as compared to the unfertilized control, however, the effects was not significant. Calculated N mineralization in these treatments showed net N mineralization, however, in case of wheat straw a net immobilization equal to 15% of the organic N was estimated. Consequently, the N recovery by maize in the latter case was -11% of the applied N. Hence, it is concluded that earthworm increased N mineralization of organic amendments especially animal manure, slurry and compost; therefore these organisms should be part of fertilization strategies in agroecosystems.

Keywords: Crop yield, Decomposition, Earthworms, Mineralization, Nitrogen

MAIZE FODDER QUALITY WAS ENHANCED BY FOLIAR APPLICATION OF PHOSPHORUS AND ZINC TO OVERCOME NUTRITIONAL DEFICIENCIES IN DAIRY ANIMALS

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ABSTRACT

Fodder quality is the major concern for dairy farming industry that depends on nutritional contents especially Phosphorus (P) and Zinc (Zn). Nutritional deficiency in animals tends to hazardous disease induction and defective growth and development. To improve the nutritional attributes of maize fodder, an experiment was designed in which P and Zn were applied by the foliar method. Three levels of P (1%, 2%, 2.5%) and two levels of Zn (1, 1.5kg/ha) were used under randomized complete block design (RCBD) in triplicate with fertilization of recommended basal dose of NPK. The results revealed that foliar application of P and Zn considerably improved the maize fodder quality such as, crude protein content (14.79%) with treatment (P-foliar 1% by weight @ 150 L ha^{-1} + Zn- foliar @ 1.5 kg ha^{-1}).), highest fat content in plant (1.61%) by treatment (P-foliar 2.5% by weight @ 150 L ha^{-1}) and maximum total minerals in plant (11.86%) with treatment (P- foliar 2% by weight @ 150 L ha^{-1} + Zn- foliar @ 1.5 kg ha^{-1}) as compared to control. Overall the treatment (P-foliar 1% by weight @ 150 L ha^{-1}) presented the better results regarding plant population (57), plant fresh weight (2.87 kg), plant dry weight (1.30 kg), plant height (159.1 cm) and moisture (2.34%). Highest Nitrogen contents (2.36%) were also observed by (P-foliar 1% by weight @ 150 L ha^{-1}). Maximum P concentration (0.30%) in maize fodder was observed in treatment (P-foliar 1% by weight @ 150 L ha^{-1}+ Zn- foliar @ 1 kg ha^{-1}) as compared to control. Zinc contents were also improved significantly with sole application of Zn fertilizers (Zn- foliar @ 1 kg ha^{-1}) as well as with combination (P-foliar @ 1% + Zn @ 1.5 kg ha^{-1}). It is concluded that antagonistic impacts in soil system of P and Zn were minimized by their foliar application, so this application method is a better way to enhance fodder quality.

Keywords: Fodder quality, Maize production, P contents in maize, Zn in fodder

EFFECT OF ORGANIC AND INORGANIC AMENDMENT ON THE PHOSPHORUS AVAILABILITY AND GROWTH OF CHICKPEA

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ABSTRACT

Phosphorous (P) is a second essential nutrient after nitrogen (N). It is a major growth limiting nutrient because of its key role in physiological and biochemical functions, energy transfer and structure of plants. Major part of P remains fixed to soil and thus remains unavailable to plants. In calcareous soils, insolubility of P may also be due to its adsorption on clayey and lime surfaces. P-solubilizing microorganisms have a remarkable effect on P solubilization by producing organic acids. In present study, a pot trial was conducted for comparing the effect of simple (SM) and processed manure (PM) (organic source) with rock phosphate (RP) and single super phosphate (SSP) (inorganic source) on growth of chickpea. One percent SM and PM was applied to the pots along with plant growth promoting rhizobacteria (PGPR). Suggested dose of N and P were applied at the time of sowing. Results showed that the seed germination was higher in the pots where RP was applied with PM (100%) than the pots where RP was applied with SM (90%) or in pots where SSP was applied with the PM (80%) or SM (70%). Result of chlorophyll contents showed that RP applied with the PM had better response as compared to the RP applied with the SM. Similar trend of chlorophyll content was observed in case of SSP. The observed positive influence of PM could be due its specific composition that helps to improve the availability of P to plants. Here, we conclude that integrated use of RP and PM could be more effective to enhance the availability of P to plants.

Keywords: Rock phosphate, Processed manure, Chickpea, P availability, PGPRs

EFFECT OF WATER STRESS ON GROWTH OF SEEDLINGS OF *Azadirachta indica, Eucalyptus camaldulensis, Dalbergia sisso* & *Albizia procera*

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ABSTRACT

Water stress is one of the main atmospheric stresses on the productivity of plant globally, mainly in arid and semi-arid regions. The effect of water stress on plant growth determine plant physical and chemical attributes including plant height, diameter, weight of root and shoot, nutritional impact, chlorophyll ratio etc. of plant. An experiment was conducted to figure out effect of different amount of water on plant growth. There were three treatments of water stress, drought, flood and normal tap water on one year seedlings of *Azadirachta indica, Eucalyptus camaldulensis, Dalbergia sisso* and *Albizia procera* for period of six months. This experiment will reveal effect of three different water amount flood, drought and normal tap water on the height, weight, diameter, infiltration capacity, chlorophyll content, and nutritional value of above four species. The initial results of the effects of flooding drought upon four species have been reported. Height of all four species in normal tap water treatment increases 10% and decreases 30% in drought treatment, and decreases up to 40 to 50% in flood treatment. Diameter increases by 60 to 70% in tap water treatment, up to 40% increase in flood and 10% decline in drought. Tap water treatment showed chlorophyll increases 70%, 50% in flood and 10% in drought. Weight was decreased by 50% in tap water treatment, 20% in drought and 10% in flood treatment.

Keywords: Water stress, Infiltration capacity, Drought, Flood, Chlorophyll content

EFFECT OF PLANT GROWTH PROMOTING RHIZOBACTERIA AND POTASSIUM FERTILIZATION ON SPINACH GROWTH UNDER SALT STRESS

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ABSTRACT

Among abiotic stresses especially salinity is one of the major environmental limiting factor for agricultural and crop production in worldwide mostly in arid and semi-arid conditions. Salinity causes osmotic stress due to low water in first phase and ion toxicity specially Na^+ accumulation on second phase which impaired plant growth. Plant growth promoting rhizobacteria (PGPR) containing ACC-deaminase in contrast with potassium application suppress harmful effects of salt stress. Potassium (K^+) is major essential macronutrient and competes with Na^+ to alleviate effects of salt stress. A pot experiment was conducted in wire house where spinach was grown for vegetative growth. Salinity was developed in normal soil with application of NaCl (S0= 0 dS m^{-1}, and S1= 10 dS m^{-1}) and two strains of plant growth promoting rhizobacteria (PGPR1 and PGPR2) were applied in combination with two potassium levels (recommended and double K) with recommended fertilizers. All growth, physiological and ionic parameters like fresh and dry weight, membrane stability index, chlorophyll a, b contents, electrolyte leakage and ionic concentration of Na, K in leaf and soil were determined. Plant growth of spinach was significantly improved with potassium fertilization along inoculation of PGPR1 and PGPR2 under salinity stress as compared to uninoculated treatments and control. Double Potassium application as compared to recommended K significantly decreased Na^+/K^+ ratio with inoculated treatments of plant growth promoting rhizobacteria in spinach. In conclusion, PGPR inoculation in combination with potassium fertilizer significantly enhance growth and K^+/Na^+ ratio in spinach under salinity stress.

Keywords: PGPR, Salinity, Potassium, Spinach

EVALUATING THE EFFECT OF FOLIAR APPLIED GB ON PHYSIOLOGY AND GROWTH OF CR STRESSED PEA

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ABSTRACT

Chromium (Cr) is one of the adverse environmental pollutants that negatively affect the plant growth and development. Glycine betaine (GB) is a growth regulator that improves the plant growth and development under Cr stress. The experiment was comprised on 3 Cr levels i.e. 0, 0.25 and 0.50 mM and GB levels i.e. 0, 0.50 mM. The study was performed in completely randomized design (CRD) having factorial arrangement. The results revealed that Cr stress considerably reduced the leaf length, root fresh weight, shoot fresh weight, leaf width and plant height, chlorophyll a, chlorophyll b Chlorophyll a/b ratio and carotenoid contents. Moreover under Cr stress the activity of SOD and POD was decreased while the activity of MDA, CAT and H_2O_2 was considerably increased under Cr stress. GB application improved the leaf length, root fresh weight, shoot fresh weight, leaf width and plant height by increasing the activity of anti-oxidant enzymes and by decreasing the activity of H_2O_2. Leaf photosynthetic pigments, total sugars and proline contents were elevated after the application of GB. In conclusion GB application contributes to decreased Cr stress in pea by improving the activity anti-oxidant enzymes.

Keywords: Glycine betaine, Plant growth, Cr stress, Chlorophyll, Chlorophyll contents

ROLE OF CARBON SEQUESTRATION TO MITIGATE THE CLIMATE CHANGE

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ABSTRACT

Pakistan potentially faces a major climate change challenge. Climate change is due to the rise in average temperature of earth. In the last 50 years, the annual average temperature in Pakistan has increased by roughly 0.5°C. By the end of this century, the annual average temperature in Pakistan is expected to rise by 3°C to 5°C for a central global emissions scenario while higher global emissions may yield a rise of 4°C to 6°C. The number of heat wave days per year has increased nearly fivefold in the last 30 years. There are some problems due to climate change like loss of carbon sinks, accumulation of carbon in environment, global warming, melting of glaciers, rise in sea level, increase in natural hazards, floods, destruction of agricultural land crops and threats to human life. There are some factors due to climate change occurs which are industrial development, deforestation, urbanization, fossil fuels, automobiles, forest fire, use of insecticides and pesticides, emission of greenhouse gasses, agricultural byproducts and population pressure. Due to these factors, the amount of greenhouse gasses (carbon dioxide, carbon monoxide, methane, nitrous oxide, chlorofluorocarbon and hydro fluorocarbon) increases. Carbon dioxide is the major component that changes the climate in the world. In this scenario, there are some resources that we can use to reduce the climate change like trees, crops, soils, wetlands and oceans. Trees are the best option to reduce the carbon from environment because it absorbed carbon dioxide directly from the atmosphere. Live trees are approximately 50% water by weight and 50% carbon (oven-dried weight). Dry (moisture-free) wood is about 48-50% carbon, 38-42% oxygen, 6-7% hydrogen and a number of other elements, such as nitrogen and sulfur in very small percentages. So results of this research proved that growing trees or Afforestation will change in the local climate. You can observe that the area where trees are grown having 3°C less temperature as compared to tree less areas.

Keywords: Afforestation, Carbon sequestration, Climate Change, Greenhouse gasses

ARSENIC IN RICE: ASSESSMENT AND REMEDIATION

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ABSTRACT

Natural and anthropogenic soil pollutants threaten the quality of life by entering into the food chain due to uptake and accumulation by crops. Among them arsenic (As) is polluting the environment from the both natural and anthropogenic sources and has received worldwide attention due to its toxicity. High concentrations of arsenic in soil and plant have been detected in several regions where rice is grown. In Pakistan, rice ranks as second amongst the staple food crop and is a major source of foreign exchange earnings. This study aimed to assess As concentration in paddy soils, rice and mitigate arsenic contaminated soil for food safety. The rice sampling survey of three districts of rice growing areas of Punjab was conducted for assessment of arsenic concentration in rice. The results demonstrated that overall 27% of brown rice samples from Hafizabad, 10% from Gujranwala and 15% from Sheikhupura were above the recently recommended permissible limit (300 ug/kg) but all the samples were less than previous RPL (1000 ug/kg). Among the varieties, maximum brown rice samples (24%) of Kainat were above the RPL and minimum (12%) were belonged to Super basmati. Relatively, wider ratio between straw and rice grain As concentration was observed in Super basmati and Kainat, which indicated that straw had higher arsenic content and was less translocated to grain. While in Super 386, relatively more arsenic was translocated to the grain. Experimental results showed that arsenic contaminated soil can easily be remediated by adding iron sulfate as an amendment.

Keywords: Arsenic, Contamination, Assessment, Remediation, Rice

ROLE OF PLANT GROWTH PROMOTING RHIZOBACTERIA ALONG WITH DIFFERENT ORGANIC CARRIER MATERIALS IN IMPROVING RESILIENCE OF MAIZE AGAINST SALINITY STRESSED CONDITIONS

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ABSTRACT

In arid and semi-arid regions, salinity drastically reduces crop production by disturbing hormonal and nutritional balances. However, plant growth promoting rhizobacteria (PGPR) through their different mechanisms of action improve plant growth under saline conditions. Use of PGPR to mitigate salinity stress is a developing technology. In natural environments, their survivability and growth may reduce due to different constraints. Use of bacterial inoculations with a suitable carrier could be a good technique to improve survivability of the introduced bacteria in soil because carrier provides a better suited micro environment to the bacteria in soil. In this study, five different carriers (peat, press mud, compost, biogas slurry and biochar) were evaluated for increasing the efficacy of PGPR consortium to mitigate the salinity stress in maize. A pot experiment was conducted under completely randomized design with three replications. Five different carriers based inoculations were evaluated at three different salinity levels (1.53, 4 and 8 dS m^{-1}) along with un-inoculated control and soil application of liquid inoculums. Recommended doses of fertilizers NPK (180, 120, 80 kg ha^{-1}) were applied. Results showed that plant growth and yield were significantly decreased with increasing salinity. But use of PGPR improved the plant growth and yield and their efficacy was further improved with different carriers at all salinity levels. Amongst the carriers, press mud proved to be the best carrier for improving microbial efficiency for improving growth and yield of maize. Press mud based inoculation increased the grain yield of maize upto 12.87, 13.36 and 13.59% at 1.53, 4 and 8 dS m^{-1}, respectively, as compared to un-inoculated control. It is concluded from the results that press mud could be the best carrier for improving efficacy of PGPR to increase maize growth and yield under salinity stress.

Keywords: Rhizobacteria, Maize, Salinity, Biogas slurry, PGPR, Consortia

ESTIMATION AND PREDICTION OF RAINFALL USING COMMERCIAL CELLULAR COMMUNICATION NETWORK FOR EFFICIENT AGRICULTURAL WATER MANAGEMENT

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ABSTRACT

The rainfall estimation using commercial telecommunication network is an advance and promising technique. The accurate estimation of rainfall is very important because it is necessary for the exact irrigation scheduling and hydrological modeling studies in the irrigated agriculture. Four years data set from 2013 to 2016 of 24 links was used to check the authenticity of cellular communication system for the rainfall estimation in the surrounded area of University of Agriculture Faisalabad (UAF). The signal attenuation between sender and receiver was used to estimate the rainfall at 15 minute temporal resolution and the average spatial resolution of 1.5 km. In this study UAF rain gauge was used as a reference point. Link based rainfall was compared with the daily UAF rainfall data. One-one line comparison of link based and UAF rain gauge was made to authenticate the accuracy of the system. The results demonstrated that R^2 value for link 6 and 11 was closed to 1 like 0.97 and 0.98 respectively. Link 13 and link 5 are located at about 7.1 km and 6.53 km distance from reference respectively so it had R^2 value of about 0.69 and 0.70. The results concluded that the low density of rain gauges and satellite techniques are unable to capture the variation in rainfall with time and space. All the presented results authenticate the capability of cellular telecommunication network to estimate the regional rainfall at high spatio-temporal resolution and to capture variations in rainfall with time and space. Prediction results concluded that the Poisson White Noise model give prediction of daily and annual rainfall with 97% accuracy. This state of the art technique can help the hydrologist for comprehensive analysis and management of the water resources.

Keywords: Signal attenuation, Cellular telecommunication network, Rainfall estimation

IMPACT OF CITY WASTE SEWAGE SLUDGE ON TRACE ELEMENTS ACCUMULATION IN TOMATO (*Lycopersicum esculentum* L.) CROP

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ABSTRACT

Sewage sludge (SS) is generated as a byproduct during the treatment of wastewater. Being organic waste, SS is a good source of plant nutrients such as nitrogen (N), phosphorus (P) and potassium (K). High levels of toxic trace elements such as cadmium (Cd), chromium (Cr), copper (Cu) nickel (Ni) and lead (Pb) may also be present in SS. It may have the potential to enhance the crop yield but entry of trace elements in food chain is also a big threat. The pot experiment was conducted to achieve the accumulation of trace elements at various SS application rates and the suitability of the use of SS for tomato plants by evaluating growth, biomass and yield responses. Three levels of SS (0.5%, 1.0% and 1.5% w/w) were soil applied (collected from I-9 sector, Islamabad waste water treatment plant, ISS). Control treatment (without SS) was included to compare the effect of treatments with SS amendment. Two weeks old seedlings of tomato (*Lycopersicon esculentum* L.) variety Sahel Syngenta was transplanted into the pots. The results showed that growth and physiological parameters of tomato remained better at lower application levels of SS. High rate of SS caused reduction in growth and physiological parameters. Shoot and root fresh weight, root/shoot length, number of flowers and chlorophyll contents were the lowest at $ISS_{1.5\%}$ level. Concentration of trace elements (Cd, Cu, Ni and Pb) in shoot and fruit of tomato was increased with the increasing rate of SS and the lowest in control. The concentrations of Cd, Ni and Pb in shoot and fruit of tomato were recorded well above the FAO/WHO critical limits (10, 0.05, 0.5 µg/g, respectively) with $ISS_{1.5\%}$.It was concluded from the results that ISS can be used for vegetable production like tomato but at lower rate to avoid trace elements contamination in the food chain.

Keywords: Sewage sludge, Wastewater, Tomato, Chlorophyll

APPLICATION OF ZEOLITE AND ZNO-NANOPARTICLES MIXED-SLURRY FOR IMPROVING YIELD AND NITROGEN UTILIZATION OF RYEGRASS UNDER ORGANIC MANAGEMENT

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ABSTRACT

Recently, there is a growing interest among agriculturists to use nanotechnology for the development of enhanced nutrient-use efficiency fertilizers. However, its sustainable use for developing mineral or organic nano-fertilizers requires a thoughtful of the fate of nutrients and their interaction with soil plant systems. Therefore, the aim of current study was to investigate the mixing of three different application rates of zinc oxide nanoparticle (ZNPs: 1.4, 2.8 and 3.6 mg kg^{-1} soil) as well as zeolite (141, 282 and 423 mg kg^{-1} soil) with biogas slurry (AS) on nutrient availability and herbage nitrogen (N) and zinc (Zn) uptake in a standard pot experiment. We found that both ZNPs and zeolite significantly increased mineral N content in soil compared to AS alone ($P<0.05$). On the other hand, plant available phosphorous or potassium and microbial biomass carbon (C) was not significantly affected by any application rate of ZNPs or zeolite mixed in AS. Microbial biomass N was significantly higher in second and third application rate of both ZNPs and zeolite mixed in AS compared to AS alone. However, this increment in mineral or microbial biomass N or Zn did not influence shoot uptake of these nutrients nor their apparent recoveries. Besides root uptake of these nutrient was significantly higher only in AS mixed with third application rate of zeolite. Hence, it is concluded that both ZNPs and zeolite can retain the mineral nutrients (especially N) in the soil but their plant uptake is not influenced by both amendments, indicating that the aforementioned parameter is the combination of complex interactions and depends on many factors that need to be explored in future studies.

Keywords: Biogas residues, Microbial biomass, Nano-fertilizers, Nutrient uptake, Slurry, Zinc

LEAF WATER POTENTIAL AND GROWTH OF MAIZE AT ELEVATED POTASSIUM LEVEL UNDER SALT STRESS

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ABSTRACT

Salinity is a major abiotic stress and yield limiting factor all over the world. In Pakistan, 6.8 million hectares out of 20.2 million hectares of cultivated area are salt affected. It reduces the nutrient uptake by plant roots and prevents the translocation of mineral nutrients especially potassium (K). Salt stress can suppress overall plant growth by lowering water potential, ion imbalance and specific ion toxicity. Ameliorating effects of elevated K have been reported by various researchers. A hydroponic experiment was conducted to check water potential of maize at elevated K fertilization in the rain protected wire house at Institute of Soil and Environmental Sciences, University of Agriculture Faisalabad. The seeds of maize were sown in sand to produce nursery and 10-12 days after sowing, nursery was transplanted in nutrient solution. Treatments were, control, 60 mM NaCl, double recommended K_2SO_4, and double recommended K_2SO_4 as well as 60 mM NaCl. Each treatment was replicated four times according to completely randomized design (CRD). Hydroponic nutrients solution was changed at the interval of 7 days for first 3 weeks and 4 days for remaining 3 weeks. Agronomic parameters such as root and shoot length, fresh and dry weight of roots and shoots were determined. Furthermore, water potential, chlorophyll contents, osmotic potential and K as well as Na contents were determined. It was found that elevated K level mitigates the adverse impact of salinity and improve overall crop growth attributes. The maximum plant growth and leaf water potential was observed in the treatment where double K_2SO_4 was applied. On the other hand, elevated salt stress not only disturbed plant metabolic processes but also decrease plant growth attributes, nevertheless elevated level of K improved water contents in plant.

Keywords: Potassium, Sodium, Elevated salinity, Water potential, Osmotic potential

ROOT MORPHOLOGICAL ADAPTATION IN MAIZE PLANT GROWN UNDER LOW PHOSPHORUS ENVIRONMENT

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ABSTRACT

Phosphorus is a major growth limiting nutrient of plants in Pakistani soils. Large portion of applied phosphorus fertilizer undergoes adsorption/fixation due to high pH (>7.0) and calcareousness (> 3% $CaCo_3$) of Pakistani soils and becomes unavailable for plants uptake. Under such conditions, many plants modify their root morphology to adapt to this low phosphorus environment and to explore more soil volume. Plants with these adaptations might be able to grow well under low availability of phosphorus. This study was planned with the aim of checking the plant root morphological adaptation to low phosphorus availability at different levels of applied phosphorus. Five different phosphorus levels (1= Full recommended dose, 2 = 75% of recommended dose, 3 = 50% of recommended dose, 4 = 25% of recommended dose, 5 = No phosphorus) were applied. Harvesting was done at flowering stage. General physical root parameters were taken and roots were also scanned for root diameter, root surface area and number of root tips determination. Root volume was measured by volumetric method. Results showed that root volume, number of root tips, root surface area, root length and specific root length were higher at lower level of applied phosphorus and becomes lower gradually as the applied phosphorus level was increased. While average root diameter was lower at lower level of applied phosphorus and increased with increasing level of applied phosphorus. It is concluded that plants that can explore more soil volume by modifying root morphology are expected to have low critical phosphorus requirements and it will be helpful adaptation of plants in current situation of phosphorus in Pakistani soils.

Keywords: Phosphorus, Calcareous and Alkaline soils, Adsorption/fixation, Roots, Maize

MOISTURE BASED IRRIGATION TO IMPROVE WATER PRODUCTIVITY UNDER RIDGE FURROW AND SUBSURFACE DRIP IRRIGATION ON INTERCROPPED PEA

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ABSTRACT

The study was conducted to find optimum irrigation technique to maximize water productivity. Pea (Pisum Sativum) crop was selected for research, which was intercropped between sugarcane. The study was carried out at Postgraduate Agriculture Research Station (PARS), University of Agriculture Faisalabad during winter season 2016 to 2017. Water quality and soil parameters like pH, electrical conductivity (EC) and sodium absorption ratio (SAR) were studied to understand the soil condition for crop production. Climatic data was taken from weather station of water management research center (WMRC), Faisalabad. All the treatments took good seed bed preparation, proper seeding, effective fertilizer application and timely Picking. Proper layout was designed with three treatments, such as furrow irrigation (T1), subsurface drip with 45 cm lateral depth (T2) and subsurface drip with 30 cm lateral depth (T3). Experimental data was analyzed using randomized complete block design (RCBD) while latin square design (LSD) test to compare the differences among treatment means. The irrigations were applied up-to field capacity of the soil and management allowed deficit (MAD) was maintained at 30% of total available water (TAW). Results showed significant difference among all the treatment especially with furrow irrigation. Water saving capacity was higher in subsurface drip irrigations (T2, T3) which saved 33.1% and 29.6% water than furrow irrigation respectively. Yield was also affected by the irrigation method, furrow irrigation (T1) provide 18.6% and 14% less yield than subsurface technique (T2, T3). The rooting and POD length was dominated under subsurface irrigation while it decrease in furrow irrigation (T1). Average irrigation interval for T1 was 9 to 10 days while it reduced with the depth of lateral, 6 days for T2 and 5 for T3. The results obtained from experimental data clearly showed that 45cm lateral depth is most feasible for Pea crop production in sense of water productivity in intercropping with august planted sugarcane.

Keywords: Water productivity, Sodium absorption ratio, Management allowed deficit

IDENTIFICATION OF SOIL LINKED PRODUCTIVITY CONSTRAINTS OF IAGS FARM BY USING GPS AND GIS BASED SOIL FERTILITY MAPS

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ABSTRACT

A soil fertility status of the Institute of Agricultural Sciences (IAGS) farm was investigated during 2016-17 and soil related crop production constraints were identified for proper utilization of farm land. Total 60 numbers of geo-referenced (GPS based) composite soil samples with the depth of 0-15cm & 15-30cm were collected. Basic soil parameters i.e. EC, pH, Soil Organic Matter (SOM), available Nitrogen, Phosphorus, Potassium and Saturation %age were determined. Around 29% soils are neutral and 71% are slightly alkaline in reaction at upper and lower soil profile. However, electrical conductivity (EC) was found between 1.4-4.1 mS cm^{-2} in studied depths. SOM varies from 0.8-2.8% while mean values were found 1.67% and 1.69% at both depth. The mean available soil N, P, K and S was found to be 106.6, 55.9, 224.1 mg per kg respectively. The mean saturation percentage was found around 44%. Fertilizer recommendation for different crops has been suggested on the basis of soil test values and suitability. Thematic maps were prepared for each soil parameter using ArcGIS10.1 package. The soil fertility thematic maps provide the readymade source of information about soil fertility status and serve as the decision making tool for successful raising of field crops and development of orchards.

Keywords: IAGS FARM, GPS, GIS, Soil fertility, Thematic maps

NANOFERTILIZERS FOR SUSTAINABLE CROP PRODUCTION: OPPORTUNITIES AND CHALLENGES

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ABSTRACT

Recently, rapid population growth has increased global food demand that has inserted huge pressure on food production and supplies. However, inefficient use of available fertilizers in the market with low nutrient use efficiency further add to the concern of sustainable crop production and in turn to the food insecurity. In the past few decades, nanoparticles (NPs) have received great attention due to their distinctive properties and useful applications in agriculture. Due to resource constraints and low use efficiency of fertilizers and associated losses to the environment, the cost to the farmer is increasing dramatically. In agriculture, nanotechnology and its derivative outcomes are being valued for various applications. Nanotechnology may help in improving the nutrient use efficiency of the fertilizer, target delivery of nutrients to crop and overcoming the nutrient leaching and volatilization losses. So far, large-scale production of nano fertilizers is not yet realized but some of the recent studies indicated that nano fertilizers are effective in various ways i.e. improving the nutrient use efficiency that may enhance the plant productivity and also reduces the environmental impact. Therefore, the aim of this study was to provide an overview of the opportunities, nanotechnology offered for producing mineral and organo-nano fertilizers with the desired chemical composition and this has raised interest among researcher and technologist for the production of nano scale and nano enabled bulk fertilizers. We also highlights the examples of the scientific opportunities for the pilot scale nanofertilizers production and engineering challenges that need to be overcome for their commercialization.

Keywords: Agro-technology, Commercialization, Fertilizer, Nanoparticles, Target delivery

EFFECT OF SLOPE, RAINFALL INTENSITY AND MULCH ON SOIL PARTICLE SIZE DISTRIBUTIONS AND NUTRIENT CONTENTS IN SURFACE SOIL

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ABSTRACT

Soil water erosion and resultant loss of surface soil fertility are major threats in reducing the potential of crop production. Nutrients losses are controlled by their pools in the soil surface layer which is exposed to water erosion and the effects of rainfall intensity and slope on this pool have not been widely studied. Therefore, a series of rainfall simulated experiments were conducted to evaluate the effects of rainfall intensities (33 $mm \cdot h^{-1}$, 54 $mm \cdot h^{-1}$, 94 $mm \cdot h^{-1}$ and 120 $mm \cdot h^{-1}$) and slopes (5^o 15^o and 25^o) on soil particle size distributions and nutrients (N P K) and soil organic carbon (SOC) contents in un-mulched and mulched soil flumes. Results showed that in un-mulched soil, clay contents (0-2 µm) decreased significantly ($p<0.01$) with slope steepness during lower rainfall intensities (33 $mm \cdot h^{-1}$, 54$mm \cdot h^{-1}$). However, during higher rainfall intensities, clay (0-2 µm), fine silt (2-20 µm) and coarse silt (20-50 µm) tended to increase while the sand contents decreased significantly ($p<0.01$) at higher (15^o and 25^o) slopes compared with 5^o slope steepness. In the mulched soil, clay (0-2 µm) and coarse silt (20-50 µm) contents decreased significantly at 5^o slope compared with steeper slopes only for rainfall intensities of 94 $mm \cdot h^{-1}$ and 120 mm h^{-1}, respectively. Average SOC, total N and available N contents significantly decreased with increase in slope steepness and rainfall intensity in unmulched soil, but decreased with increase in rainfall intensity in mulched soil. However, there were non- significant differences in the TK contents among different rainfall intensities and slopes both in mulched and un-mulched treatments. The average contents of total and available P decreased significantly in the surface soil at the 5^o slope compared with higher slope steepness under all treatments. Similar to the trends in SOC and N, P (total and available) contents also decreased significantly with increase in rainfall intensity. Soil fine particles and nutrients concentrations in soil surface layer decreased in all treatments compared with those in antecedent soil. However, there were significantly higher concentrations of fine silt, SOC, TN, TP and TK contents in soil under mulch compared with those under unmulched treatment. Results suggest mulching is one of the best management practices for maintaining soil fertility during process of soil erosion. Eluviation of soil fine particles and nutrients into lower soil layers is facilitated under lower slopes and smaller rainfall intensities thereby reducing their susceptibility to losses from site.

Keywords: Rainfall intensity, Slope, Mulch, Particles size distributions, Nutrients contents

AMELIORATING THE EFFECT OF DROUGHT STRESS THROUGH INTEGRATED APPLICATION OF ACC-DEAMINASE CONTAINING PLANT GROWTH RHIZOBACTERIA AND ORGANIC AMENDMENT TO IMPROVE THE PRODUCTIVITY OF WHEAT

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ABSTRACT

Drought stress is an important environmental stresses worldwide and serious threat to crop productivity and sustainable agriculture worldwide. To rescue plant growth in such stressful conditions, the plant growth promoting rhizobacteria provide a bulwark through various mechanisms against drought stress and imperiled sustainability of agriculture in drylands. Field experiments was conducted at the research area of the Faculty of Agricultural Sciences and Technology, Bahauddin Zakariya University, Multan and to evaluate the effectiveness of rhizobacterial strains and in combination with biogas slurry for improving growth and yield of wheat crop under skipped irrigations condition. Four levels of PGPR i.e. Control, S4 (*Alcaligenes faecalis*), S17 (*Bacillus amyloliquefaciens*) and S27 (*Pseudomonas moraviensis*) and two levels of biogas slurry (BGS) (0 and 600 kg/ha). The irrigation was skipped at tillering (SIT) and flowering (SIF) stages while control was maintained with the recommended four irrigations. The results revealed that the rhizobacterial strains inoculation significantly improved the photosynthetic rate (73.9 and 74.4%), stomatal conductance (73 and 98%), Sub-stomatal CO_2 concentration (46 and 39%) and transpiration rate (38 and 23%) at skipped irrigation (SIT and SIF) situations, respectively, compared to respective control when BGS was amended. The results showed that the inoculation of S27 isolate with the application of BGS amendment, significantly ($P \leq 0.05$) increased plant height and grain yield up to 24.3 and 30.3% by skipping irrigation at SIT stage, respectively, over control. The results suggested that S27 strain amended with BGS could be effectively used to improve the growth, physiology and yield of wheat crop under normal as well as drought stress conditions.

Keywords: Drought, PGPR, ACC-Deaminase, Wheat

ZINC UPTAKE IN MAIZE (*Zea mays* L.) GROWN UNDER DROUGHT STRESS CONDITION

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ABSTRACT

Due to the worldwide problem of global warming, less and uncertain rainfall may increase the drought periods which may have unknown effects on agro-ecosystems. In Pakistan, about 24% of total area is rain-fed and faces severe shortage of water. Pakistani soils are generally alkaline and calcareous in nature and are more prone to Zn deficiency. This problem could be even severe in arid and semi-arid regions of Pakistan. In order to study the uptake of Zn under drought stress condition, a pot experiment was conducted by using maize as experimental crop. Three level of Zn were applied including control (0 mg Zn kg^{-1} soil), recommended dose (22.2 mg Zn kg^{-1} soil) and double recommended dose (44.4 mg Zn kg^{-1} soil). Two moisture levels, i.e., optimum (80% of water holding capacity) and drought stress condition (30% of water holding capacity) with four replications were applied. For first two weeks, water for all pots was maintained at 80% WHC then half pots were shifted to 30% WHC to stimulate drought stress. Crop was harvested after three weeks of drought stress. Result showed that plant biomass, chlorophyll contents, plant height and nutrient concentrations such as nitrogen, phosphorous and potassium significantly reduced under drought stress. Similarly, there was significant decrease in Zn uptake in plant roots under drought stress. But the application of recommended dose of Zn enhanced the plant physiological parameters and nutrient uptake because Zn helps in regulating the plant metabolism under drought stress and other environmental stresses. Therefore, it is concluded that drought stress significantly decreased the Zn uptake and recommended dose of Zn application minimized the adverse effects of drought on crop growth.

Keywords: Drought stress, Zinc uptake, *Zea mays*, Water holding capacity

USE OF ACTIVATED ROCK PHOSPHATE AS A PHOSPHORUS SOURCE IN MAIZE (*Zea mays* L.) CROP

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ABSTRACT

Pakistani soils are mostly alluvial, calcareous and alkaline in nature and > 90% of soils show phosphorus (P) deficiency due to is fixation on soils. Highly solubilization of phosphatic fertilizers in soil quickly precipitates, with ions such as Calcium (Ca) and Magnesium (Mg) become unavailable to the plants. Such alarming situation demands for exploring cheaper sources of P along with slow release to achieve higher P efficiency. A pot experiment was conducted to check the efficiency of activated rock phosphate for maize crop. Triple super phosphate (TSP) and rock phosphate (RP) were also used as a P source for comparison. Each treatment was replicated four times according to completely randomized design (CRD). A basal dose of nitrogen (N) and potassium (K) were applied as a source of urea and sulfate of potash (SOP). Two germinated maize seedlings were transferred to each pot and soil moisture contents were maintained at 80% of water holding capacity throughout experiment. After 6 weeks of plant growth, the plants were harvested. The results of our experiment showed that the application of inorganically activated rock (ARP-inorganic) performed better as compared to RP and TSP. Its application resulted in higher plant biomass, chlorophyll contents, shoot N content, root P content and shoot as well as root K content. This study concluded that ARP-inorganic can be substitute of high cost commercial phosphorus fertilizer in agricultural settings of Pakistan.

Keywords: Activated Rock Phosphate, *Zea mays*, Phosphorus, Chlorophyll contents

SALT STRESS EFFECT ON GERMINATION, GROWTH, BIOMASS PRODUCTION AND PARTITIONING OF *Populus deltoids*

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ABSTRACT

Salinity is one of the major abiotic stress in all over the world they are increased day by day due to the insufficient agriculture practices. Pakistan is primarily an arid and semiarid country. Out of total 23 million ha cultivated lands, 6.8 million ha lands are affected by soil and water salinity that include slightly saline sodic (0.2 m ha). *Populus deltoides*, the eastern cottonwood or necklace poplar is a cottonwood poplar native to North America, growing throughout the eastern, central, and southwestern USA. *Populus deltoides* is a large tree growing to 20–40 m tall. The present study was conducted to explore the salinity tolerance of forest species Eastern cottonwood (*Populus deltoids)* at Nursery Department of Forestry & Range Management, University of Agriculture, Faisalabad. Plant species was exposed to different level of soil salinity (EC control, 2, 6 and 12 dS m^1) in earthen pots experiment to determine the germination percentage and other growth parameters. Results show that salinity have negative effect on germination and other biomass production but in EC 6 dS m^1 the germination percentage and other growth parameters were insignificantly different from control treatment. However in EC 12 dS m^1 showed significantly decreased as compare to others treatments. Therefore, it is concluded that *Populus deltoids* well performed under the EC 6 dS m^1.

Keywords: Salinity, *Populus deltoids*, Germination percentage, Biomass production

IMPACT OF CLIMATE CHANGE ON NUTRIENT CYCLING IN RHIZOSPHERE

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ABSTRACT

Climatic changes, such as increasing global temperatures as well as occurrence of drought periods are supposed to effect individual plants and/or plant communities by affecting their carbon sequestration potentials. The objective of this study was to elucidate the impact of drought stress on carbon (C) sequestration and rhizosphere-mediated CO_2 fluxes of plant-soil system. It also included the combined effect of drought stress and plant types on C sequestration in different soil aggregate fractions. The conceptual approach included repetitive $^{14}CO_2$ pulse labeling of plants grown under drought and optimum moisture levels. Impact of plant type was studied by growing maize crop. Drought conditions changed the source sink relationship of maize plants and as a result, relatively higher portion of C assimilates were translocated towards roots compared to plants grown under optimum conditions. In continuation, drought increased the release of root exudates that enhanced the rhizomicrobial respiration ($^{14}CO_2$) in maize plants. Due to drought stress, there was increase in microaggregate formation in planted soils and higher fresh carbon assimilates (^{14}C) into the microaggregate fractions confirmed that higher root exudation due to drought stress helped in microaggregate formation under drought stress. Thus maize plants performed quick adaptive response to drought stress by maintaining their biomass and translocating higher photosynthates towards roots for efficient water uptake.

Keywords: Nutrient cycling, Climate change, Rhizosphere, Drought stress

D. CROP BREEDING AND MOLECULAR GENETICS

BREEDING RUSTS RESISTANCE WHEAT VARIETIES FOR A CHANGING CLIMATE

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ABSTRACT

Wheat crop plays a vital role in multifaceted farming system of Pakistan. Like other countries of the world, in Pakistan sustainable wheat production is also continuously threatened by climate change. Satisfying the future demand for agricultural products largely depend on developing new cereal cultivars adapted to ever-changing environments. Plant breeders are now targeting durable forms of genetic resistance to diseases as well as tolerance to abiotic stresses such as drought, heat, frost, and other adverse environmental conditions. Among the biotic stresses, three rust diseases of wheat have been the most devastating. Stem rust was effectively controlled with adoption of the semi-dwarf spring wheats of the green revolution. However, the threat of the evolution of *Ug99* race of stem rust in East Africa and its migration to Iran cannot be neglected. The Chance of *Ug99's* migration from Iran into Pakistan, coupled with the presence of dangerous new races of stripe and leaf rusts invites enormous efforts for development of rust resistant varieties for sustainable production of the wheat in the country. In this regard the Wheat Program, NARC, Pakistan initiated an intensive breeding program with financial and technical support of USDA and CIMMYT. Diverse sources of resistance to the three rusts particularly to the stem rust race *Ug99* were introduction from CIMMYT. Through the rigorous selection procedure, four rusts resistant wheat varieties (NARC 2011, Pakistan 2013, Zincol 2016 and Borlaug 2016) have been released. These varieties are also resistant to *Ug99.* The varieties i.e. NARC 2011, Borlaug 2016 and Zincol 2016 are performing well in irrigated areas whereas Pakistan 2013 is suitable for rainfed conditions. The variety Zincol 2016 has high Zn content (35 ppm) in grain as compared to national standard check variety (25 ppm). These varieties are not only higher yielding but also possess good grain quality and other desirable traits. A considerable quantity of seed of the varieties is already present in the national seed system and will reduce the risk of Ug99 threat.

Keywords: Rust, Ug99, Wheat, Zn contents

DIVERSITY OF CHICKPEA ROOT NODULE-ASSOCIATED BACTERIA REVEALED BY CULTURE-INDEPENDENT MOLECULAR TOOLS

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ABSTRACT

In the present study, bacterial diversity and distribution of the genus *Mesorhizobium* in the root nodules and rhizospheric soil of chickpea growing at 5 different localities of Pakistan was investigated by pyrosequencing of PCR-amplified 16S rRNA and *nif*H genes. In the nodules, 56.73% of the retrieved 16S rRNA sequences and only a minor fraction 0.16% of the total 16S rRNA sequences recovered from rhizospheric soil belonged to genus *Mesorhizobium*. Among the *nif*H gene sequences recovered from nodules and rhizospheric soil, 88.83% and 16.68% of total sequences belonged to genus *Mesorhizobium*, respectively. Mesorhizobial 16S rRNA gene sequences retrieved from the nodules and rhizospheric soil clustered into 7 phylotypes. The most abundant *Mesorhizobium* phylotype 1 detected both in the nodules and rhizospheric soil, clustered with *M. muleiense* and *M. mediterraneum* in the phylogenetic tree. *nif*H gene sequences of mesorhizobia recovered from the nodules and rhizospheric soil formed 4 clusters and the dominant cluster 1 aligned with *M. ciceri*, *M. muleiense* and *M. mediterraneum* in the phylogenetic tree. 16S rRNA and *nif*H gene sequencing also revealed the presence of several non-rhizobial endophytes and important plant growth promoting bacteria of the phyla *Proteobacteria*, *Actinobacteria*, *Bacteroides* and *Firmicutes* in the root nodules and rhizospheric soil of chickpea.

Keywords: Bacteria, Chickpea, Nodule, Rhizosphere

PRINCIPAL COMPONENT ANALYSIS AND GENOME WIDE ASSOCIATION MAPPING FOR DIFFERENT PLANT TRAITS UNDER DROUGHT STRESS CONDITION

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ABSTRACT

Principal component analysis was used to determine the pattern of genetic diversity and relationship among individuals. A population panel of 226 wheat genotypes comprising traditional landraces and local cultivars were evaluated under terminal drought stress. To induce artificial drought, chemical spray of potassium iodide, at 0.4% active ingredient was applied manually to the whole plant. Ten morphological characters *i.e.* days to heading, plant height, flag leaf area, spike length, number of spikelets per spike, peduncle length, number of tillers per plant, 1000 grain weight, percent reduction in grain weight and grain yield per plant were measured. Grain yield per plant showed the highest variation with Coefficient of Variation (CV) of 49.43% followed by percent reduction in grain weight, number of tillers per plant, 1000 grain weight, peduncle length, number of spikelets per spike, plant height and days to heading. Minimum variation was observed for days to heading with the CV of 3.08%. There were two component having eigenvalue more than one. In the first component the traits viz: plant height, grain yield per plant, number of tillers per plant, number of spikelets per spike, percent reduction in grain weight, thousand grain weight, spike length and peduncle length contribute 52.22% of the total variability. In component two, days to heading contributes 11.11% of total variability. First two axes explained 63.38% of total variability among 10 characters. We conducted a genome-wide association study (GWAS) using a high-density 90K SNP array to better understand the genetic basis underlying grain yield per plant. The SNPs for grain yield were mainly distributed on the chromosome 1, 2, 3, 5 and 7. For stem reserve mobilization the significant associated SNP were identified mainly on the chromosome 1, 2, 3, 5 and 7.

Keywords: Drought stress, PCA, GWAS, SNP

ASSESSMENT OF GENETIC DIVERSITY OF MEDICINAL PLANTS OF AZAD JAMMU KASHMIR BY SSR MARKERS

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ABSTRACT

The main objective of this study was endeavor the assessment of genetic diversity, relationship, and variations, among different important medicinal plants of Azad Jammu& Kashmir by using Simple Sequence Repeats (SSR) amplification assay. Degree of polymorphism observed among the samples, suggesting the degree of genetic variability of medicinal plants of Azad Jammu Kashmir. Despite the fact we are encountering a severe decline of important medicinal plants we still have certain important species, which require our attention. Traditionally, the identification of medicinal plants based on their external features. In most cases, it is not easy to identify the medicinal plants particularly when the plants are growing through their varied developmental phases. The best method and tool for identification and classification of plants particularly the important medicinal plants based on nucleic acid identification method. Some important medicinal plants of AJK were collected from the different places of AJK and used for checking their genetic diversity. The average polymorphism observed between the 50 medicinal plants of AJK by the primer TAA15, CAC15, and KSU-PDL2 was 26.02%, 34.67%, 33.34%. The sum of amplified bands, showed by the primers TAA15, CAC15, and KSU-PDL2 were 234, 199, and 175 respectively. The average percentage of the polymorphism shown by the primers TAA15, CAC15, KSU-PDL2 was 34.67%. While the total sum of the polymorphic bands shown by the primer TAA15, CAC15, KSU-PDL2 were 61, 69, 59 respectively. The value of PIC (Polymorphic information content) shown by the primer TAA15 was 0.54. SSR marker showed a good tool for checking polymorphism and genetic diversity in present study.

Keywords: Genetic diversity, SSR markers, Medicinal plants

ASSESSMENT OF GENETIC DIVERGENCE FOR SEED YIELD AND OTHER AGRONOMIC TRAITS IN LOCALLY DEVELOPED SUNFLOWER (*Helianthus annuus* L.) HYBRID

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ABSTRACT

Fourteen locally sunflower hybrids were evaluated for 9 agro morphological traits under field condition to estimate genetic parameters, correlation coefficient, and path analysis. Analysis of variance and mean performance for yield and its component revealed significant difference among all the hybrids for all the characters under study. Days to flower initiation, days to flower completion, days to maturity and stem girth had positive correlation coefficient with plant height. Head diameter contributes positive towards stem girth, seed yield and oil content percentage. Positive direct effect was observed with days to flower initiation, head diameter, stem girth and 100 seed weight. A weak positive direct effect was also pragmatic by oil content. Highest positive indirect effect was observed in days to flower completion with seed yield. Hence, the results of study concluded the importance of head diameter, 100 seed weight and oil content in improvement of seed yield in locally developed sunflower hybrids.

Keywords: Correlation, Path coefficient, Genetic interaction, *Helianthus annuus*

RESPONSE OF CHICKPEA (*Cicer arietinum* L.) GENOTYPES TO RHIZOBIAL INOCULATION AND FERTILIZER APPLICATION

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ABSTRACT

Fifteen chickpea genotypes were evaluated under rhizobial inoculation, nitrogen application and controlled environments at The University of Agriculture Peshawar during 2016-17. Genotypes were planted in randomized complete block design with three replications under each environment. Data were recorded on days to maturity, plant height, pods plant^{-1}, 100 seed weight, seeds plant^{-1} and seed yield plant^{-1}. The combined analysis of variance revealed highly significant differences among three environments, genotypes and G × E interaction for yield and yield associated traits. Mean values of genotypes over environments for days to maturity ranged from 171.5 (SL-3-29) to 189.7 days (NDC-15-1), plant height from 43.9 (SL-3-29) to 56.1 cm (NDC-122), pods plant^{-1} from 30.9 (NDC-4-20-1) ter to 58.2 (Karak-1), 100 seed weight from 14.9 (SL-3-29) to 25.8 g (Karak-1) and seed yield plant^{-1} from 11.4 (SL-3-29) to 23.2 g (Karak-1). Genotype × environment interaction for seed yield per plant ranged from 10.3 (SL-3-29) to 27.6 g (Karak-1). Among environments maximum (27.6 g) seed yield per plant was recorded under inoculated environment while minimum (19.6 g) seed yield per plant under controlled environment. The impact of seed inoculation was more on yield and yield contributing traits compared to fertilized and controlled environments. Hence bacterial inoculation is recommended for improved chickpea yield, which is also economic for poor farmers and is environment friendly. Genotypes Karak-1, NIFA-2005 and Karak-3 out yielded all other genotypes under all the studied environments and could be suggested for general cultivation and utilization in future breeding strategies.

Keywords: Chickpea, BNF, Rhizobia, Seed yield

CO-OVEREXPRESSION OF THE *PeDREB2a* AND *KcERF* IMPROVES SALT AND DROUGHT TOLERANCE IN TRANSGENIC *Lotus corniculatus*

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ABSTRACT

DREB and *ERF* transcription factors play important role in plant adaptation to abiotic stress. This study explore the function of co-overexpression of*PeDREB2a* and *KcERF* in transgenic *Lotus corniculatus* under abiotic stress. The two genes *PeDREB2a* and *KcERF* were expressed in *Lotus corniculatus* to study the effect on phenotype, physiology and biochemical aspects of transgenic plants under drought and salt stress. The results indicated that transgenic *Lotus corniculatus* plants shows higher root length and plant growth as compared to wild type and have higher levels of proline content and low malondialdehyde content under drought and salt condition . Transgenic plants also showed elevated expression of stress related genes under normal condition, salt and drought stress. The results revealed that Co-overexpression of the two transcription factors, *PeDREB2a* and *KcERF* improved salt and drought tolerance in transgenic *Lotus corniculatus.*

Keywords: *Lotus corniculatus,* Drought stress, Genes

HETEROTIC STUDIES OF YIELD AND YIELD CONTRIBUTING TRAITS IN MAIZE F_1 HYBRIDS

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ABSTRACT

Five maize inbred lines (white kernel) were crossed in a complete diallel fashion during spring 2011 at Cereal Crops Research Institute (CCRI), Pirsabak - Nowshera, Khyber Pakhtunkhwa, Pakistan. The resulting 20 F_1 hybrids, five parental inbred lines and two checks (OPV 'Jalal' and 'Pioneer hybrid 30k08') were evaluated during subsequent summer 2011 through field experiments at four different locations; CCRI - Nowshera, The University of Haripur, Haripur, Agriculture Research Station (ARS), Baffa - Mansehra, and ARS, Mingora Swat, Khyber Pakhtunkhwa, Pakistan. All the experiments were laid out in a randomized complete block design with three replications with the objective to identify the suitable hybrid combinations on the basis of their genetic potential for commercial cultivation in Khyber Pakhtunkhwa. Large number of F_1 hybrids revealed significant positive heterotic effects for grain yield and most of the yield contributing traits at Swat, followed by ARS, Baffa - Mansehra, The University of Haripur, Haripur and (CCRI), Pirsabak - Nowshera. Majority of the F_1 hybrids revealed significantly positive mid and better parent heterotic effects for ear length, grain rows per ear, 1000-grain weight and grain yield at all the locations. For grain yield, F_1 hybrids PSEV3 × FRHW-1 and PSEV3 × FRHW-2 at CCRI, FRHW-2 × FRHW-1 and SWAJK-1 × FRHW-1 at Haripur, FRHW-1 × SWAJK-1 at Mansehra and FRHW-2 × FRHW-3 and FRHW-1 × SWAJK-1 at ARS, Mingora Swat showed desirable and significant positive mid and better parents, economic and commercial heterosis. Therefore it is concluded that these F_1 hybrids could be used in further breeding programs.

Keywords: Maize, Inbred lines, Heterosis

COMPARISON OF HYDROPONIC AND IN VITRO TECHNIQUES FOR THE SCREENING OF DROUGHT TOLERANT ACCESSIONS IN *Brassica napus* L.

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ABSTRACT

The present study was focused on comparison of hydroponic and *in vitro* techniques for the screening of drought tolerant accessions in *Brassica napus*. Seeds of ten accessions were grown in polythene bags with triplicate Completely Randomized Design by using factorial structured treatments. Fifteen days after sowing, seedlings were transplanted to the hydroponics at three drought stress levels T_0= 0 (control), T_1= 9% and T_2= 18% of polyethylene glycol 6000. Data were recorded on seedling height, root length, shoot length, fresh and dry root and weights after 15 days of transplantation. In *in vitro* culture seeds were grown in MS zero media and explants were used for callus culture. Three drought stress levels T_0= 0 (control), T_1= 9% and T_2= 18% of PEG were applied. Relative fresh weight of callus, electrolyte membrane leakage, proline content, glycine betaine and total soluble sugar contents were recorded after 21 days of callus formation. Recorded data of both experiments were subjected to analysis of variance and multiple comparison test. Hydroponics showed better results due to high germination % of accessions, genetic variability for many traits. It may also be very helpful for the study of root and its extensions under drought stress conditions.

Keywords: *Brassica napus* accessions, Drought stress, Hydroponic culture, *In vitro* culture

NANOTECHNOLOGY INNOVATIONS & THEIR APPLICATIONS IN FIELD OF AGRICULTURE

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ABSTRACT

Nanotechnology has enhanced the quality of life in the form of food items, electronics, cosmetics, biomedical treatment and the most important in field of agriculture such as battling pests and pathogens, regulating the growth and quality of crops, and developing smart materials and bionanosensors. Currently, the application of nanomaterials is expanding in all field of sciences especially in agriculture exploiting their characteristics and possible environmental destination and effects on ecosystems. There are only limited reports on nano bio interaction and investigation of their response *via* expression of proteins and change in lipids and carbohydrates of plant body which is still a major challenge. The use of quantitative biomolecules analysis of crops at biological, cellular and molecular level in response to different concentration and types of nanoparticles can be useful for identification of biomarkers. Change in expression of these biomolecules can be useful for investigation of diseases as well as the development of tailored therapeutic strategies. Considering the wide application of nano biotechnology, it is an imperative that the knowledge of nanotechnology in the field of agriculture and the training, workshops and specific degree education should be produced. In this presentation, some discussion on the important application of Nano biotechnology and their effects on the crops and other agriculture products will be highlighted.

Keywords: Nanotechnlogy, Battling pests, Biomolecules

GENETIC EVALUATION OF SUNFLOWER (*Helianthus annuus* L.) FOR YIELD OF ACHENE AND ITS RELATED TRAITS

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ABSTRACT

Ten accessions of sunflower were evaluated for achene yield and its related traits. The experiment was laid out following a randomized complete block design with three replications. Observations were recorded on quantitative traits i.e. plant height, leaf area, head diameter, 100 achene weight, achene weight per plant, stem girth, internodal distance and descriptive traits (Leaf shape, head angle, achene colour, achene stripes and seed sizes). The data were subjected to analysis of variance, correlation and path coefficient analysis to evaluate the genetic variability in the breeding material and to estimate association among various traits. Correlation analyses indicated that seed weight per plant and 100 seed weight was found to be positively correlated with all the traits studied except for internodal distance. Direct and indirect effects of various quantitative traits on achene yield per plant was observed. Plant height, leaf area, head diameter and internodal distance had direct positive effect on achene weight per plant while stem girth and 100 achene weight had negative direct effect on achene weight per plant. It is suggested that achene yield may be improved by improving the head diameter, leaf area, internodal distance and 100 achene weight. These characters may be used as a selection criterion for future breeding programme.

Keywords: Sunflower, Genetic variability, Genotypic correlation, Phenotypic correlation

CHARACTERIZATION OF SYNTHETIC WHEAT GERMPLASM USING MORPHOLOGICAL AND MOLECULAR MARKERS

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ABSTRACT

The study comprised of 40 synthetic wheat genotypes sown in randomized complete block design. The experiment was replicated twice. Each replication was consisted of one row of each genotype. At maturity following plant parameters were studied i.e. days to heading, chlorophyll content, spike length, peduncle length, extrusion length, plant height, number of spikelets per spike, number of grains per spike, thousand grain weight and yield per plant. For molecular characterization, DNA was extracted from 10 days old seedling. Inter Simple Sequence Repeats (ISSR) markers were used for molecular characterization. Analysis of variance revealed significant differences among genotypes for the studied traits. Year factor also showed significant effect for all the traits except spikelets per spike and number of grains per spike. Year * genotype interaction also showed significant effect for all the traits except plant height. Among ISSR markers, UBC-818 and UBC-825 showed highest level of polymorphism followed by UBC-845. Genetic similarity matrix showed that maximum level of similarity observed among 40 genotypes was 0.80%. Dendrogram was also generated on the basis of molecular data which grouped the genotypes into various clusters on the basis of similarity.

Keywords: ISSR, Molecular markers, Synthetic wheat, Polymorphism

EXPLOITING THE HYBRID RICE TECHNOLOGY IN CHANGING AND CHALLENGING ENVIRONMENT FOR SUSTAINABLE RICE PRODUCTION

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ABSTRACT

World population is, at present, almost 7 billion and increasing at a very high speed of 3% in an under developed country like Pakistan. Due to the urbanization, per unit area of fertile land under cultivation is decreasing at an alarming rate. Sudden floods, drought, salinity, bacterial leaf blight, and hopper attack are the serious outcome of changing environment in Pakistan. Many potential technologies like mechanical transplanting, Parachute technology, DSR technology have been tested so far but the hybrid rice cultivation was proved to be the best option especially in Sindh Province. Rice hybrids have the potential to enhance 15-25% rice yield and ultimately the production. More than 400 rice hybrids were tested and evaluated for yield, quality and other related traits in different years. Many heterotic hybrids have been identified. From the segregating populations of these heterotic hybrids many uniform, high yielding good quality aromatic long grain lines were developed and included in the germplasm. These lines are being converted, through breeding, into new CMS, Maintainer and Restorer lines. Marker Assisted Selection (MAS) is also being exploited for the confirmation of fertility restorer gene (Rf1) in these lines. These lines are, in addition, being crossed with Biotic and Abiotic stress tolerant lines to better combat with prevailing and upcoming environmental changes through the development of heterotic rice hybrids.

Keywords: Hybrid, Rice, Parachute technology, CMS

EVALUATION OF SOME ADVANCED LINES OF SORGHUM FOR GREEN FODDER YIELD AND MORPHO-ECONOMIC TRAITS

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ABSTRACT

These studies were conducted at Fodder Research Institute, Sargodha during the year 2016-2017. Five cultivars of sorghum including check (Sorghum-2011) were evaluated for plant height, stem thickness, leaf area. Number of leaves per plant, sweetness, crude protein, green fodder and dry matter yields, Cultivar Sgd-013-1 showed significant differences with higher number of leaves per plant (15.5), stem thickness (1.9 cm) and leaf area (517.5 cm^2) as compared to check (11.6) average number of leaves/plant, 1.5cm stem thickness and 460.5 cm^2 leaf area). Similarly, No.1572 was superior in green fodder yield, dry matter yield and quality (sweetness and crude protein) to Sorghum 2011. On and average Sgd-013-1 produced 70.8 tons per hectare green fodder and 12.8 tons per hectare dry matter yield as compared to Sorghum-2011 (59.6 t/ha green fodder yield and 8.4t/ha dry matter yield). Early growth stages had high crude protein level than late stages.

Keywords: Sorghum bicolor, High yielding varieties, Agronomic characters, Pakistan

MOLECULAR CHARECTERIZATION OF RANDOMLY SELECTED SPECIES OF BRASSICACEAE FAMILY ON THE BASIS OF DNA INVENTORIES

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ABSTRACT

DNA Barcoding has the capabilities to revolutionize the approach of identifying and cataloguing biodiversity; nevertheless, tremendous controversy surrounds one of the crucial proposed purposes. The cytochrome C oxidase gene (COXI) is commonly recommended. The Consortium for the Barcode of existence (CBOL) has proposed two regions of DNA to be used as a twin-locus barcode. Two proposed barcoding areas were examined, ribulose-1,5-bisphosphate carboxylase/oxygenase (*rbcl*) and maturase K (*mat-k*) for their ease of amplification, discriminatory vigor, and sequence excellent. Present study is designed to investigate chloroplast DNA (cpDNA) barcoding skills to determine known species and provide a well-resolved phylogeny for the household Brassicaceae, to be able to do that, phylogenetic tree was created for species in the Brassicaceae. Outcome decided how good the barcoding region delimits species which have been famous situated on morphology. In addition, the consequences of sampling on the success of barcoding experiences had been discovered. Seven species of Brassicaceae specie *i.e.* (*Brassica oleracea* var. Capitate, *Brassica oleracea* var. Capitata f. Rubra, *Brassica oleracea* var. Botrytis, *Brassica rapa* subsp. Oleifera, *Brassica rapa* subsp. Rapa, *Raphanus sativus*, and *Raphanus sativus* var. Longipinnatus) which might be known to sequence. Phylogenetic analysis of the barcoding region published insights into the causes these seven species would be effectually differentiated utilizing barcoding technique; the 1326r/390f *mat-K* gene was amplifiable in all plants used in this gain knowledge of. The *rbcl* gene is an effective candidate to be used as a DNA barcode headquartered on its discriminatory vigor and sequence fine at the same time extra efforts are needed to find the replacement of the 1326r/ 390f *mat-K* gene.

Keywords: *Mat-K* and *rbcl* in Brassicaceae family, DNA barcoding of Brassicaceae family

MOLECULAR CHARECTERIZATION OF VARIETIES OF GENUS TRITICUM ON THE BASIS OF DNA INVENTORIES

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ABSTRACT

DNA barcoding an innovative scientific device that utilizes a short length DNA regions registered as DNA barcode for species investigation, by comparing the particular barcoding regions with the sequences already placed within reference library. The Consortium for the Barcode of existence (CBOL) has proposed two regions of DNA to be used as a twin-locus barcode *i.e. rbcl* and *mat-k* in plants. Wheat (*Triticum aestivum* L.) is the economically significant and vital strategic cereal for the majority of world's populations. Current study utilizes four varieties of *Titicum aestivum* and one variety of *Triticum durum*. DNA barcoding approach has been applied to these local varieties with using barcoding marker *matk* and *rbcL*. Study also involves the utilization of various bioinformatics tools. The finding of current study suggested that *matk* is an effective barcoding locus at species and varietal level as compared to *rbcL* in all varieties of Wheat.

Keywords: DNA barcoding, Wheat, *rbcl*, *mat-k*

HETEROTIC RESPONSE OF NITROGEN USE EFFICIENCY AND ASSOCIATED TRAITS IN BREAD WHEAT

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ABSTRACT

To economize the use of synthetic fertilizer as well as to hamper environment deterioration, development of wheat varieties well suited to minimal nitrogen availability has gained importance worldwide. The prime objective of this study was to estimate heterobeltiosis for nitrogen use efficiency and associated traits in bread wheat. Three years (2013-16) study was carried out to investigate pattern of inheritance of nitrogen use efficiency (NUE) at The University of Agriculture, Peshawar Pakistan. During 2013/14, thirty wheat varieties were preliminary screened under with (N+) and without nitrogen (N0) conditions as independent experiments to identify contrasting groups for hybridization scheme. Based on the result of previous year, six wheat varieties viz. Shahkar-13 (Shk), Pirsabak-05 (PS) and Tatara-96(Tat) as N-efficient, while Hasham-08 (Hsm), Inqilab (Inq) and Pak-81 (Pak) as N-inefficient were crossed in 6 × 6 straight diallel fashion during 2014/15. Six parents and their F_1 diallel crosses were evaluated under N+ and N0 conditions as separate experiments during 2015/16. Heterobiltiosis for most of the traits wereeither nonsignificant or significant but non favourable, except for few traits with limited number of crosses both under N+ and N0 conditions. Better parent heterosis was predominantly higher in cross combination Shk × Hsm and PS × Tat for most of the traits under N+ and N0 conditions, respectively. Hence, these cross combinations are recommended for further exploitation in wheat breeding programs focusing on the development of N-efficient bread wheat cultivar in the country.

Keywords: Wheat, Nitrogen use efficiency, Heterosis, Heterobiltiosis

IDENTIFICATION OF POTENTIAL PARENTS FOR INTROGRESSION OF CLCUD RESISTANCE IN UPLAND COTTON

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ABSTRACT

Several viruses infect cotton plant across the globe. Climate change favors the growth and reproduction of vector, and this has increased the rate of disease transmission. Cotton crop is affected by cotton leaf curl disease (CLCuD) which is a major limiting factor for cotton production in Pakistan. Several begomovirus species are responsible for this disease. Native cotton species, the *Gossypium arboreum* L. is resistant to this disease and its vector, but this species was replaced by *Gossypium hirsutum* L. due to high yield of seed cotton but it was not adapted to CLCuD. Keeping in view the heavy yield losses and importance of resistance sources, thirty eight genotypes of *G. hirsutum* had been screened. Data in triplicate, based on symptomatology, was recorded at different growth stages of crop. In addition, species/strain specific PCR based diagnostic assay was developed to evaluate the genotypes at molecular level. Twelve genotypes were found to be highly resistant, whereas thirteen were resistant, and rest of them belong to moderately susceptible to susceptible group. Specific primers were designed to identify particular species/strain, infecting the cotton genotypes. Burewala strain (CLCuKoV-Bur) was detected in most of the genotypes but plants showed mild symptoms due to low titer of virus particles. Cotton leaf curl Multan virus (CLCuMuV) was also found in some genotypes but cotton leaf curl Kokhran virus (CLCuKoV) was not present in any genotype. The resistant sources identified in this study could be used in breeding programs for the development of promising germplasm.

Keywords: Cotton, Germplasm, Resistant, Begomovirus, Symptomatology

ISOLATION, CLONING AND EXPRESSION CHARACTERIZATION OF GSSNAP33; A SNARE FAMILY PROTEIN GENE FROM WILD SOYBEAN *Glycine soja*

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ABSTRACT

Abiotic stresses are among the key factors which severely reduce growth and yield in crop plants and subsequent economic losses all around the world. The proteins of SNAREs superfamily (N-ethylmaleimide-sensitive factor attachment protein receptor) specifically, the SNAP25-type proteins and t-SNAREs, have been known to regulate various cellular processes and plant resistance mechanisms. However, the role of SNAP25-type proteins under abiotic stress conditions is still remains unclear particularly in soybean. In this study, we reported the isolation of GsSNAP33 gene from wild soybean via homologous cloning method to further characterize its expression levels under abiotic stresses, bioinformatics analysis and subcellular location. *GsSNAP33* gene with molecular weight of 33,311 Da and 300 amino acid residues exhibited a special case due to presence of Qb-Qc SNARE domains in the individual polypeptide chain. Multiple sequence alignment unveiled the highest similarity of the GsSNAP33 protein to other proteins from *Glycine max*, *Vigna radiata* and *Phasleous vulgaris* in the range of 63-91%. The Phylogenetic analysis showed the abundance of SNAP33 proteins mostly among dicot plants. The GsSNAP33 gene structure analysis showed presence of five exon and four introns. The protein subcellular localization studies showed that the GsSNAP33-eGFP fusion protein was resided in to the plasma membrane. In addition, the expression profiles of the *GsSNAP33* gene in different organs using quantitative real-time PCR assays confirmed that *GsSNAP33* was widely expressed in both vegetative and reproductive organs with the highest expression levels in the pods, seeds and roots respectively. Furthermore, our results showed that the *GsSNAP33* gene expression level can be induced under NaCl, ABA, PEG6000 and NaHCO3 treatments and found considerably higher in roots compared to those in leaves of *Glycine soja*. Taken together, the results obtained in this study can be used to manipulate GsSNAP33 protein or nucleotide for transformation purposes or to further clarify its role in stress mediated signal transduction pathways.

Keywords: *Glycine soja*; *GsSNAP33*; functional analysis, Bioinformatics analysis, Expression analysis

GENETIC DIVERSITY FOR GRAIN FILLING PERIOD AND ITS RELATIONSHIP WITH YIELD COMPONENTS IN *Trticum aestivum*

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ABSTRACT

Wheat crop is more likely to prone all types of stresses (biotic) worldwide, although researchers are working to find out the means of combat mechanism to evade the risk of food security. The reason of the present study was screening of early maturing as well as high yielding germplasm, as it is one of the sustainable and economically feasible preference for increasing crop efficiency and stability for the crop genetic improvement for high yielding genotypes. In the proposed study, 50 lines with two replication from CIMMYT (34th ESWYT nursery) were analyzed for grain filling duration (days to 50% heading and days to 50% maturity). From biplot analysis, following lines 125, 137, 138, 140, 141, 145 and 148 150 were selected as high yielding genotypes with shorter grain filling period. Grain yield showed negative and significant association with days to 50% maturity and days to 50% heading, whereas grain yield exhibited positive as well as significant correlation with grain weight/ spike, spike length, thousand grain weight, number of grains per spike, productive tillers m^{-1} and spikelets per spike. Days to to 50% heading has positive and significant correlation with grain size, grain weight per spike, ear length, thousand grain weight and falg leaf area. Selected lines could be exploited in future breeding programms for achiving the targets of high yield as well as in escape of biotic stresses.

Keywords: Biplot analysis, Biotic stress, Days to 50% heading/maturity, Grain yield

ASSESSMENT OF DROUGHT TOLERANCE IN COTTON (*Gossypium hirsutum* L.) GENOTYPES AT EARLY GROWTH STAGES BY USING PRINCIPLE COMPONENT ANALYSIS AND SSR MARKERS

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ABSTRACT

Drought has very severe effects on crop growth and performance. The normal physiology and chemistry of crop plants is disturbed with poor moisture availability. In order to assess the performance of cotton accession under such drought environment present study was planned. For this purpose, 40 cotton genotypes were assessed at two moisture levels i.e. normal (T1) and drought stress (T2). Seeds of forty cotton genotypes were seeded in polythene bags by following split plot under CRD arrangement. Assessment of cotton genotypes was made against different characters at seedling stage (biomass, shoot length, root length, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight, lateral root number, relative water content and excised leaf water loss). Data were analyzed by using split plot under CRD analysis of variance. Data were further analyzed by principal component analysis for selection of drought tolerant and sensitive genotypes. Highly significant differences among genotypes for all the parameters were found under two moisture levels. A significant reduction in almost all characters was shown under water deficit treatments. First three principle components/factors, showed more than 1 eigenvalue under all three moisture levels. The first two principle components (F1 and F2) contributed 58.11% and 57.70% cumulative variability in normal and drought condition, respectively. Root length, shoot fresh weight, shoot dry weight, root fresh weight, lateral root number, relative water content and excised leaf water loss were proved to be the most effective selection indicators under water deficit condition at seedling stage. AA-802, IR-3701, NS-121, VH-295, VH-144, NIAB-111, VH-148, FH-142 and AS-01 at normal condition; NIAB-111, VH-144, IR-3701, VH-295, IUB-212, NS-121, SB-149, FH-142 at drought condition performed better and were proved to be drought tolerant. Molecular marker studies were conducted on a small sample of 15 selected cotton genotypes (10 drought tolerant and 5 drought sensitive). This study revealed the presence of genetic variability for the trait of interest and it exhibits its potential for exploitation in the future breeding for drought tolerance.

Keywords: Cotton, Drought, Physiology, Principle component analysis, Genetic variability

GENIC ANALYSIS FOR YIELD IN TRAITS OF COTTON (*Gossypium hirsutum*) L.

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ABSTRACT

The study was conducted for nine upland cotton cultivars in six lines (BZU-75, FH-901, CIM-448, FH-900, CIM-573, and BZU-70) and three testers (CIM-616, IR-3701, and MNH-886) were hybridized in Line × Tester mating fashion. Results revealed that comparison of each (lines × testers) for general combining ability effect for yield per plant. Analysis showed that CIM-616 contain highest positive general combining ability (29.09) and assigned as better general combiners subsequently FH-900 (27.53), CIM-448 (26.42), FH-900 (13.20), CIM-573 (19.75) and IR-3701 (0.92). Remaining 3, achieved negative general combining ability in which poorest general combiner is BZU-70 with (-56.57) for yield per plant followed by BZU-75 (-30.35) and MNH-886 (-30.01). Out of eighteen crosses, eight crosses achieved positive specific combining ability, in which CIM-448 × MNH-886 obtain positive specific combining ability effect (103.40) subsequently FH-900 × IR-3701 (22.01), BZU-75 × MNH-886 (46.42), BZU-70 × IR-3701 (5.63), BZU-75 × IR-3701 (22.40), CIM-573 × CIM-616 (27.40), FH-900 × CIM-616 (5.85) and BZU-70 × CIM-616 (45.68). Remaining 10 crosses attained negative value and proved poor specific combiners. The cross BZU-70 × MNH-886 with negative specific combining ability effect (-52.31) followed by CIM-448 × CIM-616 (-29.20), FH-901 × MNH-886 (-21.09) and FH-901 × CIM-616 (-15.87). Genic analysis for yield per plant revealed that additive variance (-226.31) is lesser as compared to dominance variance (8820.94), hence yield per plant is controlling non-additive gene action.

Keywords: Hybrid, Cotton CULTIVARS, Yield, Testers

COMPARATIVE METABOLITE PROFILING OF TWO WHEAT GENOTYPES WITH CONTRASTING NITROGEN STRESS TOLERANCE

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ABSTRACT

Increasing demands for wheat productivity together with environmental concerns about the use of nitrogen-based fertilizers dictate the importance of improving nitrogen use efficiency (NUE). Identifying biological processes responsible for efficient fertilizer use will provide tools for crop improvement under reduced nutrient inputs. Metabolic response under nitrogen (N) stress was investigated at Centre for Carbon Water and Food (CCWF), The University of Sydney, Australia. GC-MS and LC-MS techniques were used for metabolite and amino acid profiling in N-stress tolerant (Krichauff) and sensitive (Berkut) varieties under with (normal) and without nitrogen (stress) conditions in 28 days old seedlings. Twenty six metabolites including organic acids, sugars and amino acids were characterized in both genotypes under stress and normal conditions. Organic acids (citric acid and oxalic acid) and sugars (glucose, sucrose, fructose and mannose) were significantly increased in both varieties under stress conditions, whereas, malic and oxalic acids were increased in tolerant (Krichauff), while decreased in susceptible (Berkut) genotype. Sugar alcohol (pentaerythitol, xylitol and myo-inositol) remains similar in both genotypes under stress and normal conditions. Seven out of twenty amino acids (glycine, cysteine, valine, methionine, isoleucine, leucine and tryptophan) were not detected in both genotypes under both stress and normal conditions. Most of the remaining amino acid were detected under normal condition only, exhibiting the relationship of amino acid with nitrogen applications. Amino acids viz. serine, aspargine, alanine, threonine, glutamine and proline were specifically decreased under stress condition in Krichauff, whereas glutamic acid increases in both genotypes under stress than normal conditions. Compared with Berkut, Krichauff experienced greater increase in both sugars and organic acids, and more pronounced decrease in most of the amino acids under stress condition. L-ascorbic acid, allo-insitol, lysine and tyrosine were unique metabolites found only in tolerant (Krichauff) genotype. Metabolic responses of wheat to nitrogen stress was dynamic and involve many metabolites. Greater N-tolerance and different metabolic expression in Krichauff necessitate further studies to examine various pathways and adaptive reactions at critical stress conditions. Current findings of metabolite profiling might help in unveiling the genetic targets for the improvement of nitrogen use efficiency in wheat.

Keywords: Ascorbic, Insitol, Metabolite, Nitrogen stress, Wheat

ISOLATION AND CHARACTERIZATION OF POTENTIAL PLANT GROTH PROMOTING RHIZOBACTERIA (PGPR) FROM RHIZOSPHERE OF *Cyprus rotundus* L.

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ABSTRACT

Weedy grass species usually flourish in unfavorable environment and proceed in suitable habitats that are sometimes grown as crops. Despite of their potential to grow in unfavorable environment, weed rhizosphere is under explored. In perspective of increasing food security and environmental quality, the utilization of plant growth promoting rhizobacteria for diminishing chemicals contribution in agriculture is a conceivably an important issue. PGPRs isolated from weeds rhizosphere are being used in different crops that help them in better surveillance i.e. biological nitrogen fixation, phosphate solubilization, IAA production and biocontrol actives. In present study, rhizospheric soil samples were collected from Deela (*Cyprusrotundus* L) in three different crops (cotton, rice and maize).Total 45 bacterial isolates were collected using nutrient rich medium (LB agar) and 15 isolates on selective medium (Nitrogen Free Malate Media) However, 5 isolates produced halo zone on Pikovskaya agar plates and 9 Isolates showed positive activity for Indole-3-Acetic Acid production. Some isolates were positive to show catalase, ammonia, gelatinase and protease activities by using specific growth medium. On the basis of their biochemical activities 10 isolates were tested for plant inoculation studies. Out of 10 isolates 6 (A1P2, A2P2, A3P4, A2P5, B3P1, C1P5) were showed better maize radical and root germination. On the basis of these results we can assume that these noxious weeds are useful for growth of potent PGPRs that are an effective source for plant growth for further plant growth promotion activities.

Keywords: PGPRs, Bio-chemical analysis, Nitrogen free malate media, Pikovskaya, IAA

GENOTYPIC AND ENVIRONMENTAL VARIATION IN THE PHENOLIC ANTIOXIDANT PROPERTIES OF PAKISTANI WHEAT VARIETIES

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ABSTRACT

Wheat variety and environment have a great impact on nutrient composition and are of great importance for both food and environment quality. The objective of this study was to determine the effects of variety and growing environment on the nutritional composition, phenolic contents and antioxidant activities from commercial wheat cultivars grown in Pakistan. Chemical composition, total phenolic contents and antioxidant activities were measured in twenty-seven spring wheat varieties grown for two cropping years. Preliminary assessment of antioxidant strength of the extracts was carried out by the evaluation of total phenolic contents (TPC), antioxidant activity (AA) and free radical scavenging activity (FRSA). The grain length, grain width and thousand kernel weight of different wheat varieties ranged from 6.75-6.77 mm, 3.44-3.45 mm and 42.95-45.16 g respectively among different wheat varieties. Similarly, the moisture content, ash content, crude fat content, crude fiber content, crude protein content, wet gluten content, dry gluten content, flour gliadins content, flour glutenin content and SDS-Sedimentation value varied from 10.23-10.61%, 1.47-1.48%, 1.16-1.21%, 1.37-1.40%, 11.86-12.02%, 25.39-25.46%, 8.85-8.87%, 0.46-0.52%, 0.46-0.49% and 24.99-25.85 ml respectively among different wheat varieties. Likewise, iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), sodium (Na), potassium (K), calcium (Ca), magnesium (Mg) and phosphorus (P) content ranged from 31.73-32.21 mg/kg, 38.57-38.60 mg/kg, 19.44-19.76 mg/kg, 3.73-3.88 mg/kg, 45.19-46.90 mg/kg, 3900.2-3983.1 mg/kg, 361.28-376.30 mg/kg, 1291.9-1301.2 mg/kg and 3029.3-3091.4 mg/kg respectively among different wheat varieties. In the same way, the results for total phenolic contents, free radical scavenging activity (DPPH assay) and antioxidant activity via Beta Carotene bleaching assay varied from 12.40-11.73mg GE/g, 18.48-18.99% and 14.23-15.97% respectively. Our research clearly indicated that wheat variety, input conditions, environmental and genotypic variations have effect on the phenolic antioxidant properties.

Keywords: Glutenin, Phenolic antioxidants, Wheat

GENE ACTION AND COMBINING ABILITY STUDIES IN *Oryza sativa* L.

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ABSTRACT

Rice is staple food of major portion of world population. Present experiment was executed to study the genetics of major traits of Rice by using Line × Tester design. The experiment was conducted involving five *Oryza sativa* genotypes iand their F_1 hybrids in a Randomized Complete Block Design with three replications. The data were collected for number of tillers per plant, panicle length, seeds per panicle, seed index, plant height, flag leaf area and yield par plant. Analysis of variance revealed significant difference among genotypes for all of the traits and data was subjected to Line x tester analysis. NM-15 and Basmati-385 were best general combiners for most of the traits while cross combination NM-15 × Basmati-Pak and NM-15 × Shaheen-Basmati were best for most of the traits. Analysis revealed predominance of non-additive type of gene action for most of the traits studied. It is concluded that selection may be delayed up to later generations for the improving the rice traits.

Keywords: Rice, Line × tester analysis, Gene action, Morphology, Combining ability

GENETIC STUDIES OF VARIOUS YIELD TRAITS OF *Gossypium hirsutum* L. UNDER SALINITY STRESS

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ABSTRACT

Cotton is a dynamic fibre crop of the world. It is susceptible to salinity stress which is a major abiotic factor effecting, crop plant growth, seed cotton yield and fibre quality. In this study six cotton genotypes were crossed in half Diallel fashion and their F_1 along with parents were sown in salt stressed conditions (10 dS m^{-1} and 15 dS m^{-1}), following split-plot arrangement. At maturity data for seed cotton yield and related traits were collected and subjected to statistical analysis. Griffing approach was used to determine combining abilities effects and genetic components. Parent CIM-602 showed good GCA performance for almost all of the observed traits followed by CIM-616, under normal and stress condition along with cross combination CIM-616 × CIM-602 and CIM-616 × FH-142 exhibited high SCA under normal and salinity stress of 10dSm^{-1} for most of the traits. Further breeding procedure may helpful for development of salt tolerant genotypes through selection in later generations.

Keywords: Salinity stress, Cotton, Diallel analysis, Combining ability studies, Genetics

ASSESSMENT OF SPRING × WINTER WHEAT CROSSES FOR GRAIN YIELD AND YIELD CONTRIBUTING TRAITS USING LINE × TESTER ANALYSIS

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ABSTRACT

Bread wheat (*Triticum aestivum* L.) is the major staple food of Pakistan. Introgression of winter wheat genepool into spring wheat is being considered as one of the strategies to break through the yield plateau and good source of disease resistance. The present study conducted in the College of Agriculture, University of Sargodha was planned to observe the gene recombination effects of exotic winter wheat × local spring wheat F_1 crosses for grain yield and related traits along with leaf rust severity using line × tester mating design. During 2015-6. three Chinese winter wheat genotypes viz. C-11, C-19 and C-21 were used as a testers and five spring wheat varieties Pb-11, Galaxy-2013, Saher-06, Fsd-08 and Ujalla-16 were used as female parents to develop F_1 crosses. During 2016-2017, F_1 crossed seeds along with parents were sown in randomized complete block design in triplicate. The results indicated that male parent (tester) C-11 showed positive GCA for days taken to physiological maturity, plant height, peduncle length, spikelets per spike, number of tillers per plant, number of grains per plant and grain yield per main spike. Among the F_1 wheat crosses Punjab-2011 × C-21 was the perfect specific combination for days taken to physiological maturity. The female line Ujalla-2016 showed good general combiner for days taken to physiological maturity while female parent Galaxy-2013 proved to be a good positive general combiner for days taken to heading, peduncle length, number of tillers per plant and harvest index. Regarding disease scoring, out of 15 F_1 cross combinations Ujalla-2103 × C-19, Saher-2006 × C-11, Seher-2006 × C-21, Punjab-2011 × C-21, Punjab-2011 × C-11 and Faisalabad-2008 × C-21 showed resistance/tolerance against leaf rust. The female parent Punjab-2011 illustrated positive GCA for grain yield per plant,1000-grain weight and spikelets per spike.

Keywords: Spring and winter wheat, GCA, SCA, Line × tester

INHERITANCE PATTERN OF EXCISED LEAF WATER LOSS AND RELATIVE WATER CONTENT IN *Gossypium hirsutum* L. FOR WATER STRESS CONDITIONS

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ABSTRACT

Very little information is available to understand the genetics of relative water content (RWL) and excised leaf water loss (ELWL) in cotton. A study was conducted on 30 cotton genotypes, which screened on the basis of root and shoot related traits at seedling stage in glasshouse. Ten cotton genotypes namely CP-15/2, NIAB-111, CIM-1100, BH-160, CIM-446, CRIS-134, MNH-93, FH-900, CIM-482 and CIM-707 were identified as drought tolerant due to overwhelming performance. In contrast, NIAB Karishma, CIM-506, FH-1000, MNH-129, Acala-1517C and S-12 were declared as drought sensitive, later on they were hybridized following Line × Tester mating fashion. Then hybrids were evaluated at seedling and maturity stage in greenhouse and field conditions respectively for collection of observation which were used for genetic analysis. A considerable reduction in both traits was observed under stress conditions. Lines × Tester analysis showed that relative water content and excised leaf water loss are governed by non-additive and dominant genetic effects under normal conditions and water stress conditions. Both traits showed high heterotic effects under both conditions. Higher estimates of heritability suggested a potential for genetic improvement through breeding and selection. Cotton breeders may utilize these potential parents and combinations in breeding programs on drought tolerance.

Keywords: Cotton, ELWL, Genetic effect, Heritability, RWL, Water stress

ESTIMATION OF COMBINING ABILITY ANALYSIS IN MAIZE USING LINE TESTER ANALYSIS UNDER NORMAL AND WATER DEFICIT CONDITIONS

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ABSTRACT

Twenty genotypes of maize were assessed under water stress condition at seedling stage in green house. Seedling data was recorded for shoot length, root length, root/shoot ratio, fresh shoot weight, fresh root weight, dry root weight, dry shoot weight, density of root, stomata frequency, leaf venation, stomata size and epidermal cell size. On the basis of preliminary evaluation, four promising inbred lines viz. A521-1, A556, OH28 and OH41 were selected to use as female parents to cross with three testers viz. Agati-85, Soneri and Sultan used as male parents in line × tester mating design in field for developing their F_1 hybrids. In next experiment, parents with their hybrids were planted in field under normal and water deficit condition to measure various morphological traits by using duplicated randomize complete block design (RCBD). At maturity, data was recorded for plant height, leaf area, leaves per plant, leaf angle, leaf temperature, leaf chlorophyll content, cob length, cob diameter, number of kernel rows per ear, kernel per row, 100 grain weight and grain yield per plant. The data was analysed using line × tester analysis which showed that the female parents A521-1 and OH28 were best general combiner under normal conditions. The female parents OH28 and OH41 were best general combiner under water stress condition. Among crosses A521-1 × Sultan and OH41 × Agati-85 were best specific combiner under normal and water stress condition respectively. It was concluded that parental genotypes like A521-1, OH28 and OH41 and crosses like A521-1 × Sultan and OH41 × Agati-85 can be used for further breeding programs. Characters like plant height, leaf area, leaf angle, leaf chlorophyll content, 100-grain weight and grain yield per plant can be used as selection criteria for developing drought tolerant hybrids and synthetic varieties.

Keywords: Maize, Line × tester, Drought, Water deficit

HETEROSIS AND HETEROBELTIOSIS STUDIES IN BREAD WHEAT (*Triticum aestivum* L.) CROSSES

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ABSTRACT

Bread wheat is well known crop in world. It provides 72% calories and protein in daily food and is cheap source of energy. It plays an important role to develop economy of Pakistan. In changing climate scenario there is need to develop high yielding wheat varieties for sheltered food security. Present experiment was conducted to estimate the heritability, heterosis and heterobeltiosis among forty F_1 hybrids developed from crossing diverse parents. Results showed that UOS-950×Pb-11 had highest heritability for number of grains spike^{-1} (89.4%) followed by Sehar-06×Galaxy-13 (89.22%) for 1000 grain weight and grain yield per plant. The cross CIM-130 (2012-13)×Millat-11 showed highest heterosis for peduncle length (74.49%). CIM-54 (2012-13)×SA42/Shafaq showed high heterosis for number of spikes plant^{-1} (44.05%). The cross (Galaxy-13×Pb-11) showed high heterosis for number of spikelet's spike^{-1} (27.88%). The cross (Galaxy -13×UOS-540) showed high heterosis (55.23%) and heterobeltiosis (54.59) for 1000-grain weight and 55.41% and 54.84% respectively for number of grains spike^{-1}. The cross (Inq-91/Prl/Fsd-08×Lyp-73) showed high mid parent heterosis for grain yield plant^{-1} (89.27%) and over better parent 45.51%. The cross (Pb-11×CIM E-5 2012-13) showed high heterobeltiosis for number of grains/spike (54.84%) and 1000-grain weight (54.59%). The cross AARI-11×Galaxy-13 showed highest negative heterobeltiosis for days to heading (-3.65). Pb-11×Galaxy-13 showed highest negative heterobeltiosis for days to maturity (-4.74%). UOS-950×Pb-11 showed high positive value of heterobeltiosis for grain yield plant^{-1} (53.56%). It was concluded that the crosses which showed high heterosis and heterobeltiosos values alongwith high heritability for yield and yield attributing traits should be selected and moved further for varietal developmental procedure.

Keywords: Wheat (*Triticum aestivum* L.), Heritability, Heterosis and heterobeltiosis

MULTI-ENVIRONMENT TRIAL (MET) GRAIN YIELD DATA ANALYSIS USING CLUSTERING AND GGE BIPLOT FOR ADAPTATION OF GMO MAIZE (*Zea mays*)

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ABSTRACT

Without testing under wide range of agro-ecological conditions, any cultivar/hybrid does not qualify for general cultivation. Newly introduced Genetically Modified Maize, need to be tested under controlled condition and multiple environments, especially under specific crop zone. To achieve this goal, adaptability trials were conducted in spring 2017 by National Maize Coordinated Research Program with collaboration of Pioneer and Monsanto seed companies. Due to complexity of genetic architecture, seed yield is highly influenced by the environmental fluctuations; the present study for grain yield comprised of twenty six maize hybrids including checks over seven diverse locations (Pakpattan, Okara, Depalpur, Mangamadi, Sahwal, Faisalabad & Islamabad) was performed in Punjab maize growing areas. Analysis of variance for partition of sum of squares for G X E model indicated that differences among groups of hybrids, environment and genotypes x environments interaction were significant. The partitioning of the sum of squares indicated that genotypic, environmental & their interaction groups accounted for 90.88%, 97.36% & 41.12% of the total sum of squares respectively. Cluster analysis of hybrids (26) and environments (7) separated into 7 and 4 groups respectively for grain yield response pattern across the environments and across genotypes. The hybrid G10 has the highest average grain yield (10.81 ton ha^{-1}) showing the highest projection on the performance line followed by the hybrid GM 1 (10.69 ton ha^{-1}). The location Manga Mandi was discriminating as well as most representatives, as it is far away from the plot origin followed by location Islamabad. On the other hand, location Okara had the discriminating ability (far away from the origin) but not representative of the average location. The GGE biplot methodology proved to be a useful tool for identifying locations that optimized cultivar performance and for making better use of limited resources available for the testing program.

Keywords: GGE, GMO maize, Cluster, Biplot

HARNESSING THE POTENTIAL OF BACTERIAL PHYSIOLOGY FROM STRESSED SOILS: A RESEARCH APPROACH

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ABSTRACT

Soils contaminated with either salts or wastewater may be termed as stressed soils. Soil salinity negatively influences the nutrient use efficiency and sustainable crop production is severely affected in saline soils. Similarly, some agricultural soils are irrigated with industrial wastewater, which deteriorates the soil structure and texture. Such soils need sustainable and environment-friendly solutions. The objective of this research was to find out some multifarious bacteria capable to tolerate high metal and salt concentration in addition to their bioremediation potential. A strain *Bacillus* sp. MR-1/2 was identified on molecular basis through 16S rRNA gene sequence analysis. The strains exhibited substantial potential of phosphate solubilization indole-3-acetic acid production, and 1-aminocyclopropane-1-carboxylic acid deaminase activity. The strain MR-1/2 tolerated high concentrations (i.e. up to 1000 mg L^{-1}) of different metals ions (Ni^{2+}, Cd^{2+}, Co^{2+}, Zn^{2+}, and Cr^{6+}) in culture medium. It was found very efficient in decolorizing the azo dyes (i.e. reactive black-5, reactive red-120, direct blue-1 and congo red) even in the presence of up to 6% NaCl. It also demonstrated considerable *in vitro* phosphate solubilizing ability at high heavy metal ions and salt levels. Similarly, it sustained its 1-aminocyclopropane-1-carboxylic acid deaminase activity at high metal and salt levels. Bioinformatics analysis of its 537 bp azoreductase gene of strain MR-1/2 and deduced protein sequence revealed that it decolorized azo dyes through NADH-ubiquinone:oxidoreductase activity. Based on comparison to its most closely related protein sequences in the database, the deduced azoreductase protein was found to have different enzyme activity for decolorization of azo dyes. Similarly, *Planomicrobium* sp. MSSA-10 was isolated from saline soil which stimulated the pea growth under induced salt stress by regulating the antioxidants and reducing the levels of reactive oxygen species.

Keywords: PGPRs, Stressed soil, Bioremediation, Azo dyes, Heavy metals, Environment

EFFECT OF ANTIBIOTICS ON IN VITRO MORPHOGENESIS OF DURUM WHEAT (*Triticum turgidum* L. Var. Durum)

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ABSTRACT

Tissue culture technology is used for the improvement of crops. This technology is useful for the development of crop varieties with improved resistance against biotic and abiotic stresses. Durum wheat is grown on large area in the country but its production is very low and can be improved using tissue culture technology. For tissue culture optimization of regeneration protocol is prerequisite. For this purpose three cultivars of durum wheat CBD-156, CBD-157 and CBD-158 were used for *in vitro* culture of mature embryos. For the assessment of the callus induction and regeneration efficiency, mature embryo were cultured on MS media supplemented with different concentration of 2, 4-D (0, 1, 2, 3, 4, 5 and 6 mg/L) and antibiotics, Kanamycin sulphate (0, 25, 50 and 75 mg/L) and Hygromycin B (0, 10, 20 and 30mg/L). Kinetin and IAA were used for shoot and root regeneration respectively. Responses of regeneration and growth parameters were recorded. CBD-157 performed best regarding maximum callus mass as compare to other genotypes and 3mg/L 2, 4-D proved to be the better level for the production of embryogenic calli.

Keywords: Durum wheat, Morphogenesis, Antibiotics, Regeneration

FOLIAR APPLICATION OF TRIACONTANOL MODULATES PHYSIO-CHEMICAL CHANGES IN LINSEED (*Linum usitatissimum* L.) GENOTYPES

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ABSTRACT

A field experiment was conducted at Government College University, Faisalabad to optimize different levels of triacontanol (TRIA) on linseed (*Linum usitatissimum* L.) genotypes under normal climatic conditions. Seeds of linseed genotypes were sown in normal loamy field soil. After 54 days of germination different levels of triacontanol (i.e., 0, 10^{-5}, 10^{-6}, 10^{-7}, 10^{-8}, 10^{-9} and 10^{-10} M) were applied as foliar application. The results obtained showed that the root and shoot lengths, shoots fresh and dry weights, root fresh and dry weights increased significantly at 10^{-6} M level of triacontanol, while all other biochemical parameters such as ratio of chlorophyll *a/b*, malondialdehyde (MDA), hydrogen peroxide (H_2O_2), total phenolic and free proline showed differential response to different levels of foliar-applied triacontanol in different linseed genotypes. Overall, all linseed genotypes showed better growth under 10^{-6} M level of foliar application of triacontanol.

Keywords: Foliar application, Triacontanol, Linseed

PCR DETECTION OF BEGOMOVIRUSES FROM CHILLIES, THEIR ASSOCIATED WEEDS IN MULTAN, REGION

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ABSTRACT

Chilli (*Capsicum annuum* L.) has its unique place in the world diet in its green fruits (as vegetable) as well as a ripe dried form (as a spice). Begomoviruses are a serious constraint causing leaf curl diseases in the cultivation of several crops in the Indian subcontinent. Leaf curl disease of chilli is now a serious problem in Pakistan. Survey was conducted in chilli field areas of Southern Punjab for identification and prevalence of Begomoviruses. The incidence of these distressing pathogens has created leaf curl diseases with causing huge losses. Leaves samples of chilies showing yellowing, vein thickening and leaf curling symptoms were collected. Weeds were also collected from these fields. Detection of pathogen was done by using PCR technique. Cotton samples infected by CLCuV were used as positive. DNA was extracted by using DNA kit. A pair of abutting oligonucleotide primers (Beg1/Beg2) was used for amplification. Total reaction mixture of 25 ul containing 5uM Master mix, 17 uM water, 1 uM each primers and 1uM DNA template. Amplification conditions utilized were typically 35 cycles of melting at 94°C for 1 min, annealing at 50°C for 1 min and extension for 1.5 min at 72°C. All collected samples of chillies were detected positive by PCR which are badly infected. While detection of Begomoviruse was not detected from *Digeria* muricata, *Dactylotenium aegyptium, Echinochloa colonum, Horse purslane* but was detected from samples of *Amaranthus viridis and Chenopodium murale*. PCR products result from amplifications with primers Beg1 and Beg2 was seen on ethidium bromide stained agarose gel. Samples were the results of amplifications from nucleic acids extracted from chillies and weeds infected with *Begomoviruses.*

Keywords: Begomoviruses, Chilli, Weeds

ISOLATION AND CHARACTERIZATION OF SALT TOLERTANT PLANT GROWTH PROMOTING RHIZOBACTERIA

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ABSTRACT

Salinity is one of the major environmental stresses that is growing rapidly all over the world with every passing day. It effects plant growth in different ways such as growth reduction, less yield, and excessive uptake of sodium. Halotolerant plant growth promoting rhizobacteria promote the plant growth under saline environment. Isolation of 50 halotolerant rhizobacteria from the rhizosphere of native plants of salt mine were done on LB nutrient agar with different concentration of NaCl (250 mM, 500 mM and 1000 mM). Out of 50 isolates, 15 isolates showed positive response for nitrogen fixation on nitrogen free malate media. For indole-acetic- acid test, 6 isolates showed pink coloration. For Pikovskaya test, 5 isolates showed clear halo zones on phosphate solubilizing media. Out of these 50 isolated bacteria, some showed positive results for catalase, gelatinase, ammonia, and protease activities by using specific growth medium. On the basis of their bio-chemical analysis, 10 isolates were selected for plant inoculation studies. Five isolates {(H-1 (7.5), H-1(8.5), D-2(8.5), D-1(8.5), and B-3 (8)} showed better maize germination percentage and radical development. On the basis of these result, we can assume that these isolates are potential candidates for growth enhancement under saline conditions. According to plant inoculation studies, these isolates are identified as an effective source for plant growth under saline conditions for further plant growth promotion activities.

Keywords: Salinity problems, PGPR, Bio-chemical analysis, Plant inoculation

EFFECT OF CHEMICAL MUTAGENS ON MORPHOLOGICAL, YIELD AND FIBER QUALITY TRAITS OF COTTON

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ABSTRACT

Being an important cash crop of Pakistan, Cotton has a major share in the agriculture. Due to continuous breeding of same germplasm to produce new high yield cultivars, genetic base of the germplasm has become narrow and yield of cotton is stagnant since last two decades. Keeping in view these facts, major objective of the study was to enhance the genetic variation of the available germplasm of cotton by treating with chemical mutagens. To this end, an experiment was conducted using three treatments of mutagen (sodium azide) and a control. Data were collected for morphological traits, yield traits and fiber quality traits. Results showed highly significant differences among genotypes and treatments for most of the studies traits which ensure the creation of new genetic variation due to mutation. Genetic diversity was further analyzed with SSR markers. It is concluded from the results that sodium azide may be a useful mutagen to create genetic variation in a germplasm to be used for a breeding program.

Keywords: Chemical mutagen, Yield and fiber traits, Genetic variation, Mutation

SCREENING OF DROUGHT TOLERANT GENOTYPES FOR VARIOUS SEEDLING TRAITS IN WHEAT

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ABSTRACT

Wheat is an important crop and plays crucial role in human diet. In Pakistan, wheat yield affects greater due to shortage of water which is the root cause of yield reduction. So an experiment was designed to explore genetic potential in wheat which improves the present situation. This experiment was conducted in Department of Plant Breeding & Genetics, Ghazi University, D. G. Khan in 2016-17. Fourteen wheat varieties/genotypes were grown in plastic trays with soil growing media. The experiment was laid out in completely randomized design (CRD) replicated thrice under normal and water stress conditions. After 21 days of germination, plants per replication for each genotype from each treatment were harvested and data were recorded for various seedling traits. The results indicated significant differences among all the wheat genotypes studied, for both treatments (normal and water stress) as well as interaction between genotypes and treatments which indicated that each genotype showed different behavior to all the plat traits under two treatments. Mean squares for all seedling traits indicated that Punjab-11 (V10) showed best performance for shoot length, root length, fresh shoot weight, fresh shoot weight, dry root weight, dry shoot weight and shoot length followed by Faisalabad-08 (V9) and Punjab-11/Millet-11 (V8) varieties respectively. Similarly, correlation analysis indicated that there is strong relationship among relative growth rate and other plant traits. So, it is concluded that V10, V9 and V8 showed best performance under normal as well as under water stress conditions. So, these varieties can be utilized for further wheat breeding program for development of water stress tolerant varieties.

Keywords: Wheat, Seedling traits, Genetic variability, Water stress

HETEROSIS ESTIMATES FOR SEED COTTON YIELD AND PHYSIOLOGICAL TRAITS UNDER NORMAL AND WATER DEFICIT CONDITION IN *Gossypium hirsutum* L.

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ABSTRACT

Increasing water shortage for irrigation is a major constrain to sustainable cotton production. Cotton plant observes reduction in seed cotton yield as well as fibre quality when subjected to water deficit conditions. Present investigation were conducted to study the heterosis of seed cotton yield and physiological traits in F_1 cotton crosses under normal irrigation and water deficit stress. F_1 crosses were developed in the greenhouse keeping stress tolerant genotypes as lines and sensitive as a testers using line × tester technique. $30F_1$ crosses along with 13 parents were planted under two stress levels i.e. well-watered and water-deficit in field condition to examine the genetic basis of seed cotton yield, water potential, osmotic potential, pressure potential and chlorophyll fluorescence. Under normal and water deficit condition genotypes showed highly significantly differences for seed cotton yield, water potential, osmotic potential, pressure potential and chlorophyll fluorescence. Overall higher significant heterosis over better parent were observed for most of the traits in crosses FH-159 × KZ-191 and VH-289 × AA-703 under normal and water deficit condition respectively. Meanwhile higher but significant better parent heterosis was observed in crosses VH-291 × AA-703 (62.65%), VH-291 × NS-131(31.36%), VH-289 × AA-703 (54.29%) and FH-153 × NS-131 (33.7%) for water potential, osmotic potential, pressure potential and chlorophyll fluorescence respectively. While, for seed cotton yield, the crosses FH-207 × NS-131 (19.71%), S-15 × AA-703 (30.58%) and FH-329 × NS-131 (31.13%) showed higher and significant heterosis over better parent under water deficit condition that may be used in development of hybrid for water shortage areas in Pakistan.

Keywords: Cotton, Drought, Heterosis, Water potential, Osmotic potential, Pressure potential

IDENTIFICATION AND MOLECULAR CHARACTERIZATION OF EXOTIC TOMATO GERMPLASM FOR ZINC BIOFORTIFICATION IN ARID REGION

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ABSTRACT

Zinc is a vital part of human nutrition and there is a global Zn deficiency being reported in humans affecting all aged individuals especially children. Interestingly, human Zn deficiency correlates very well with soil Zn deficiency worldwide. Biofortification is an important tool to improve the nutritional value of food crops by using agronomy, plant breeding and biotechnology. Tomato (*Solanum lycopersicum*) is one of the significant fruit/vegetable crops popularly being consumed all over the world including Pakistan. The improvement in Zn content of tomato for biofortification purpose can be attained by exploiting its genetic variation and by agronomic means. The current study was aimed at identification and characterization of various exotic tomato varieties for Zn biofortification in arid climate of Layyah. We have analysed genetic variation of 20 exotic tomato varieties for Zn accumulation after foliar application of three doses of Zn fertilizer under off-season tunnel farming system in Layyah in comparison to the locally grown control variety. There was substantial genetic variation for agronomic traits such as yield, Plant height, no. of fruit clusters, no. of fruits/cluster, fruit length, fruit width, taste and attractiveness. Analyses of Zn content and the expression of few known Zn transporter genes such as *SlIRT1*, *SlZNT1*, *SlMTP1* etc. is being carried out to identify best Zn Bio-fortified variety, best Zn foliar concentration and to understand underling Zn molecular mechanisms. This can be one step further towards the progress of a viable Zn Biofortification technology.

Keywords: Biofortification, Zinc, *Solanum lycopersicum*, *SlIRT1*, *SlZNT1*, *SlMTP1*

RELATIVE GENE EXPRESSION OF NITROGEN METABOLISM GENES IN WILD AND CULTIVATED BARLEY UNDER LOW NITROGEN SUPPLY

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ABSTRACT

To understand the crop response to low nitrogen application it is essential to develop new techniques of manipulating genes for breeding new crop cultivars or lines with greater nitrogen use efficiency (NUE). However, less is known about the variances among barley (*Hordeum vulgare* L.) genotypes for their responses to N starvation. In current study, four barley genotypes, *ZD9* &*XZ149* (higher NUE) and *HXRL*&*XZ56* (lower NUE) were used to investigate the expression pattern for N uptake (NRT2.1) and N assimilatory (GS1 & GS2) genes in barley leaves and roots at seedling stage in response to low nitrogen (0.1mM) and normal nitrogen (2mM) levels. Compared to the normal N supply, under low N, all the genotypes expressed less number of tillers, decreased soluble proteins, chlorophyll and N concentration in both roots and shoots. However significant difference was found among the genotypes with N efficient genotypes (*ZD9* & *XZ149*) showed higher N concentration, increased number of tillers, improved chlorophyll and soluble proteins in both roots and shoots as compared to the inefficient genotypes (*HXRL* & *XZ56*). Furthermore, nitrate transporter gene NRT2.1 expressed more under low N in both roots and leaves of N efficient genotypes at different time periods while glutamine synthetase GS1 and GS2 expressed more under normal N in leaves and in the roots they expressed higher under low N. Compared to the lower NUE genotype (*HXRL* & *XZ56*), the higher NUE genotype (*ZD9* & *XZ149*) under low N re-supply performed better in response to N stress, and may require relatively less N fertilizer application for normal growth and development.

Keywords: NUE, Barley genotypes, N metabolism, N assimilation, Chlorophyll

STUDY OF GENETIC VARIABILITY, CORRELATION COEFFICIENT AND PATH ANALYSIS IN ADVANCE LINES OF GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

The present studied was conducted to estimate genetic variability, character association and path coefficient analysis in 11 groundnut advance breeding lines along with check *vis* BARD-479 in RCBD at National Agricultural Research Centre, Islamabad. The genotypes were highly significant for 20-pod length, shelling percentage, 100-Kernal weight, leaflet length, leaflet width and Dry pod yield while non-significant for number of branches, plant height and plant width. Plant width, 20-pod length and dry pod yield had positive correlation with plant height. Number of branches contributes positively towards plant height, leaflet length and leaflet width. Plant width had negative association with all characters except dry pod yield. Shelling percentage also contribute positively towards all characters except for leaflet length. A strong positive direct effect was observed in 20-pod length, shelling percentage, 100-kernel weight and leaflet length with dry pod yield indicating the importance of characters linkage for improvement in groundnut. A weak direct effect was also experimented with number of branches, plant height and plant width while direct negative relation was also seen in leaflet width. A strong indirect effect was pragmatic by plant width with dry plant yield. Hence, present study revealed importance of 20 pod length, shelling percentage and 100-kernel weights. On the basis of results, it is suggested that genotypes i.e., PG-1221, PG-1254 and PG-1266 were high yielding and selected for further selection process.

Keywords: Genetic variability, Correlation coefficient, Path Analysis, Groundnut

MULTIVARIATE APPROACHES FOR EXPLORING PHENOTYPIC VARIATION IN EXOTIC SOYBEAN (*Glycine max* L.) GERMPLASM

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ABSTRACT

Twenty-two soybean entries were evaluated for various yield related agro-morphological traits during Kharif 2016 for selection of high yielding and adaptable genotypes. The data were recorded for quantitative traits i.e. days to 50% flowering, days to maturity, plant height, number of pods plant^{-1}, number of branches plant^{-1}, plot yield (kg) and seed yield (kg ha^{-1}). Maximum phenotypic variability (CV%) was observed for number of pods plant $^{-1}$ (21.7) followed by plant height (19.89) and seed yield (14.37). Genotype E-788 has the highest seed yield (1644 kg ha^{-1}) followed by Aust-941 (1631 kg ha^{-1}) and No. 3702 (1595 kg ha^{-1}). The data were subjected to Principal Component Analysis (PCA) which distributed total variation into 7 components. First three principal components (PCs) had eigen value higher than unity (>1) and represented 75% of the total phenotypic variation present in the studied population. Seed yield, number of branches plant^{-1}, number of pods plant^{-1} and plant height were the major contributor to phenotypic variability. Also, Euclidean distances based cluster analysis was performed using wards' method which distributed all the twenty-two genotypes into two major groups. The distribution among these clusters were based on the seed yield, plant height, days to maturity and number of pods plant^{-1}. The present study revealed presence of significant genetic diversity among exotic soybean germplasm. The genotypes i.e. No-3702, Aust-941, E-788 and 536-2D can be used in soybean to exploite genetic potential through crop improvement via breeding program for varieties evolution for higher seed yield and early maturity. It is further recommended to explore genetic diversity in the soybean crop using biochemical and molecular characterization techniques for selection of trait specific breeding material.

Keywords: Soybean, Genetic diversity, PCA, Cluster analysis

FACTOR-WISE CONTRIBUTION OF SEEDLING AND YIELD TRAITS IN *Brassica napus* L.

ABSTRACT

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ABSTRACT

Brassica napus L. is one of the most important oilseed crop. The most complex trait in oilseed crops is yield. For working on yield correlation, direct and indirect effect of different variables is of utmost importance. Present study was conducted keeping in view the importance on *Brassica napus* L. in the research area of Department of Plant Breeding and Genetics, University of Agriculture Faisalabad, during 2015-2017. The first experiment was conducted in the field and the second one in the greenhouse .Data were recorded for different traits and was subjected to correlation, analysis of variance, path coefficient analysis, heritability and LSD analysis. B- 56 was the best for plant height, fresh root weight and fresh shoot weight. Results revealed that ZM-M-6 was good for primary number of branches. Rainbow showed good results for secondary number of branches and seed weight/plant. Faisal Canola showed better results for siliqua length. Shirlee showed better results for number of seeds/siliqua. Punjab Sarsoon was good for siliquae/plant. Chakwal Sarsoon was better for dried root weight, root length and 100-seed weight. Z-M-4 was good in shoot length. 27017 was the best for dried root weight. Plant height and siliquae/plant can be used as selection criteria in future breeding programs for high yielding varieties.

Keywords: Oilseed, Yield parameters, LSD

CLIMATE CHANGE AND MAIZE BREEDING: CHALLENGES AND OPPORTUNITIES

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ABSTRACT

Climate change is being addressed as the greatest challenge facing the world at the beginning of the century and being the most important long-term issue which we face as a global community. A number of developing countries are encountered by climate change e.g. the global average temperature is expected to increase between 2°C and 4.5°C during the current century. Pakistan is situated in South East Asia, the country listed in the third world countries, is vulnerable to climate change, and extreme climatic conditions so threatening the food security. No industry is more dependent on predictable weather and climate patterns than agriculture. Volatile climate changes create enormous challenges to meeting the needs of the world's growing population on the major crops of Pakistan especially maize. Average temperature will affect maize crop negatively bringing about 6% reduction in maize production till the year 2030. FAO and others project predict that global agriculture production must be double by 2050 to close the gap between food supply and demand. Various factors such as population growth, increasing urbanization and rising incomes affect the ability of the food supply to meet its demand. Assessment tools are needed to estimate climate change risks and vulnerabilities for a range of development projects. Agriculture sector is responsive to the variation in climate. The link between climate changes and agriculture sector is holding a major importance. Being a plant breeder actions must be taken to mitigate the problem of climate change by moving towards the sustainable agriculture, shifting our life from artificial to natural style, identifying the new candidate climate resilient genetic resources from cultivated/ wild relatives to breed climate resilient crop varieties and above all conventional as well as transcriptomic and genomic analysis are expected to provide definite genetic bases to combat with climate change especially heat.

Keywords: Maize, Climate change, Breeding

E. HORTICULTURAL PRODUCTION CHANGE

VARIATION STUDY FOR MORPHOLOGICAL PARAMETERS OF HIGH YIELD IN CHERRY TOMATO GENOTYPES

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ABSTRACT

The present study was aimed to investigate the character of inter leaf distance, number of leaves before first cluster and number of flower on first cluster in contributing yield of seven different indeterminate cherry tomato genotypes. The experiment was conducted using Randomized Complete Block Design at Directorate of Vegetable, National Agricultural Research Center in 2017. The analysis of variance showed significant difference among all genotypes for all studied characters including number of leaves before first bunch, number of flower per cluster and inter leaf distance. The highest mean value for number of leaves before first bunch observed in the genotype 70-I indicating earliness in this genotype. Genotype 60-I showed maximum number of flower per cluster which is indices for high yield in cherry tomatoes as size or weight of cherry tomatoes is not considerable. Maximum mean inter leaf distance observed in genotype 60-I and minimum in 70-I thus the genotype 70-I is best in term of plant characters for high yield and earliness. In general it is concluded that 70-I is best for early production and yield and could be utilized for cherry tomato breeding programs.

Keywords: Cherry tomato, Morphology, Variability

EFFICACY OF N-HEXANE AND PETROLEUM ETHER SOLVENTS FOR ESSENTIAL OIL EXTRACTION OF *Tagetes erecta* cv. MINT MARIGOLD

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ABSTRACT

Marigold is enriched with the essential oil that are widely use in perfume and pharmaceutical industry. Different techniques including; solvent extraction, expression, CO_2 extraction, distillation and enfleurage are common for marigold oil extraction. In the present investigation, the effect of two solvents; petroleum ether (PE) and n-hexane (HE) were evaluated for the yield and physio-chemical properties of marigold essential oil. The data regarding concrete and absolute oil percentage, color, refractive index, congealing point, optical rotation, specific gravity and acid number were measured. The results depicted that maximum refractive index (1.72) was measured under petroleum ether. The absolute essential oil yield was maximum using n-hexane solvent (46 g) and minimum (18.76 g) by petroleum ether. The acid number and specific gravity of essential oil were 4 and 0.855 respectively using both, the petroleum ether and n-hexane solvent. The essential oil percent composition under the influence of PE and HE using gas chromatography were; limonene (12.21% and 13.40%), (E)- ocimene (7.42% and 8.23%), dihydrotagetone (8.45% and 9.29%, β-linalol (0.05% and 1.01%), β-ocimene (0.16% and 1.18%), verbinone (5.70% and 11.50%), Carvone (1.17% and 6.59%), 3-Methoxy-2,5,6-trimethylphenol (0.30% and 1.62%), Piperitenone (1.02% and 1.69%), 9-Octadecenamide (Z) (0.23% and 0.40%). It is concluded from this investigation that n-hexane proved to be more efficient for solvent essential oil extraction technique in marigold.

Keywords: Solvent extraction, CO_2 extraction, Essential oil

QUALITY CARROT SEED PRODUCTION BY THE USE OF EXOGENOUS AUXINS APPLICATION

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ABSTRACT

Seed quality affects the stand establishment and final yield of any crop. Quality seed lean on the growth stage and on the plant status and for quality carrot seed umbel order is vital component. Primary and secondary umbels seeds are of better quality than those from tertiary umbels. Besides several other factors, umbel order, if managed and kept low, can produce high yield of good quality seed. Auxins play role in apical dominance and thus can be tested to suppress tertiary umbels. It was hypothesized that suppression of tertiary umbels could shift the supply of photosynthates towards primary and secondary umbels, which could further improve their quality. This study aimed to examine the effects of synthetic auxin on alteration of umbel order in carrot seed production. Different concentrations (0, 100, 200 and 300 ppm) of two auxins (IAA and NAA) were sprayed on carrot stecklings. Foliar application of IAA or NAA @ 200 ppm significantly increased the number of secondary umbels by suppressing the tertiary umbels. Foliar application of IAA or NAA @ 200 ppm improved seed yield, weight of 1000-seeds harvested from primary, secondary and tertiary umbels as well as seed quality attributes, i.e., germination (%), vigour index, and activities of enzymes (SOD, POD, CAT). Furthermore, foliar application of IAA or NAA @ 200 ppm minimized the conductivity of seed leachates and malondialdehyde contents in seedlings raised from seeds of all umbel orders. Results imply that that exogenous application of auxins, i.e., IAA or NAA @ 200 ppm can be the most effective strategy to modify umbel order, to improve seed yield and quality.

Keywords: *Daucus carota*, Umbel position, Auxins, Seed yield, Antioxidant enzymes

POSTHARVEST MANAGEMENT OF FRUITS AND VEGETABLE: A POTENTIAL FOR REDUCING POVERTY, HIDDEN HUNGER AND MALNUTRITION IN PAKISTAN

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ABSTRACT

Fruits and vegetable are vital source of essential nutrients and their cultivation is an emerging and prominent horticulture subsector in throughout the world and almost one-third of the produced fruit and vegetable is destroyed before reaching the consumer. The losses of fruits and vegetables in Pakistan from 30 to 80%, depending on a crop status and harvesting method. Perishable horticultural crops are most sensitive to post harvest losses. Due to shortage of postharvest technology including moisture control, temperature control to maintain the cold chain and management skills causes various financial loss and food security control. Drawbacks among them are high levels of poverty, hidden hunger and malnutrition. All such factors that are directly are indirectly related to post harvest losses must be handled carefully. Worldwide, applications of postharvest techniques like use of 1-methylcyclopropene (1-MCP), temperature management and ethylene has proved to decrease postharvest losses of fruits and vegetables. Various biochemical and non-chemical approaches are significant for monitoring decomposition and pathogenic smicrobes especially on ready to eat horticultural products. Postharvest technologies such as moisture control, edible coating, temperature management, dehydration, controlled ripening and chemical treatment methods are dynamic approaches to decrease fruits and vegetables postharvest losses, improve food and nutritional security and alleviate poverty in Pakistan, reduce use of pesticide and application sewage water on fruits and vegetables production in order to ensure the safety of final consumer.

Keywords: Fruits, Vegetables, Ethylene, Temperature, Postharvest technologies, Chemicals

WASTE OF FRESH FRUIT AND VEGETABLES AT RETAILERS IN PAKISTAN MEASURING AND CALCULATION OF MASS, ECONOMIC COST AND CLIMATE IMPACT

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ABSTRACT

Food waste is a significant problem for environmental, economic and food security reasons. The retailer, food service and consumers have been recognized as the parts of the food supply chain where the possibility of reducing food waste is greatest in industrialized countries. In this study, primary data on fresh fruit and vegetables (FFV) waste collected through direct measurements in three large retail stores in Pakistan were analyzed from the perspectives of wasted mass, economic cost and climate impact. A method of measuring and calculating the economic cost of FFV waste was developed and includes the cost of wasted produce, the cost of personnel time for waste management and the cost of waste collection and disposal. The results show that seven FFV categories, which have been termed "hotspot categories", contributed to the majority of the waste, both in terms of wasted mass, economic cost and climate impact. The "hotspot categories" are apple, banana, grape, lettuce, mango, chilies, and tomato. The cost benefit analysis conducted showed that it is economically wise to invest in more working time for employees in waste management to accomplish a reduction of wasted mass and climate impact without an economic loss for the store. These results are relevant for supporting the implementation of policies and initiatives aimed at food waste reduction at retail level.

Keywords: Food waste, In-store waste, Fruit and vegetables, Economic cost, Retail

EFFECT OF DROUGHT ON VEGETABLES PRODUCTION AND MORPHOLOGICAL AND PHYSIOLOGICAL ADAPTATIONS OF PLANTS UNDER DROUGHT

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ABSTRACT

Drought is one of the important factors which are affecting the world food security and the major reason behind the great famines of the past. The world's water supply is fixed, thus increasing population pressure and competition for water resources will make the effect of successive droughts more severe. Water availability is expected to be highly sensitive to climate change and severe water stress conditions will affect vegetable production. Increasing temperature accompanied by decreased precipitation could cause reduction of irrigation water availability and increase in evapotranspiration, leading to severe crop water stress conditions. Development of hybrid varieties, integrated insect-pest and diseases management practices, integrated nutrient management and standardizing improved agro techniques have changed the scenario of vegetables production. Several economically important vegetable crops are highly sensitive or moderately sensitive to drought stress which is a major threat in diminishing the productivity of vegetables in terms of yield. Yield is an important trait which is adversely affected by the drought but it depends on the growth stage and time of prevailing drought. Moreover, highest yield reduction in vegetables is noticed when drought occurs at flowering and fruit formation stage. In slowly developing water deficit, plants may escape drought stress by shortening their life cycle. However, the oxidative stress of rapid dehydration is very damaging to the photosynthetic processes and the capacity for energy dissipation and metabolic protection against reactive oxygen species is the key to survival under drought conditions. Although, plants prepare themselves to face the drought conditions by modifying or altering their morphology and physiology or by the activation of different enzymes which helps to activate plant's defense system to tolerate stress conditions but there is a need to identify potential genotypes with excellent drought tolerant mechanisms which could be used further in developing drought tolerant genotypes. Improved, adapted vegetable germplasm is the most cost effective option to meet the challenges of a changing climate. Genotypes with improved attributes conditioned by superior combinations of alleles at multiple loci could be identified and used in crop improvement program.

Keywords: Defense system, Dehydration, Food security, Metabolic protection, Precipitation

PRODUCTION POTENTIAL OF VARIOUS TUNNEL FARMING SYSTEMS IN PUNJAB, PAKISTAN

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ABSTRACT

Farmers could not get fair return of their agri-produce and profitable marketing of seasonal vegetables is low due to lack of advanced technologies, processing facilities, unfair marketing practices, and inadequate infrastructure. Moreover, summer vegetables are more susceptible to diseases and pests. Farmers, however, can grow these crops in winter as off-season vegetables for better returns through controlled environment in tunnels. Tunnel farming provides healthy environment for producing maximum crop yields, improves nutrient-uptake by plants with better crop and water management practices. Two types of tunnel i.e., walk-in tunnel and high tunnel are mostly used for producing off-season vegetables. Studies were conducted in various parts of the country to evaluate production potential and economic feasibility for selected vegetables grown in vertical direction inside the tunnels. Quonset and arch type's high tunnels were common for tomato and parthenocaric cucumber production with insect net and spun bond fabric covering, while walk-in tunnels were used for cucumber, chili and sweet paper. Component wise, the highest input cost was found with labor for operational practices (35-39%), covering material (24-28%), seed, fertilizer (8-12%), while the lowest cost was estimated with plant protection (3-4%) with respect to total production cost. As for the as the return or output potential, the high tunnel contribute greater return as compared to walk-in and low tunnels.

Keywords: Cucumber, Chili, Sweet paper, Off-season vegetables

YIELD AND WATER USE EFFICIENCY OF KINNOW MANDARIN UNDER FURROW AND FLOOD IRRIGATION SYSTEM

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ABSTRACT

Most of irrigation in orchard is through flooding which is considered sub economical due to wasting of water and spreading of soil born diseases. Keeping in view the importance of natural water resources, there was a dire need of searching the way of applying irrigation water that would be environment friendly and easily adopted by growers. So a research trial was initiated at Citrus Research Institute, Sargodha on kinnow mandarin for four year cropping season 2011 to 2015. An orchard with an area of 0.41 ha (half for each system) was selected for this experiment. There were two treatments with three trees/plot, replicated 4 times. Tensiometers were installed at 30, 60 and 90 cm soil depths to monitor the water levels in both furrow and flood systems. Irrigations were applied when tensiometer readings reached 40 centibars. Total quantity of irrigation water used was measured with a flume meter and then percentage of water saving was calculated. The study resulted that furrow irrigation system significantly increased the number of fruits per tree (1173), fruit yield (183.95 kg per plant), fruit diameter (69.11 mm) and juice 47.85% over flood irrigation system where the number of fruit per tree were 817, fruit yield 126.61 kg per plant, fruit diameter 65.73 mm and juice 46.83%. While TSS/Acidity ratio, peel, rag percentage were remained statistically unaffected with these systems of irrigation. Average 24 numbers of irrigations were applied with average water saving of 44.50% and water use efficiency (WUE) 4.68 kg m^{-3} in furrow system whereas in flood irrigation system average number of irrigations were 15 and WUE was 2.68 kg $^{-3}$. Therefore, it is concluded that furrow irrigation system is more beneficial as compared to flood system.

Key words: *Citrus reticulata*, WUE, Yield, Water saving, Irrigation methods

ASSESSMENT OF ALLELIC VARIATION AMONG CITRUS GENOTYPES USING MICROSATELLITE MARKERS

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ABSTRACT

Detection of genetic polymorphism is an essential component for plant breeders in cultivar identification to develop fingerprint database. The SSRs (simple sequence repeats) are most extensively employed molecular markers which are used in fingerprinting, genetic mapping, phylogenetic correlations and molecular diversity. In present investigations, ten citrus genotypes were evaluated with ten SSR/microsatellite markers out of which nine markers yielded twenty-two identified alleles with mean value of 2.4 allele/locus. A series of amplified fragments numbers ranged from 1-3 was observed. Highest number of amplified fragments/alleles i.e.; 3 was given by each of two markers i.e.; P-1223 and P-94 and proved highly polymorphic while the least number of alleles i.e.; 1 was amplified by marker CAC-23 and CAC-39. Maximum number of alleles was identified in genotypes Jaffa, Succari and Washington naval. Genetic similarity value ranges from 100.0-40.00. Phylogenetic tree or dendrogram was constructed among ten citrus genotypes which presented all genotypes in two major clusters. The present study revealed that SSR markers are proved highly valuable for the estimation and characterization of genetic diversity and assessing phylogenetic relationship among citrus genotypes.

Keywords: Citrus, Genetic diversity, Molecular markers

POSITIVE AND SIGNIFICANT IMPACTS OF GRAFTING IN VEGETABLE PRODUCTION IN PAKISTAN

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ABSTRACT

Grafting in vegetables is gaining popularity as growers and researchers found its positive and significant impact on enhancing yield, increasing biotic and abiotic resistance and improvement in quality of the produce. These benefits have already had a noteworthy impact in sustainable agriculture production. Successful grafting highly depends on a number of factors including genetic characteristics, vigorous root stock and scion stock with greater affinity, grafting operational techniques, environmental conditions during healing period and incubation of grafted seedlings. Twenty eight countries around the globe including Indonesia, Philippines, Taiwan, Thailand, Netherland, Vietnam, South Korea and USA are engaged in grafting of vegetables since decades but in Pakistan, grafting of vegetables is not yet a common technique to tackle a lot of issues of vegetables including low productivity, susceptibility to biotic and abiotic stress and inferior quality produce. Vegetables are considered as rich source of vitamins, minerals, dietary fiber, carbohydrates and proteins. In Pakistan, around thirty different kinds of vegetables are grown commercially to feed the increasing population. Presently, the vegetable consumption in Pakistan is about 100 g per capita per day, while 400 g per capita per day is recommended by World Health Organization. It is the need of time to use grafting as a tool in vegetable production commercially to get superior quality produce with maximum yield potential to meet the gradually increasing demand of food for country's increasing population.

Keywords: Demand, Growers, Researchers, Sustainable, WHO

GROWTH AND PHYSIOLOGICAL RESPONSE OF SALT SENSITIVE TOMATO COMMERCIAL VARIETY GRAFTED ONTO RESISTANT ROOTSTOCK UNDER SALINITY STRESS

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ABSTRACT

Salinity is one of the most restraining factors that greatly reduces growth and yield of vegetable crops. The ability of plant species to cope with high levels of salinity depends on the capability to eliminate salt from the root or impound salt in vacuoles to tolerate high concentrations of salt in cytoplasm. Tolerance to salinity is of prime importance as many vegetable crops including tomato are susceptible to salinity stress. Grafting is a useful approach to deal with the biotic and abiotic stress in tomato. A study was conducted with objective to increase the salinity tolerance of susceptible commercial tomato variety (Washington Cherry) by grafting onto a salt-resistant rootstock. Twenty one days old seedlings of two tomato genotypes, LA (salt-tolerant) and Washington Cherry (salt-sensitive) were subjected to grafting treatments, i.e., non-graft and self-graft controls and reciprocal-graft. Plants were grown in an inert media comprising equal proportion of perlite and vermiculite mixture and received a modified Hoagland's nutrient solution containing either 0 or 100 mM NaCl. Salinity significantly reduced the growth indices of tomato plants in all treatments including plant height, number of leaves, leaf area, leaf length, days to flowering, biomass and root characteristics. However, these reductions were less prominent in tomato plants of Washington Cherry grafted onto resistant rootstock. Similarly, the Fv/Fm values of young fully expanded leaves were maintained higher when sensitive commercial variety was grafted onto resistant rootstock compared to other grafting treatments. It is concluded from this experiment that deleterious effects of salinity can be lessened by grafting sensitive commercial tomato variety onto a root stock resistant to salinity stress.

Keywords: Impound, Modified, Perlite, Susceptible, Vacuole, Vegetables, Vermiculite

ENHANCEMENT OF YIELD AND QUALITY OF CUCUMBER BY THE FOLIAR APPLICATION OF ZINC

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ABSTRACT

Zinc is a vital micro nutrient and its adequate supply is considered indispensable for growth, development and normal functioning of plants. The current experiment was performed to discover the result of Zn foliar application on cucumber crop grown under tunnel. The experiment was conducted in tunnel under CRD arrangement with three replications. Four levels viz., control, Zn @ 0.25%, Zn @ 0.5% and Zn @ 1% zinc solutions were applied as foliar spray at initiation of flowering. All zinc levels produced significant results regarding various attributes. Other treatments resulted significantly but zinc applied @ 1.00% produced highly significant result enhancing yield and quality compared with control. Morphologically and physiologically zinc spray proved beneficial for enhancing, growth, yield and quality. Overall, yield per plant of cucumber was enhanced with the application of Zn @ 1.00% (6.3 kg), followed by Zn @ 0.50% (5.4 kg). While Zn @ 0.25% (4.5 kg) gave less yield and control gave minimum yield (3.1 kg) per plant. Zinc also influence positively regarding its concentration in leaf, stem and fruit. It was concluded that complete nutrition having all the nutrients required by plant is essential for better crop production and quality.

Keywords: *Cucumis sativus*, Zinc, Foliar application, Physiology

OIL EXTRACTION AND CHEMICAL COMPOSITION OF INDIGENOUS SCENTED ROSE SPECIES

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ABSTRACT

Roses are mainly used for decoration and oil extraction for the usage in perfumery industry. The indigenous scented rose species used for oil production in Pakistan are *R. damascena* Mill., *R. centifolia,* and Gruss an teplitz etc. In the present research project, the quantitative traits of the rose oil among indigenous *Rosa* species were investigated under local climatic conditions of Rawalpindi, Pakistan. For this purpose, three main scented rose species; *Rosa damascena, Rosa centifolia* and Gruss an teplitz were grown in the experimental area, Department of Horticulture, PMAS-Arid Agriculture University, Rawalpindi. Oil content (%) was measured from the *Rosa* species by using Soxhlet extractor with N-hexane. For this purpose, Rose flowers, at the time of full bloom, were collected and put in the separate baskets and labeled. The petals were separated, weighed and spread in a tray under shade at room temperature. 500 g of petals were used for solvent extraction of rose oil in Soxhlet's apparatus. The oil contents calculated as proportion (%) of flower weight. To conduct this experiment, completely randomized design was used with three replications. *R. damascena* produced maximum oil content (73.138%) absolute oil percentage on the basis of concrete oil followed by *R. centifolia* and Gruss an teplitz with the values of 72.140 and 55.023% respectively. While the oil constituent's variation among rose oil from these indigenous rose species were determined by using GAS chromatograph. The results showed variation in main components of volatile oil percentage among these three species. Main components identified were citronellol, linalool, farnesol, geraniol, eugenol, phenethyleacetate, nerol, benzyle alcohol, citronellyle acetate and phenethyle alcohol.

Keywords: Indigenous *Rosa*, *Rosa* oil, Oil extraction, Rose absolute

COMPARATIVE EFFICACY OF FOLIAR APPLICATION OF VARIOUS COMMERCIAL FORMULATIONS OF MICRO AND MACRO NUTRIENTS ON GROWTH, FLOWER YIELD AND QUALITY OF HYBRID ROSE

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ABSTRACT

Various biochemical processes that occur within the plant body are crucial for normal plant growth and maturity, driven through macronutrients and micronutrients uptake. Micronutrients are required by plants in much smaller amount for healthy plant growth. Rose responds positively to the foliar spray of micronutrients. Flower quality and flower yield increases significantly with foliar application of micronutrients. Different commercial formulations of micronutrients including Micropower, Chelated mix micronutrients (CMM), Trace elements (TE) and VC-10 were used in this experiment. Micronutrients were applied through foliar application method, while application of different macronutrients combination NPK (17-17-17), NPK (15-32-7) and NPK (15-20-15) were applied through soil by fertigation. Two hybrid rose cultivars viz., Angelique and Amalia were grown at Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad with five treatments including T_0 (control without any formulation), T_1 (NPK (17-17-17), T_2 (NPK (15-32-7) + Micropower + TE), T_3 (NPK (15-32-7) + TE + CMM) and T_4 (NPK (15-20-15) + CMM + TE + VC-10) were used in this experiment. Results showed the vegetative and reproductive performance of both hybrid cultivars of rose was significantly increased by foliar application of mixed concentration of TE + CMM with 15-32-7 NPK soil fertigation and foliar spray of CMM + TE + VC-10 with 15-20-15 NPK soil fertigation. Plant height, number of leaves, leaf area, number of flowers plant^{-1}, bud diameter, stalk length, stalk diameter, fresh and dry weight of flowers, chlorophyll contents and flower diameter was significantly increased by Angelique cultivar than Amalia under T_3 and T_4, while days to first flower emergence were greatly reduced. Overall, Angelique performed well regarding growth and flowering parameters with foliar application of T_4 treatment which suggested that foliar spray of different combination of micro nutrient formulations can significantly enhance growth and reproductive performance of rose by producing cut flowers of excellent quality.

Keywords: Angelique, Amalia, Flower emergence, Reproductive performance, Excellent

EFFECT OF ORGANIC ADDITIVES AND PLANT SPACING FOR FRUIT QUALITY OF STRAWBERRY (*Fragaria ananasa*) CULTIVAR CHANDLER IN ARID CLIMATE

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ABSTRACT

Strawberry was considered to be the fruit of temperate areas earlier but now it is popularly growing in the plain areas of Pakistan during winter time period. Strawberry is rich in vitamins and minerals. The study was designed to evaluate the effect of organic media mixes and plant spacing on the growth and yield of strawberry (*Fragaria ananassa*) cultivar Chandler. This research optimized the planting distance for better yield performance in Arid agro-climatic areas. Four different media (Peat moss, poultry waste, Farm yard manure, Soil and mix of all these four media additives) were used with different plant to plant spacing of 20, 30 and 50 cm to evaluate their effect on Fruit size, total soluble solids, Fruit Yield, Chlorophyll Contents and fruit quality (fruit color + taste) of strawberry. The effect of soil with addition to peat moss was maximum in all parameters. The plant spacing of 20 cm proved to be good in all parameters. Peat moss showed maximum fruit yield (531.56 g), Chlorophyll contents (12.53), TSS (8.45), fruit size and fruit quality (red color with maximum sweet taste) as compared to all other media and control treatment. Maximum sweet taste was observed in peat moss while, minimum were observed in soil + poultry waste, maximum dark red color was observed in soil + peat moss while, minimum in soil. The sweeter taste was found in soil + peat moss (1.83) and minimum in soil + poultry waste. Statistical analysis of data regarding all parameters showed significant effect of media and non-significant regarding plant spacing.

Keywords: Strawberry, Plant spacing, Organic additives, Fruit production, Fruit quality

PRE-HARVEST APPLICATION OF CALCIUM CHLORIDE AND SALICYLIC ACID ON THE FRUIT QUALITY OF KINNOW (*Citrus reticulata* BLANCO)

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ABSTRACT

Citrus (Kinnow) is a leading fruit of Pakistan which is grown on large scale in Pakistan especially in Sargodha. However, fruit quality is the major concern to the growers, processor and consumers. The present study was focused on the role of salicylic acid and calcium chloride on fruit quality of Kinnow. An aqueous solution containing different concentrations of SA (0.8, 1.2 and 1.6 g/L) and $CaCl_2$ (0.4, 0.6, and 0.8 g/L) were sprayed onto the whole tree till run off at fruit maturity (60 mm) on mandarins cv. Kinnow. Control trees were kept as unsprayed. The experimental layout was randomised complete block design. A single tree as an experimental unit and replicated three times. At commercial harvest, 10 ripe fruit per tree were randomly harvested around the tree canopy to measure the fruit quality. The results showed that SA (0.8 g/L) and $CaCl_2$ (0.4 g/L) significantly reduced the fruit drop (16.67%) and (13.67%) respectively as compared to control (23.33). Similarly, the treatment of $CaCl_2$ (0.8 g/L) showed minimum disease incidence (20%) as compared to control (33.33%) and all other treatments of $CaCl_2$. However, the spray application of SA (0.8 g/L) was more effective (13%) than control (33.33%) and all other treatments of SA. The treatment of $CaCl_2$ (0.4 g/L) significantly improves the fruit weight (147.11 g) as compared to control (140.25 g) and all treatments of $CaCl_2$ and SA. The results showed that $CaCl_2$ and SA significantly improved the fruit drop, TSS, TA, TSS/TA, juice content, rind, flavedo thickness, pH, fruit diameter and acidity percentage. In the light of these findings we can conclude that application of calcium chloride and salicylic acid was effective for minimizing fruit drop and enhancing the quality of mandarin's cv. Kinnow.

Keywords: Growth elicitors, Fruit drop, Kinnow, Quality

GENETIC DIVERSITY AMONG GENOTYPES OF *Rosa centifolia* AND *Rosa damascena*

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ABSTRACT

Rosa centifolia and *R. damascena* are commercially important essential oil containing *Rosa* species in Pakistan. Genetic analysis of these genotypes is very important for certification, commercialization and breeding. Investigations were made to evaluate the genetic relationship among 08 genotypes of *R. centifolia* each from Punjab/Pakistan and Oregon/USA; and 02 genotypes of *R. damascena* each from Punjab/Pakistan and Iran. The genotypes of *R. centifolia* from Punjab/Pakistan included Faisalabad, Sargodha, Sialkot, Lahore, Pattoki, Pakpattan, Kahror Pakka and Sheikhupura, while those of Oregon/USA included Fantin-Latour, Gros Choux d' Hollande, Centifolia varigata, Rosa de Meaux, Cabbage rose1, Cabbage rose2, Pompon de Bourgogne and Paul Ricault. As regards the *R. damascena,* the genotypes from Punjab/Pakistan included Faisalabad and Pattoki, while those from Iran included Osco and Kashan. Thirteen polymorphic microsatellite markers were used to study genetic diversity by using cluster analysis and dendrogram made by UPGMA (Unweighted pair-group method). In Pakistani genotypes of *R. centifolia*, genetic diversity was observed among the districts while high level of homology was observed within the district. Pakistani genotypes (*R. centifolia* Faisalabad and *R. centifolia* Sargodha) were found genetically more divergent to Fantin-Latour and Paul Ricault but closely related with cabbage rose 2. After comparison of both *R. centifolia* and *R. damascena* genotypes collected from Pakistan, USA and Iran, *Rosa damascena* Faisalabad was found genetically diverse from other (one Pakistani and two Iranian) genotypes of *R. damascena*, however, interestingly, it exhibited close genetic relationship with some *R. centifolia* genotypes including Rose de Meaux, Gros Choux d'Hollande and Fantin Latour. In conclusion, the Pakistani *R. centifolia* genotypes had highest genetic variation from two USA genotypes (Fantin-Latour and Paul Ricault). Genetic closeness of Pakistani genotypes with Cabbage rose2 showed their common ancestors. Future investigations should be on identification of superior genes of Pakistani roses with special focus on recurrent flowering at high temperature.

Keywords: Simple Sequence Repeat, Essential oil rose, Heterozygosity, Rose breeding

SALINITY TOLERANCE POTENTIAL IN POTATO IS ASSOCIATED WITH K+ INTAKE AND RESISTANCE TO Na^+ ION

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ABSTRACT

Abrupt climate changes (e.g. temperature, precipitation etc.) are causing several challenges for agriculture sector like escalating salinity stress due to accumulation of soluble salts in rhizosphere. Potato crop, a part of daily diet and staple food in several countries, is particularly affected by salinity due to herbaceous nature especially in arid and semi-arid regions of the globe. Hence, salt tolerant germplasm has to be identified for sustainability of potato industry. A dedicated screening study was conducted to evaluate salinity tolerance potential of thirteen potato cultivars on the basis of morphological and ionic attributes in shoots and roots. Potato tubers were planted in plastic pots (9.0 L) containing fine sand with various salinity levels (0, 25, 50, 75, 100 and 125 mM). Cultivars were categorized into tolerant and sensitive ones as per their performance against various salinity levels on the basis of credit numbers given to each parameter. Resultantly, significant differences in plant emergence and growth was observed among studied cultivars under similar salinity levels. N-Y Lara was found to be the most tolerant cultivar with maximum aggregated credit numbers (109) and K^+ intake along-with minimum Na^+ intake while reciprocal results were exhibited by 720-110 NARC (30). Na^+ exhibited significant antagonistic correlation with potassium and studied morphological parameters i.e., mean emergence time, shoot and root lengths, shoot fresh and dry weights and root fresh and dry weights. This manuscript provides detailed account of the salinity stress investigation in potato. Conclusively, this study would help investigate physiological, biochemical, ionic and molecular mechanisms in tolerant and sensitive cultivars.

Keywords: Stress, Climate change, Saline, Morphological, Correlation, Ionic

EFFECT OF HUMIC ACID ON GROWTH AND FLOWERNG OF NARCISSUS

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ABSTRACT

Narcissus is a spring flowering bulb and well suited as a garden flower, pot plant and as a cut flower with bright color and fragrance. Present experiment was conducted in Floriculture Research Area, Institute of Horticulture Sciences, University of Agriculture, Faisalabad, Pakistan. The experiment was carried out to analyze the response of different levels of humic acid (8%) and constant dose of NPK (17: 17: 17) according to Randomized Complete Block Design. The effect of humic Acid application for days to sprouting of Narcissus was also pronounced highly significant. The results regarding sprouting percentage were found highly significant. Maximum sprouting percentage was recorded (97.33%) in T4 and minimum sprouting percentage was observed (78.3%) in T0 treatment. Maximum number of leaves per plant was gained by T4 (6.00 number of leaves) as compared to T0 (3.33 number of leaves). Leaf area (cm2) was increased with increased in humic acid application. Maximum leaf area (cm2) was gained by T4 (59.639 cm^2) while minimum leaf area (38.809 cm^2) was gained by T0. Among humic acid application, treatments containing both HA and NPK application (T3 and T2) showed more leaf area (55.036 cm^2 and 48.541 cm^2) than single dose of NPK application (44.928 cm^2) in T1 form.Total leaf chlorophyll contents (mg g^{-1}) was increased with increased in humic acid application. Maximum total leaf chlorophyll contents (mg g^{-1}) was gained by T4 (1.0741 mg g^{-1}) while minimum total leaf chlorophyll contents (mg g^{-1}) (0.8960 mg g^{-1}) was gained by T0. Among HA applications, three applications of HA along with NPK surpassed all other treatments for most of growth, and physiological indices of the narcissus production and proved to be effective for enhancing yield and quality in narcissus.

Keywords: Narcissus, Humic acid, Bulbs, Growth

EXOGENOUS APPLICATION OF PUT, SA, OA AND $CACL_2$ DELAYED FRUIT RIPENING AND MAINTAINING FRUIT QUALITY OF 'SAMAR BAHISHT CHAUNSA' MANGO

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ABSTRACT

The potential of different anti-ripening chemicals in regulating the fruit ripening phenomenon as well as fruit biochemical characters of 'Samar Bahisht Chaunsa' mango fruit were investigated. The effects of postharvest application of PUT (2 m*M*), SA (4 m*M*), OA (4 m*M*) and $CaCl_2$ (5%) on regulating fruit biochemical changes were investigated during ripening at 32 ± 3°C for 7 days and cold storage at 12 ± 1°C for 28 days. Fruit were sampled at 2- and 7-day intervals during ripening and cold storage, respectively. Fruit treated with 2 m*M* PUT and 5% $CaCl_2$ showed highest suppression in ethylene production, respiration rate and maintained higher fruit firmness during ripening as well as cold storage. All treated fruit showed lower SSC and SSC:TA ratio, while TA and ascorbic acid content showed the reverse trend during the whole ripening and cold storage period. Postharvest application of SA (4 m*M*) and OA (5 m*M*) treatments were effective in maintaining higher total phenolic and antioxidant contents during ripening and cold storage period than control. Conclusively, the exogenous treatment of PUT (2 m*M*), SA (4 m*M*), OA (5 m*M*) or $CaCl_2$ (5%) may extends the postharvest shelf and storage life of 'Samar Bahisht Chaunsa' mango fruit. Moreover, fruit treated with 2 m*M* PUT and 5% $CaCl_2$ suppressed ethylene production and respiration rate; while, 2 m*M* OA and 4 m*M* SA exhibited higher total phenolic and antioxidant contents with better quality of mango fruit.
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Keywords: Anti-ripening chemicals, Mango, Ripening, Quality

PERFORMANCE ASSESSMENT OF DIFFERENT ONION VARIETIES RAISED THROUGH SMALL AND LARGE SETS UNDER FAISALABAD CONDITIONS

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ABSTRACT

Onion is one of the important condiments widely used in all households through the year. Rapid increase in population is exerting more pressure on its demand. Onion being perishable commodity could not be stored for longer period. Less availability of fresh onion increases its price in Punjab during late summer months up to January-February. This study was conducted in the vegetable area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad to evaluate the impact of set size (large vs. small) on growth and yield of different onion varieties viz., Phulkara, Dark Red and Nasarpuri Pak. Results showed that small onion sets performed better and excelled over large sets for all the studied traits. Largest sized bulbs were recorded in Nasrpuri Pak. Onion variety Nasarpuri Pak raised through small onion sets showed the highest value for leaf blade length, leaf weight, bulb weight, bulb diameter, number of leaves per plant, neck diameter, chlorophyll b, TSS, total phenolics content and dry matter content. While, root weight, root volume and ascorbic acid contents were highest in Phulkara. Soluble sugars, bolting (%) and double bulbs (%) were higher in Dark Red when raised through small sets. It can be concluded from the results that small sets (up to 1.0 mm) of Nasarpuri Pak should be used to get high off season yield of onion.

Keywords: *Allium cepa* L., Onion Sets, Varieties, Growth, Yield

COMPARISON OF PHYSICO-CHEMICAL PROPERTIES IN SEEDED AND SEEDLESS KINNOW FRUITS AT VARIOUS DEVELOPMENTAL STAGES

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ABSTRACT

In the present study, seeded and seedless Kinnow was compared by using different physico-chemical and bio-chemical properties and their antioxidant activities at three developmental stages. The obtained results by seedless Kinnow indicated that total phenols (99.73 mg/100ml) and antioxidant activity (61.40) higher values at ripe stage as compared to flavonoids that were higher in seeded Kinnow showed increasing trends at ripening stage. Seedless Kinnow mandarin showed maximum values for physico-chemical parameters *i.e.* TSS (12.41 Brix), ascorbic acid contents (62.23 mg 100 g^{-1}), pH (6.95%) and less TA (1.73%) was showed. Thus it had been concluded from the obtained results that, seedless Kinnow contains high quality parameters values as compared to seeded at ripe stage, over or under mature fruits did not possess absolute proportion of quality characteristics, hence not as beneficial for human health as mature fruits.

Keywords: Total phenols, Antioxidant activity, Total flavonoids, Ascorbic acid contents

VARIOUS QUANTITATIVE REGIMES OF NPK INFLUENCE THE GROWTH AND QUALITY OF SAFFRON (*Crocus sativus* L.) WHEN GROWN IN SUBTROPICAL CLIMATE

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ABSTRACT

Saffron (*Crocus sativus* L.) is amongst the world's most expensive aromatic and medicinal plant, being sensitive and difficult to produce in bulk, it has attractive flowers having different colors and varying sizes. Being a potential crop of high economic as well as ornamental value it has great demand globally but inexpedient cultural practices are some of the bottlenecks in its production. The study conducted at Institute of Horticultural Sciences, University of Agriculture, Faisalabad Pakistan, revealed that different levels of NPK significantly affected the growth and quality of saffron. The experiment was executed in shade house, Floriculture Research Area where soil based application of NPK in three splits was done, one at planting time and other after 25 and 60 days of sowing. Experiment was laid out according to Randomized Complete Block Design with five treatments, replicated thrice. It was found that an appropriate dose of NPK at (45 gm^{-2}) had highly significant influenced sprouting percentage, leaf length, number of leaves $plant^{-1}$, flower size, flower fresh mass, corm size, corm mass and all other growth and quality parameters. Application of NPK at 45 gm^{-2} showed maximum growth in morphological and floral indices as compared to control. Moreover, results also indicated that higher levels NPK (60 g m^{-2}) had negative influence on saffron quality and growth.

Keywords: Saffron, Corm, Medicinal plant, Flower quality

PREHARVEST EXOGENOUS APPLICATION OF BACTERIAL STRAINS TO ASSESS THEIR INFLUENCE ON CUTFLOWER AND BULB QUALITY OF TULIPS (*Tulipa gesneriana* L.) cv. 'CLEAR WATER'

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ABSTRACT

Tulips are amongst the delicacies of cut flower that possess distinguished status in global floriculture. However, they are not as productive in subtropical regions as they are in temperate zones due to climatic vagaries. This crop has recently been introduced in Pakistan but the exotic cultivars responded with partial success in the new environment. A study conducted to investigate the effect of different beneficial microbes to evaluate the quality of flower and bulb of cut Tulip (*Tulipa gesneriana* L.) cultivar Clear Water under the local environmental conditions of Faisalabad Pakistan. Sowing of bulbs was carried out in an open field under Randomized Complete Block Design having five treatments. Significant difference among treatments was obtained by using Tuckey's test at 5% level of significance among variables. Bacterial strains (treatments) were exogenously applied having the volume of 100 ml (10^8 CFU mL^{-1}) for prechilled bulbs and were replicated thrice, considered as control (distilled water), *Burkholderia pytofirmans* (PsJN), *Bacillus* sp. (MN-54), *Enterobacter* sp (MN-17) and *Caulobacter* sp. (FA-13) was used. The results revealed that tulip responded well to bacterial strains and significant improvement was observed in morphological attributes, bulb attributes and other quality parameters. PsJN proved to be the best one regarding morphological and floral traits from commercial point of view. The highest values of plant fresh mass, leaf chlorophyll contents, leaf area, flower diameter, scape length, vase life, number of bulbils and bulbils diameter were observed maximum as compared to control.

Keywords: Tulip, Bulb, Bacterial strains, Flower quality, Cutflower

PREHARVEST EXOGENOUS APPLICATION OF PROLINE IMPROVES LONGEVITY OF CUT TULIPS (*Tulipa gesneriana* L.)

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ABSTRACT

Tulip (*Tulipa gesneriana* L.) is an attractive and delicate ornamental bulbous, spring perennial flower that belongs to the liliaceae family having delightful and vibrant colors. It is an unaccustomed crop that needs to synchronize its life cycle according to agro-climatic conditions of Faisalabad. For this purpose, a study was designed to elucidate the exogenous application of proline at six distinct levels i.e. 0 mM, 3 mM, 6 mM, 9 mM, 12 mM and 15 mM with three replications applied at two leaf and bud break stage. Single cultivar of tulip, namely 'Columbus' was tested in the study to assess the morphological and floral traits. Experiment was executed in open field and laid out according to Randomized complete block design at Floriculture area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad. Sowing of bulbs was done in the month of December, 2016. Results revealed that 6mM of Proline produced maximum leaf area, scape length, tepal and flower diameter while maximum bulb diameter was attained when 9 mM of proline was exogenously applied. Moreover, the postharvest display life was also hastened by its application at 6 mM and had increased the longevity to 3 days more as compared to control where cut tulips sustained their freshness to 4 days only.

Keywords: Bulb, Tulip, Proline, Bud break stage, Cutflower

PERFORMANCE OF 'SINDHRI' AND 'SAMAR BAHISHT CHAUNSA' MANGOES UNDER LOW TEMPERATURE STORAGE FOR REFRIGERATED SHIPMENT

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ABSTRACT

The behaviour of two commercial mango cultivars including 'Sindhri' and 'Samar Bahisht Chaunsa (S.B. Chaunsa)' was evaluated under different storage temperatures (8, 10, 12, and 14°C; ±1°C; 80-85% RH) for different periods (7, 14, 21 and 28 days). The quality of both cultivars was significantly affected by the storage temperature and duration. Both cultivars were negatively affected at 8°C and 14°C with significantly severe chilling injury and more physiological weight loss respectively. The performance of 'Sindhri' mangoes at 10 and 12°C was at par due to statistically similar physiological weight loss during storage and comparable physico-chemical fruit quality at ripening (skin shriveling, disease development, TSS/Acid ratio and vitamin-C). The initial studies suggested the optimum storage temperature for Sindhri mangoes ranging between 10 and 12°C. The confirmatory trial on 'Sindhri' mangoes led to the confirmation of protocol for mature, desapped (0.5% lime), precooled, hot water dipped (52°C) and fungicide treated (Prochloraz) 'Sindhri' fruit at 11°C; 80-85% RH for 28 days indicating the potential for successful shipment to distant offshore markets. The precooling after harvesting showed potential to extend the storability of 'Sindhri' mangoes for about one week along with well-maintained quality. The fruit of cv. 'Sindhri' developed uniform peel colour during poststorage (after 28 days) handling at 25±1°C without ethylene. Moreover, better colour development was also noted even after 35 days of storage with the help of exogenous ethylene treatment (100 ppm, 48 hrs, 24±1°C). The response of cv. 'S.B.Chaunsa' was complicated, it was found sensitive to low temperature storage due to skin discolouration at all the tested storage temperatures. The storage performance at higher temperature needs to be tested for optimal poststorage skin colour development.

Keywords: *Mangifera indica*, Fruit quality, Sea-freight, Cold storage, Export, Shelflife

AUGMENTING GLADIOLUS QUALITY AND ANTIOXIDANT ACTIVITY BY PRE HARVEST APPLICATION OF CALCIUM DURING LOW TEMPERATURE STRESS IN TWO GROWING CONDITIONS

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ABSTRACT

Low temperature induced stress is one of the most important constraints for successful cultivation of crops. The current research was conducted to evaluate the role of calcium (Ca) and polythene tunnel protected conditions on plant growth and amelioration of low temperature stress in *Gladiolus grandiflora*. The calcium solution of concentrations (0, 0.4% and 0.6%) was applied on foliage of plants at fully developed leaf stage. The average temperature during study was (4 ^{0}C/18 ^{0}C) in open field conditions and (6 ^{0}C/21 ^{0}C) under polythene tunnel system. The interacted treatments thus formed were T_1: (0% Ca + Dec + Open Field), T_2: (0.4% Ca + Dec + Open Field), T_3: (0.6% Ca + Dec + Open Field), T_4: (0% Ca + Jan + Open Field), T_5: (0.4% Ca + Jan + Open Field), T_6: (0.6% Ca + Jan + Open Field), T_7: (0% Ca + Dec + Polythene Tunnel), T_8: (0.4% Ca + Dec +Polythene Tunnel), T_9: (0.6% Ca + Dec +Polythene Tunnel), T_{10}: (0% Ca + Jan +Polythene Tunnel), T_{11}: (0.4% Ca + Jan +Polythene Tunnel) and T_{12}: (0.6% Ca + Jan +Polythene Tunnel). The plants growing in low temperature stress open field conditions exhibited reduction in antioxidant enzyme (POD and CAT) attributes, chlorophyll contents, vegetative and reproductive growth, and vase life as compared to protected conditions with calcium application. The electrolyte leakage and number of days to flowering was enhanced during open field conditions. The interacted treatment T_9: (0.6% Ca + Dec +Polythene Tunnel) was radically increased the growth and quality parameters by increasing number of leaves per plant, leaf area, spike length, spike diameter, number of florets per spike, size of flowers, vase life, chlorophyll contents and antioxidant enzyme activity (POD, CAT), while number of day taken to flowering and electrolyte leakage was reduced in treatment. The improved stress tolerance in Ca applied plants under protected conditions was attributed to the enhanced growth, quality and synthesis of antioxidant enzymes activities. The present study supports the application of Ca along with protected polythene production system for alleviation of low temperature stress in *G. grandiflora*.

Keywords: Antioxidant enzymes, Calcium, Low temperature, Polythene tunnel, Gladiolus

BENEFICIAL ROLE OF MAGNESIUM AND GREEN NET SHAD IN HIGH TEMPERATURE STRESS ALLEVIATION AND GROWTH IMPROVEMENT IN *Gladiolus grandiflora*

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ABSTRACT

High temperature induced stress is one of the most important constraints for successful cultivation of crops. The current research was conducted to evaluate the beneficial role of magnesium and green net shad protected conditions on plant growth and amelioration of high temperature stress in *Gladiolus grandiflora*. The magnesium solution of concentrations (0, 0.2% and 0.4%) was applied on foliage of plants at fully developed leaf stage. The average temperature during study was (23˚C/36˚C) in open field conditions and (20˚C/32˚C) under green net shade system. The interacted treatments thus formed were T_1: (0% Mg + May + Open Field), T_2: (0.2% Mg + May + Open Field), T_3: (0.4% Mg + May + Open Field), T_4: (0% Mg + Jun + Open Field), T_5: (0.2% Mg + Jun + Open Field), T_6: (0.4% Mg + Jun + Open Field), T_7: (0% Mg + May + Green net shade), T_8: (0.2% Mg + May + Green net shade), T_9: (0.4% Mg + May + Green net shade), T_{10}: (0% Mg + Jun + Green net shade), T_{11}: (0.2% Mg + Jun + Green net shade) and T_{12}: (0.4% Mg + Jun + Green net shade). The plants growing in high temperature stress in open field conditions exhibited reduction in antioxidant enzyme peroxidase and catalase (POD, CAT) attributes, chlorophyll contents, vegetative and reproductive growth, and vase life as compared to green net shade protected conditions with magnesium application. The electrolyte leakage and number of days to flowering was higher during open field conditions. The interacted treatment T9: (0.4% Mg + May + green net shade) was radically increased the growth and quality parameters by increasing number of leaves per plant, leaf area, spike length, spike diameter, number of florets per spike, size of flowers, vase life, chlorophyll contents and antioxidant enzyme activity (POD, CAT), while number of day taken to flowering and electrolyte leakage was reduced in treatment. The improved stress tolerance in magnesium applied plants under protected conditions was attributed to the enhanced growth, quality, vase life and synthesis of antioxidant enzymes. The present study supports the application of magnesium along with green net shade production system for alleviation of low temperature stress in *G. grandiflora*.

Keywords: Gladiolus, Magnesium, Temperature stress, Polythene tunnel, Antioxidants

EVALUATION OF NUTRITIONAL AND BIOCHEMICAL ATTRIBUTES OF PLEUROTUS SPP AGAINST WHEAT STRAW AUGMENTATION WITH MORINGA LEAVES

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ABSTRACT

Pleurotus spp is an edible mushroom having a brilliant taste and aroma. *Pleurotus* mushroom is being grown worldwide due to its capability of growing under varying conditions of temperature and highly nutritious value. An experiment was conducted to evaluate the biochemical attributes of two strains of *Pleurotus* spp viz. *Pleurotus sajar caju* and *Pleurotus columbinus* by using wheat straw and moringa leaves as a basal medium. Experiment was conducted under CRD (completely randomized design) with five replications of each treatment. Different treatments of basal medium were used which include T_0: wheat straw, T_1: moringa leaves, T_2: wheat straw + moringa leaves (1:3), T_3: wheat straw + moringa leaves (1:1) and T_4: wheat straw + moringa leaves (3:1). Parameters which were studied during this experiment were TSS (Brix^o), moisture percentage (%), sugars (reducing, non-reducing and total sugars), ascorbic acid contents (mg/100ml), acidity percentage, nitrogen, phosphorus and potassium of mushroom and substrates analysis include pH of substrates, nitrogen, phosphorus and potassium contents of substrates before and after cropping. Recorded data was analysed by applying ANOVA and means values were compared by LSD test at 5% probability level. Results regarding biochemical attributes showed that sugar contents were highest at T_2 and T_3 as compared to other treatments. Acidity % was found higher in *Pleurotus sajar caju* than *Pleurotus columbinus.* On other hand, total soluble solids, ascorbic acid showed non-significant results for both strains. Nitrogen, phosphorus and potassium contents of *Pleurotus sajar caju* were higher than *Pleurotus columbinus.*

Keywords: *Pleurotus sajar caju*, Mushroom, Sugar contents, Nitrogen, Acidity

EFFECT OF MALEIC HYDRAZIDE ON ENHANCING THE FLOWERING TIME IN CHRYSANTHEMUM (*Chrysanthemum morifolium*)

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ABSTRACT

The study was conducted at Hazara Agriculture Research Station Abbottabad Pakistan during 2015-16 to quantify the effect various concentrations (0, 1000, 1500, 2000, 2500 and 3000 ppm) of Maleic Hydrazide (MH) on plant height, number of branches, leaves, flowers per plant, leaf area, days to flowering, blooming period, flower size and flower fresh weight. The experiment was conducted as a Completely randomized block design with 6 MH concentrations replicated four times. The terminal cuttings of chrysanthemum were taken from the stock and were planted in 7 cm plastic pots individually on 10th June. Plants were transplanted to 28 cm pots on 10th July. MH solution was sprayed on plant in the morning at fortnightly intervals. The experiment was repeated in 2011. Data on vegetative and flowering characteristics indicated that flowering in chrysanthemum varied significantly for most of the studied variables. The plants sprayed with MH@ 3000 ppm resulted an increased number of branches (10.2), leaves (47), and days to flower (160 days), while the untreated chrysanthemum plants had more plant height (47.6 cm), least number of branches (6.9), had higher leaf area (92.8 cm^2), less days to flower (136 days), bigger flower size (4.9 cm) and higher flower fresh weight (3.5 g). Although plants treated with MH @ 3000 ppm produced small sized flowers (4.0 cm) and with lower fresh weight (2.9 g) flowers, however the treatment was considered best as it produced flowers 26 days late (on 16th November) different from the normal season.

Keywords: Chrysanthemum flowering, Maleic hydrazide, Late flowering

KINNOW MANDARIN STORAGE LIFE AND FRUIT QUALITY INFLUENCED BY GEOGRAPHICAL LOCATIONS

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ABSTRACT

This study investigated the storage potential and fruit quality of Kinnow mandarin grown in four Kinnow producing districts of Punjab province, Pakistan including Sargodha (SGD), Toba Tek Singh (TTS), Vehari (VHR) and Khanewal (KHW). Fruit were harvested at commercial maturity from six commercial orchards of selected districts and compared for storage/shipping potential both under ambient (25±1 ◦C) and cold storage conditions (4±1◦C; 85-90% RH). Under ambient conditions, fruit were analyzed for quality parameters before and after shelf storage of seven days. Under cold storage conditions, fruit were kept for 60 days at cold storage conditions and fruit quality was assessed before storage, after 30 days of storage (1st removal) and after 60 days of storage (2nd removal). Regarding storage comparison at ambient conditions, significantly higher fruit firmness was recorded in fruits from district VHR before and after shelf storage, obtaining scores 2.32 and 2.19 respectively however higher juice percentage was recorded in fruit harvested from TTS district afterward SGD (42.69% and 42.45% respectively) after storage at shelf of seven days. Weight loss (5.58%) was significant higher in fruits obtained from district KHW and minimum (4.41%) in fruits from district SGD. District TTS exhibit significantly higher total soluble solids (11.78 °Brix) and TSS/TA ratio (12.09) after shelf storage. As regards comparison under cold room, district TTS exhibited significantly higher TSS after 1st and 2nd removals however, district SGD exhibit higher TTS/TA ratio after 2nd removal. Juice contents (juice percentage) was greater in fruits from district SGD after 1st and 2nd removal. No symptoms of chilling injury (CI) was observed after 1st removal however, CI was found in fruit from district KHW and VHR after 2nd removal. Significant, increasing trend was found in total phenolic content (TCP) with the increase in storage period while antioxidants activity increased non-significantly with the increase in storage period.

Keywords: Storage life, Kinnow fruit quality, Geographical locations

EFFECT OF SEED PRIMING ON GROWTH, FLOWERING AND CUT FLOWER QUALITY OF CARNATION

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ABSTRACT

Carnation is one of the most important commercially grown flowers in the world. It has wide variations in shape and colors as well as good keeping quality. It has been used in bedding, edging, borders, pots and rock gardens, in boutonnieres, corsages, bouquets and floral arrangements. The present experiment was conducted to study the effects of seed priming through various chemicals such as salicylic acid, glycinebetaine, potassium nitrate, ascorbic acid and hydropriming on growth and floral quality attributes of carnation. The seeds were pre-treated with different priming agents (salicylic acid 100 mg/L, glycinebetaine 1536 mg/L, potassium nitrate 10 g/L, ascorbic acid 50 mg/L, and water) for 24 hours and then sown in clay pots. A control (dry seeds) was also included in the treatments. Hydropriming (water treatment) resulted in the maximum seed germination (43.04%) and took minimum days to initiate first flower bud (87 days). Salicylic acid treated seeds resulted in the plants with delayed flower bud initiation and had maximum flower stalk length (3.08 cm), root length (21.89 cm), fresh weight of foliage (54.35 g), dry weight of foliage (16.66 g), fresh weight of roots (3.97 g), dry weight of roots (1.64 g), total biomass per plant (52.84 g), and longer length of growth cycle (177.5 days). Potassium nitrate treatment showed the maximum fresh weight per flower (4.24 g), dry weight per flower (0.95 g) and flower stalk diameter (10.44 mm). The minimum fresh and dry weights per flower were recorded (2.75 0.68 g respectively), were recorded in unprimed seeds (control).

Keywords: *Dianthus caryophyllus*, Flower attributes, Hydropriming, Seed priming agents

POSTHARVEST FRUIT SOFTENING AND QUALITY MANAGEMENT OF PEACH BY EXOGENOUS OXALIC ACID APPLICATION

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ABSTRACT

Peach being climacteric fruit ripe quickly after harvest and exhibit fast ripening at ambient conditions. Rapid postharvest fruit softening and quality deterioration limits its postharvest storage life. Therefore, a study was carried out to understand the role of oxalic acid (OA) to manage postharvest fruit softening and quality of peach. The fruits were dipped for 5 min in solutions containing different concentration of OA *viz.* 0, 1, 2 or 3 m*M* + Tween 20® (1 g L^{-1}). The treated fruit were kept at ambient conditions (25 ± 2 °C; RH 60-65%). Physiological characteristics (ethylene production, respiration rate, weight loss), biochemical characteristics [soluble solid contents (SSC), titreable acidity (TA), SSC:TA ratio], fruit firmness, activities of cell wall hydrolyzing enzymes [pectin esterase (PE), endo-1-4-*β* glucanase (EGase), *endo*-polygalacturonase (*endo*-PG), *exo*-polygalacturonase (*exo*-PG)] and antioxidative enzymes [catalase (CAT), peroxidase (POD), superoxide dismutase (SOD)] were determined during ripening at ambient conditions, cold storage and at post-storage ripening. Postharvest application of OA at higher dose (3 m*M*) reduced ethylene production and fruit softening of peach fruit accompanied with increased antioxidative activity during ripening. Reduced activities of fruit softening enzymes including PE, EGase, *endo*-PG and *exo*-PG were observed in 3 m*M* OA-treated fruit, as compared to untreated fruit during ripening. Lowest fruit weight loss, SSC, while highest fruit firmness were observed in 3 m*M* OA-treated peach fruit than untreated fruit. Application of 3 m*M* OA significantly enhanced the antioxidant scavenging activity (ASA), total phenolic contents (TPC) and activities of antioxidative enzymes including CAT, POD and SOD, as compared to untreated control peach fruit during ripening. Thus, application of 3 m*M* OA significantly reduced ethylene production, fruit softening, fruit softening enzymes activities and increased anti-oxidative activity of peach fruit during ripening at ambient conditions.

Keywords: Antioxidants, Ethylene, Fruit softening enzymes, Fruit quality, Shelf life

POSTHARVEST APPLICATION OF CALCIUM CHLORIDE LESSENS ACTIVITIES OF FRUIT SOFTENING ENZYMES AND ENHANCES ANTI-OXIDATIVE ACTIVITY OF PEACH

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ABSTRACT

Application of calcium chloride ($CaCl_2$) has been reported to delay ripening of fruit. Hence, a study was conducted to examine the effects of postharvest $CaCl_2$ application on peach fruit (*Prunus persica* L. Batsch. cv. 'Flordaking') softening and quality characteristics during ripening at ambient conditions. The fruit after harvest were dipped for 5 min in aqueous solutions containing different concentration of $CaCl_2$ *viz.* 0, 2%, 4% or 6% + Tween 20® (1 g L^{-1}). The treated fruit were kept at ambient conditions (25 ± 2 °C; RH 60-65%). The fruit were evaluated for physiological (ethylene production, respiration rate, weight loss, fruit firmness); biochemical fruit quality characters; [soluble solid contents (SSC), titrable acidity (TA), SSC:TA ratio], fruit firmness, activities of cell wall hydrolyzing enzymes [pectin esterase (PE), endo-1-4-*β* glucanase (EGase), *endo*-polygalacturonase (*endo*-PG), *exo*-polygalacturonase (*exo*-PG)] and antioxidative enzymes [catalase (CAT), peroxidase (POD), superoxide dismutase (SOD)] during ripening. Postharvest application of 6% $CaCl_2$ significantly reduced ethylene production and respiration rate during ripening, at ambient and followed by cold storage. Reduced fruit softening and activities of fruit softening enzymes including PE, EGase, *endo*-PG and *exo*-PG were exhibited by 6% $CaCl_2$-treated fruit as compared to untreated fruit. Lowest fruit weight loss, SSC, while highest fruit firmness were observed in 6% $CaCl_2$-treated peach fruit than untreated fruit during ripening. Application of 6% $CaCl_2$ significantly enhanced the antioxidant scavenging activity (ASA), total phenolic contents (TPC) and activities of anti-oxidative enzymes including CAT, POD and SOD than untreated peach fruit during ripening at ambient conditions. Although application of 6% $CaCl_2$ significantly reduced ethylene production, fruit softening, fruit softening enzymes activities and increased anti-oxidative activity, however, peach fruit treated with higher concentration of $CaCl_2$ (6%) exhibited skin discoloration and superficial pitting at ripening followed by cold storage. Keeping the above deleterious effects of higher dose, 4% $CaCl_2$ was more preferable to maintain fruit softening and quality of peach fruit during ripening.

Keywords: Antioxidents, Calcium Chloride, Fruit softening enzymes, Fruit quality, Shelf life

IMPACT OF SALICYLIC ACID AND ASCORBIC ACID ON SHELF LIFE OF TOMATO

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ABSTRACT

The research was conducted to assess the role of salicylic acid (SA) and ascorbic acid (AsA) on shelf life of tomato. Uniform sized fruit of variety "Sahil" was dipped in distilled water, SA (2 mM), AsA (2 mM) for five minutes and then placed at room temperature with three replications. Fruit were evaluated at three removals with three days interval. Physical parameters included fruit weight loss percentage, juice contents, fruit volume, fruit diameter, biochemical parameters included TSS, titratable acidity, ascorbic acid while organoleptic observations were recorded as Shriveling and visual quality. At first removal, applied antioxidants ousted the distilled water treated (control) fruit in all the observed parameters but their own response was at par. At 2nd and 3rd removal, the difference became significant promoting the SA, being a shelf life extending agent. SA maintained less weight loss, more juice contents, fruit volume, good external appearance, high TSS, less Ascorbic acid and titratable acidity at 3rd removal. It can be concluded from the study that SA applied at 2 mM concentration, was more effective to improve shelf life of tomato as compared to distilled water and ascorbic acid.

Keywords: Ascorbic acid, Salicylic acid, Tomato, Shelf life

VEGETABLES IRRIGATED WITH SEWERAGE WATER ACCUMULATED HIGHER CADMIUM CONCENTRATIONS POTENTIALLY TOXIC FOR HUMAN HEALTH

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ABSTRACT

Cadmium (Cd) is toxic heavy metal for human health and can be carcinogenic if ingested. Iron (Fe) and zinc (Zn) are also metals useful for proper human nutrition. Various vegetables including Radish, Carrot, Turnip, Spinach and Fenugreek are being irrigated with untreated sewerage water in areas around most of the cities in Pakistan and can be toxic for human health if contaminated with heavy metals. The aim of the present study was to analyze the concentration of Cd, Zn and Fe metals in these vegetables irrigated with untreated sewerage water compared to control. There was generally enhanced shoot and root growth observed in vegetables probably due to enhanced organic matter although pithiness was observed in the root of radish irrigated with sewerage water. Very high concentrations of Cd up to 7 ppm in roots while up to 4.5 ppm in shoot were observed in most of these vegetables. Zn concentrations in carrot, radish, spinach and fenugreek were decreased by sewerage water application but a slight increase in Zn in turnip was observed. Iron concentration in Radish, spinach and fenugreek were also decreased by sewerage water treatment while turnip had positive response for iron in sewerage water treatment. It is hence concluded that untreated sewerage irrigated vegetables, highly contaminated with Cd, are potentially toxic for human consumption and hence should be banned in Pakistan. Furthermore, it is recommended that the sewerage water should be treated to eliminate toxic compounds including Cd and then could be made available for crop production if found fit for irrigation.

Keywords: Cadmium, Zinc, Iron, Heavy metals, Health risk, Vegetables, Sewage water

HEAVY METAL ACCUMULATION IN FRAGRANT *ROSA* SPECIES IMPARTS STRUCTURAL MODIFICATION UNDER MARGINAL QUALITY WATER

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ABSTRACT

Wastewater irrigation has emerged as a potential alternative to renewable water in agriculture particularly in water scarce regions around the globe. However, the possible risks of heavy metals accumulation in plant parts are usually overlooked. The present study aimed at investigating heavy metals induced structural modifications in roots and stem of scented *Rosa* species irrigated with marginal quality water. Chemicals and minerals were in acceptable range in canal water and treated wastewater while untreated wastewater contained higher electrical conductivity, chemical oxygen demand, biological oxygen demand and heavy metals content (Co, Cu, Cd, Pb) than permissible levels. Four *Rosa* species viz. *Rosa damascena*, *R. bourboniana*, *R.* Gruss-an-Teplitz and *R. centifolia* were evaluated for their response to wastewater. Results revealed that treated wastewater significantly increased collenchyma (cortex and pith) and parenchyma tissues (vascular bundle, xylem and phloem) of *R.* Gruss-an-Teplitz. Root dermal tissues (epidermis) of *R. bourboniana* also reacted significantly to treated wastewater however *R. damascena* and *R. centifolia* were least affected under all irrigations. Except chromium all metal contents in root of roses were in permissible range according to WHO values for medicinal plants under all irrigation sources. *Rosa centifolia* contained higher metal quantities than other species in roots that's why it was anatomically most affected. We propose that *R.* Gruss-an-Teplitz proved to be highly resistant whereas *R. centifolia* was most susceptible species to grow with marginal quality water. It is also strongly recommended that untreated wastewater must be treated to some extent which can serve as alternate water source to fresh water.

Keywords: Environmental pollution, Metal toxicity, Scented roses, Tissues alteration

INFLUENCE OF AZOTOBACTER SEED INOCULATION ON EMERGENCE AND YIELD OF EARLY SOWN CARROT

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ABSTRACT

Present study was performed in Vegetable seed Laboratory and Vegetable Research Area at Institute of Horticultural Sciences, University of Agriculture Faisalabad, Punjab-Pakistan. Carrot (*Daucus carota*) is a famous winter vegetable among Umbelliferae family and it is very popular because of its good nutritional value and health benefits. Carrot is usually sown in the month of October but due to its high profitability for early season production, it is practiced to sow during the months of August-September in Punjab. However, there are some issues of low seed emergence and stand establishment due to high temperature, early in the season. That's why, crop yield directly affected under such conditions. Hence, a study was planned to manage these issues for improved early carrot crop. Application of plant growth promoting rhizobacteria (PGPR) is well known for plant growth and yield improvements. To earn the benefits from PGPR, carrot seeds (cultivar T-29) were inoculated with Azotobacter @ (AB 1 g/10 g of seeds and AB 2g/10 g of seeds, while untreated seeds served as control) and evaluated in term of emergence related attributes as well as crop yield during the year 2015 and 2016. Statistical analysis of data showed significant improvements for final emergence percentage (FEP), seedling fresh weight (SFW), seedling dry weight (SDW), seedling length (SL) and seedling vigour index (SVI) and yield attributes with Azotobacter application at both levels. Overall results showed that, FEP was improved ~25% (AB 2g/10 g of seeds) while carrot root yield was enhanced ~20% (AB 1 g/10 g of seeds) with Azotobacter seed inoculation as compared to untreated seeds or control. Thus, it was concluded that carrot seed inoculation with azotobacter @ AB 1 g and/or 2 g/10 g of seeds could improve emergence potential along with higher yield of early carrot crop under high temperature.

Keywords: Carrot, Seed inoculation, Azotobacter, Emergence, Yield, High temperature

EFFECT OF ASCORBIC ACID ON PERICARP BROWNING, BIOCHEMICAL QUALITY AND ACTIVITIES OF ANTIOXIDATIVE ENZYMES IN LITCHI

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ABSTRACT

Postharvest pericarp browning reduces the quality and visual appearance of litchi fruit. Therefore, in this study influence of different ascorbic acid concentrations (0, 15, 30, 45 or 60 m*M*) on pericarp browning, biochemical quality, antioxidative and enzymatic changes in litchi cv. 'Gola' fruit under extended cold storage was investigated which has not been studied extensively. Fruit dipping in 45 m*M* ascorbic acid maintained higher anthocyanin contents by reduced browning index and fruit weight loss. Activities of antioxidative enzymes (SOD and CAT), level of TPC and total antioxidants contents were significantly higher in peel as well as pulp tissues of 45 m*M* ascorbic acid-treated fruit. Whereas, activities of PPO in litchi peel and POD enzymes in peel as well as pulp tissues were reduced in 45 m*M* ascorbic acid-treated fruit. Conclusively, application of 45 m*M* ascorbic significantly delayed pericarp browning and maintained better quality of 'Gola' litchi fruit during cold storage.

Keywords: Antioxidative enzymes, Ascorbic acid, Fruit quality, Litchi, Pericarp browning

INFLUENCE OF HEXANAL VAPOR ON THE STORAGE LIFE AND PERICARP BROWNING IN LITCHI CV. 'GOLA' FRUIT

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ABSTRACT

Litchi is highly perishable fruit having very short shelf life and pericarp browning is the major factor affecting its postharvest quality. Therefore, this study was conducted to investigate the effect of hexanal fumigation on pericarp browning, changes in activities of antioxidative enzymes and biochemical quality attributes of litchi cv. 'Gola' fruit under cold storage conditions. Fruit harvested at physiological maturity were fumigated with different concentrations (0, 250, 500, 750 and 1000 µL L^{-1}) for 45 min and then stored at 5 ± 1°C with 90 ± 5% RH for 28 days. Postharvest fumigation of hexanal could not control pericarp browning and resulted in lower anthocyanin and increased weight loss than control fruit. Maximum SSC, lowest TA and highest SSC: TA was observed in 1000 µL L^{-1} hexanal-treated fruit, while ascorbic acid was higher in 250 µL hexanal-treated fruit. Control fruit exhibited higher total phenolics and total antioxidants in peel and pulp tissues, as compared to hexanal-treated fruit. Activities of antioxidative enzymes (SOD and CAT) and level of total phenolics and total antioxidants in litchi peel and pulp tissues were low in hexanal-treated fruit. On the other hand, activities of PPO and POD enzymes in litchi peel tissues were higher in hexanal-treated fruit. Conclusively, postharvest fumigation of hexanal could not control pericarp browning, but comparatively maintained fruit quality of 'Gola' litchi longer than control during cold storage.

Keywords: Antioxidative enzymes, Fruit quality, Hexanal, Litchi

CORRELATION BETWEEN TRUE SEED AND TUBER DORMANCY IN A *Solanum tuberosum* GROUP *phureja* × *stenotomum* POPULATION

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ABSTRACT

Short tuber dormancy is desirable when multiple cropping seasons occur yearly, yet most potato cultivars were developed for regions with one growing season per year and have long dormancy. Although several methods exist for breaking tuber dormancy, they can lead to uneven emergence and poor stand counts. Breeding short dormancy cultivars could alleviate this problem. A long-day adapted diploid hybrid population of *S. tuberosum* Group *phureja- S. stenotomum* (*phu-stn*) has been developed with short tuber dormancy. The purpose of this study was to determine if there was a correlation between tuber dormancy in these *phu-stn* parents and true potato seed dormancy in their offspring, which would allow rapid breeding of short-dormancy germplasm. Tuber dormancy was evaluated for 12 diploid *phu-stn* parents harvested from three different locations: Presque Isle, Maine (ME); Plymouth, North Carolina (NC) and Beltsville, Maryland (MD); and stored at 7 °C in MD. Twelve crosses were made among these parents; each parent was represented twice in the offspring. True potato seed (TPS) from these 12 families were disinfected and soaked in water for 24 hours, dried, and sown in tissue culture. TPS germination was recorded daily for 35 days and the proportion germinated calculated. The experiment was conducted three times. Parental tuber dormancy ranged from 6-10+ weeks. TPS family proportion germination ranged from 9 to 99%. There was no correlation (r = 0.01) between parental tuber dormancy and TPS family germination proportion. These results show that the relationship between offspring TPS dormancy and their parent's tuber dormancy is unpredictable. Additional research is needed to determine if selection for early sprouting in the offspring *in vitro* is correlated with short tuber dormancy in subsequent field generations of these offspring.

Keywords: Tuber dormancy, True potato seed, Diploid, *In vitro,* Hybrid

FIELD EVALUATION OF DIFFERENT TUBER-DORMANCY BREAKING METHODS IN SIX POTATO GENOTYPES

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ABSTRACT

Different exogenous dormancy breaking methods are used worldwide to force sprouting in potato tubers. In this study we evaluated four methods for breaking dormancy in six genotypes: plant growth regulators (60 mg L^{-1} benzyl aminopurine + 20 mg L^{-1} gibberellic acid), electric current (80 volt), cold pre-treatment (2°C) and irradiation (3.5 kGy). After treatments, tubers were planted at 60 cm × 20 cm spacing in a randomized complete block design with three replications. All recommended cultural practices were adopted during the course of experimentation. Haulms were cut 90 days after planting. The treatments were harvested ten days after haulm-cutting to allow tubers to suberize in the field. Dormancy breaking methods and genotypes were significant ($p<0.05$) for days to emergence, emergence percentage, number of stems and tubers per plant and leaf area. Plant photosynthetic rate, transpiration rate, stomatal conductance, leaf chlorophyll content, tuber specific gravity and tuber dry matter content were significantly affected by both the main and interactive effects of dormancy breaking methods and genotypes. Overall, PGRs treated tubers gave the best and early emergence and highest crop stands, followed by electric current, cold storage and irradiation.

Keywords: Growth regulators, Tuber dormancy, Electric current, Cold pre-treatment

EVALUATION OF HEAT TOLERANCE POTENTIAL IN DIFFERENT OKRA GENOTYPES UNDER DIFFERENT SOWING DATES

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ABSTRACT

Heat stress id dilemma for vegetable production in hot ares of the Punjab. To overcome with the economic losses of okra under heat stress different strategies had been applied. The present study was designed to screen out heat tolerant okra genotypes at Sargodah and Okara in Punjab. In this experiment screening of okra genotypes for heat tolerance were done. Exotic and local germplasm collected from AVRDC and AARI. (VI 039622, VI056456, OH-139, Tokita, OH-713, VI060206, OH-152, VI060133, VI046566 Sabazpari) was sown with two different sowing date (15th March and 1st April). Data related to gas exchange related attributes (photosynthetic rate, transpiration rate, water use efficiency, conductance of stomata, electrolyte leakage and biochemical parameters (protein, chlorophyll contents, super oxide, catalase, dismutase, peroxidase) and yield related attributes (average weight and diameter of fruit) were collected. Proper statistical design and procedure showed that on an average second transplanting date was better as compared to first transplanting date as production of antioxidants were more. Subartic genotype (having EC 48%) was found superior at all levels at both the transplanting dates and sabzpari (having EC 76%) inferior for various parameters studied.

Keywords: Heat stress, Okra, Punjab, Yield, Screening, Genotypes

EVALUATION OF HEAT TOLERANCE POTENTIAL IN DIFFERENT *Capsicum annum* GENOTYPES UNDER HEAT STRESS

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ABSTRACT

Heat stress is main issue for growing of summer vegetables above threshold level which ultimately results in serious losses of their production and economy of the farming community. To cope with these economic losses different strategies had been adopted. The purpose of present study was designed to screen out heat tolerant genotypes of bell pepper (*Capsicum annuum* L.), brought from Ayyub Agriculture Research Institute, Faisalabad. During study ten genotypes of bell pepper (C1G3, C3G5, C7G4, V6G4, C2-E, C5G4, C43-D, C4G3, C43-A, C2G3) were grown in growth chamber having well equipped heating and cooling system. Heat treatment (32℃/40℃ day/night) was given to one month old seedling for one week. Data regarding growth index (number of leaves, root length, shoot length, seedling dry weight, seedling fresh weight, physiological (electrolyte leakage (EL), chlorophyll contents) and leaf water related attributes (leaf water potential, leaf turgor potential, leaf osmotic potential, relative water contents) were collected. The research findings proved that heat stress significantly affected morphology and physiology. The genotypes which followed the order for the heat stress tolerance as C5G4, C1G3, C2G3, C43-A, C3G5, C43-D, V6G4, C4G3, C43-A and C2G3 respectively. Based on physical and physiological parameters, genotypes C5G4 and C1G3 having EL of 45% and 49% respectively, were among the most tolerant genotypes and the most sensitive were C43-A and C2G3 havving EL of 78% and 80%, respectively. It was concluded that different bell pepper genotypes have different ability to behave with heat stress.

Keywords: Bell pepper, Heat stress, Genotypes, Physiology, Electrolyte leakage

ULTRA HIGH DENSITY PLANTING SYSTEM (UHDPS): RECENT DEVELOPMENT IN PRODUCTION OF GUAVA

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ABSTRACT

Guava, the poor man's fruit is an important fruit crop in tropical and subtropical areas of Pakistan due to the hardy nature of its tree and highly productive even in marginal lands. Being very hardy, it gives an assured crop even with very little care. But, recently, this crop has showing a paradigm shift in production system, from subsistence farming to commercial production. Traditional system of guava cultivation has often posed problems in attaining desired level of productivity due to large tree canopy. Hence, existing production system needs to improve, besides increasing its productivity. At this time, there is a worldwide trend to plant fruit trees at high density to control tree size and maintain desired architecture for better light interception and ease in handling such as pruning and training, pest control and harvesting. UHDPS is a modern method of fruit cultivation with dwarf plant and modified canopy. Through UHDPS plantation, production and quality of guava fruit will be enhanced. Presently, our institute is working on UHDPS to replacing the existing production system (conventional guava production system has often created problems in attaining desired level of production due to large canopy and lower number of plants in unit area) with highly productive UHDPS (maximum yield and high quality guava could be produced through UHDPS by controlling tree size and architecture through hedging and topping). UHDPS includes adoption of suitable plant density, canopy management, quality planting material, support and management system with appropriate inputs. In regards of higher economic benefits and popularity of UHDPS, it is now high time to encourage the adoption of this technology by the guava growers. Availability of institutional credit for adoption of this technology would definitely popularize it further among the horticulturists. Indeed, credit inflow into this sub sector is most likely to help guava growers in improving their economic condition faster.

Keywords: *Psidium guajava*, UHDPS, Canopy management, High production

EFFECT OF POST-HARVEST TREATMENTS AND STORAGE CONDITIONS ON SHELF LIFE OF FENUGREEK

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ABSTRACT

Leafy vegetables quickly deteriorate after harvest at ambient conditions. Refrigerated storageis the only option but due to its huge initial capital investment, every farmer cannot adopt this method in developing countries. Lack of these cool storage facilities results huge postharvest losses. Zero energy cool chamber (ZEEC) work on the principle of evaporative cooling and does not require electrical power to operate. In this study, ZECC was constructed at COMSATS Institute of Information Technology, Vehari Campus to appraise the effect of storage conditions on shelf life of fenugreek. Freshly harvested fenugreek were washed air dried at room temperature and the divided into four lots and each lot had nine equal bunches (36 bunches). Following treatments were applied with three replications per treatment:$T_{1=}$ Ambient conditions in laboratory (control), $T_{2=}$ Perforated polyethylene bag and ZECC, $T_{3=}$ Zero energy cool chamber (ZECC), $T_{4=}$ Dipped in ice chilled water and kept in ZECC. Three days after harvest (3-DAH) mass loss (%) was lower (T_2 =4.13%, T_3 =8.73% and T_4 =17.74%) in Fenugreek kept in ZECC and higher (38.14%) in laboratory. Visual quality was better (T_2 = 8, T_3 = 5 and T_4 =7) and wilting was less (T_2 = 1, T_3 = 2 and T_4 =1) in ZECC as compared to laboratory at ambient conditions. Shelf life of fenugreek was less than one day in laboratory while it increases in ZECC (T_2 = greater than three days, T_3 = less than three days and T_4 = less than two days). Color score of fenugreek was also good in ZECC as compared to laboratory. Cost benefit ratio of the new technology was also calculated.

Keywords: Fenugreek, Shelf life, Visual quality, Post-harvest treatments

EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH AND PRODUCTION OF ZINNIA (*Zinnia elegans* L.)

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ABSTRACT

Zinnia is one of the most significant cut flower that is to be utilized in the families for the affection, love and ultimately us as the boarder of the plants. Their production requires major food inputs from organic and mineral fertilizers. For quality flower production, mineral and organic based fertilizers were used. Treatment units contained T_0 no fertilizer used, T_1 recommended dose of mineral fertilizer, T_2, organic fertilizer (FYM) used and T_3 mixed half doses of mineral and organic fertilizer were used in 4 replications. Among the treatments applied, the highest flower weight (17.00 g) was observed in the treatment of T_2 inorganic fertilizers. However, the lowest flower mass was shown by the control T_1(without application) among all applied treatments that were 9.67 g. Fresh flower mass is very important attribute in terms of plant growth and development. Of all applied treatments, the inorganic fertilizer (T_3) application showed the highest chlorophyll content (13.08 g kg^{-1}) among all applied treatments followed by T_4 mixture of organic and inorganic fertilizers having chlorophyll content (11.61 g kg^{-1}). The vase life of the flowers was much higher in the treated inorganic fertilizer plants compared to the control. Among all applied treatments, application of inorganic fertilizers showed the highest vase life among all applied treatments followed by a mixture of organic and inorganic fertilizers. One of the most important causes of low vase life of the plant is deterioration in the water content of the flower. It is experienced from the current study that inorganic fertilizers has significant effects on the zinnia plant as it provide the nutrients necessary for the plant growth and productivity while the other means of fertilizers such as organic fertilizers have less significant results than inorganic fertilizers. The optimal use of organic and inorganic fertilizers in the production system may help to quantify policy formulation for the potential and faster production of desired crops, minimize nutrient losses in the root zone and reduce environmental risks.

Keywords: Zinnia, Organic fertilizer, Mineral fertilizers, Vase life

AN ANALYSIS OF GENDER ROLE IN FOOD SECURITY WITH SPECIAL CONTEXT OF WOMEN VEGETABLE GROWERS

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ABSTRACT

Vegetables play a vital role in agricultural sector. Vegetables are the finest supply of food nutrients desirable for the reasonable human diet. According to economic survey of Pakistan 2016 vegetables share in GDP 2.3%. Vegetables also prevent human body from different diseases. In Pakistan about 1131 acres of area under which vegetables are and total production are 5314.76 million tons. Through export vegetables Pakistan earns a value in dollars $151.1 million. Rural women play an important role in vegetable production. About 70% of rural women have met their income from this mean. As food producers rural women are considered the key players to overcome the food insecurity. In making policies and strategies mostly female farmers are ignored. Gender narrates openly women's roles in farming duties and allocating assets. Vegetables quantity decline 4.8% with respect to previous year due to lack of awareness and proper infrastructure. The purpose of this study was to determine the role of women in vegetable production. For this research study the research was conducted in Tehsil Safdrabad. One union council was selected and in one union council 4 villages were selected through purposive sampling technique (based on intensive women involvement in vegetable growers). A list of women vegetable growers was prepared with the help of Agricultural Officer (AO) Ext and 27 vegetable growers from the list were selected randomly from each village. The sample size was 108.An interview schedule technique was developed for data collection. The collected data was analyzed through computer software Statistical Package for Social Sciences (SPSS) for drawing conclusions and formulating the recommendations. Descriptive and inferential statistical techniques were applied for data analysis. It was found that the rural women had participation in agricultural activities i.e. seed cleaning (38.0%), sowing (40.7%), irrigating vegetables (48.1%), hoeing (67.6%), picking (100.0%), grading (81.5%) and packing (79.6%). Women had also participation in food processing i.e. making beard (78.7%), dough making (75.9%), making curry (88.9%). Govt. give schemes to the rural women, implement laws and regulations for women and gender biased attitude should be vanished.

Keywords: Gender role, Food security, Women vegetable growers

EFFECT OF PGRs ON VEGETATIVE AND REPRODUCTIVE TRAITS OF BITTER GOURD (*Momordica charantia* L.): A FIELD ASSESSMENT

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ABSTRACT

Bitter gourd (*Momordica charantia* L.) is a popular vegetable grown as field crop and backyard vegetable in various Asian countries. A field assessment was accomplished to find the potential effects of plant growth regulators (PGRs) on bitter gourd cv. "Faisalabad Long" productivity. Data on different vegetative and reproductive traits was taken under RCBD with experimental units in triplicates. According to the results, T_0 (control) took maximum days to flower followed by T_2 (GA_3 @ 200 ppm). Both T_1 (IAA @ 200 ppm) and T_3 (IAA 100 + GA_3 50 ppm) took minimum days to flowering and induced higher male and female flower ratio, enhanced number of nodes and considerable increase in plant height. While, maximum fruit length, seed yield per vine were observed in T_1 and T_2. Fruit yield and number of fruits plant^{-1} was higher in T_1 followed by T_3 and T_2 respectively. Single fruit weight was same in both T_2 and T_3. All treatments indicated similar results for number of male and female flower plant^{-1} as compared to control. However, PGRs did not influenced the number of branches plant^{-1}. Maximum number of days to first harvest were observed in T_0 (control) with similar response among other treatments. While, minimum days to first harvest and maximum fruit diameter were recorded in T_2 (IAA @ 200 ppm) plants. Overall, it has been concluded that application of IAA and GA3 has significantly furnished the biological traits and yield of Bitter gourd (*Momordica charantia* L.).

Keywords: Bitter gourd, *Momordica charantia*, Plant growth regulator, IAA, GA_3

ROLE OF GLYCINE BETAINE IN ALLEVIATING THE ADVERSE EFFECTS OF HEAT STRESS IN CHILLIES

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ABSTRACT

Chilli (*Capsicum frutescence*) is the second largely consumed vegetable in the world and belong to the family *Solanaceae*. Various stages of chilli plant are affected by high temperature which leads to economic yield losses in fruit production. The present study was designed to evaluate the various morphological and physiological attributes in chilli genotypes. Research was conducted in growth room of mushroom lab at Institute of Horticultural Sciences, University of Agriculture, Faisalabad. Seeds of 15 chilli genotypes were sown in medium sized plastic pots, filled with sand, which were irrigated according to the requirement of plants. Experiment was performed with four replications. After seed sowing, Hoagland's nutrient solution with half strength (0.5) was used for nourishment. Heat stress was applied four weeks after emergence by increasing 2ºC/day temperatures up to 40/32ºC day and night temperature. Chilli plants were kept at 40/32ºC day and night temperature for one week. After attaining desired high temperature, different levels (0, 5, 10 and 15 mM) of glycine betaine were sprayed on the chilli seedlings. Seven days after glycine betaine application, plants were harvested for analyzing various parameters. The research findings concluded that glycine betaine showed mitigating effects of heat stress on morphological and physiological parameters like photosynthetic measurements, cholrophlyll contents and transpiration rate, sub stomatal CO_2, leaf surface temperature and water use efficiency.

Keywords: Chilli, Hoagland's nutrient solution, Glycine betaine, Heat stress

CREASING IN SWEET ORANGE: THE ROLE OF AMINOETHOXYVINYLGLYCINE

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ABSTRACT

Creasing is a physiological disorder of rind in sweet orange [*Citrus sinensis* (L.) Osbeck] fruit and causes serious economic losses in various countries of the world. The reversible inhibitor of ethylene, aminoethoxyvinylglycine (AVG) with the effects of different concentrations (0, 20, 40 and 60 mgL^{-1}) AVG with 0.05% 'Tween 20' as a surfactant applied at the fruit set, the golf ball or at the colour break stage on controlling creasing, rheological properties of fruit and rind as well as fruit quality in of Washington Navel and Lane Late sweet orange was investigated. Creasing was substantially reduced and fruit quality was improved with the exogenous application of AVG depending upon its concentration and stage of application in both cultivars. The spray application of AVG (60 mg L^{-1}) at the golf ball stage was effective in reducing creasing (27.86% and 24.29%) compared to the control (52.14 and 51.53%) in cv. Washington Navel during 2011 and 2012, respectively. Whilst, in cv. Lane Late lowest creasing was observed, When AVG was applied at fruit set stage (22.86%) compared to the control (51.43%) during 2012. In cv. Washington Navel, AVG treatment (60 mgL^{-1}) was more effective to increase the fruit firmness (318.97 N) and rind hardness (25.94 N), when applied at fruit set stage. However, rind tensile strength was higher, when AVG was applied at the golf ball stage (54.13 N). In cv. Lane Late, the rind harness (28.61 N), rind tensile strength (78.82 N) was also higher, when AVG was sprayed at fruit set stage. Whilst, the fruit compression force (369.68 N) was higher when AVG was applied at the golf ball stage. Similarly, the treatment AVG (60 mgL^{-1}) was more effective in improving fruit weight (281.00 and 298.50 g) and fruit diameter (87.30 and 82.69 mm), rind thickness (5.56 and 5.38 mm) and total sugars (15.27 $mg.100ml^{-1}$) when AVG was applied at the fruit golf ball stage in cv. Washington Navel and Lane Late, respectively. Similarly, rind harness (25.94 and 28.61 N), total antioxidants (45.30 and 46.48 mM trolo × 100 ml^{-1}), total sugars (13.64 and 15.27 mg 100 ml^{-1}), citric acid (1.66 and 1.32 mg 100 ml^{-1}), malic acid (0.36 and 0.63 mg 100 ml^{-1}) and succinic acid (0.35 and 0.38 mg 100 ml^{-1}) were also higher, when AVG was applied at the fruit set stage in both cultivars. In conclusion, the exogenous applications of AVG substantially reduces the creasing incidence, improves rheological properties of fruit and rind as well as fruit quality in Washington Navel and Lane Late sweet orange fruit.

Keywords: AVG, Creasing, Ethylene inhibitor, Fruit quality, Sweet orange

FRUIT QUALITY OF SWEET ORANGES (*Citrus sinensis* L. OSBECK) IN RELATION TO TREE AGE

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ABSTRACT

Amongst citrus species, sweet orange (*Citrus sinensis* L. Osbeck) occupies a dominant position in the orange producing countries in the world. Sweet orange is widely consumed both as fresh fruit as well as juice and its global demand is attributed due to higher vitamin C and antioxidants. Fruit quality is most important for the external appearance and marketability of sweet orange fruit especially for fresh consumption. There are so many factors affecting fruit quality, tree age is the most important one, but remains unexplored so far. The present study, we investigated the role of tree age on fruit quality of different cultivars of sweet oranges. The difference between fruit quality of 5-year young and 15-year old trees was discussed in the current study. In case of fruit weight, maximum fruit weight (238 g) was recorded in 15-year old sweet orange cv. Sallustiana cultivar while minimum fruit weight (142 g) was recorded in 5-year young tree of Succari sweet orange fruit. The results of the fruit diameter showed that the maximum fruit diameter (77.142 mm) was recorded in 15-year old Sallustiana orange but the minimum fruit diameter (66.046 mm) was observed in 5-year young tree of sweet orange cv. Succari. The minimum value of rind thickness (4.142 mm) was noted in 15-year old tree of cv. Red blood. On the other hand maximum value of rind thickness was observed in 5-year young tree of cv. Sallustiana. The data regarding total soluble solids (TSS), acidity (TA), TSS/TA, juice content, rind, flavedo thickness, pH and fruit diameter have also been discussed.

Keyword: Tree age, Cultivars, Fruit, Quality, Sweet orange

ROLE OF PLANT GROWTH PROMOTING RHIZOBACTERIA (PGPR) TO INCREASE ESSENTIAL OIL PRODUCTION IN *Rosa damascena*

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ABSTRACT

The role of plant growth promoting rhizobacteria (PGPR) for improving yield and essential oil contents in *Rosa damascena* was evaluated in this study. PGPR strains LSI_{19}, F_6 and LC_4 were selected for a field experiment in factorial arrangement under randomized complete block design (RCBD) with four replications. The experiment comprised of root application of eight combinations of PGPR treatments in the form of liquid inoculum along fertilizer treatments like zero NP, NP @ 30 and 10 g/m^2 and NP @ 60 and 20 g/m^2. Results regarding essential oil contents showed that highest concrete oil percentage (0.164) was found in treatment combination of F_6+LC_4+LSI_{19}+NP @ 30 and 10 g/m^2 (which was increased up to 19.77%) when compared to un-inoculated control with no fertilizer. In the same way, 26.11% increase in absolute oil contents percentage was observed in F_6+LC_4+LSI_{19}+NP @ 30 and 10 g/m^2. Therefore, components of essential oil like citronellol, phenethyl alcohol, geranial, methyl eugenol, linalool, citral, geranyl acetate and farnesol showed improvement in PGPR combination of F_6, LC_4 and LSI_{19} and NP fertilization @ 30 and 10 g/m^2 when compared with other treatments. It was also observed that increasing levels of nutrients (NP fertilization @ 60 and 20 g/m^2) have negative effect on oil contents. It is quite clear from the study that PGPR strains had the potential to essential oil contents of damask rose and may help to reduce the usage of fertilizers.

Keywords: *Rosa damascena*, Essential oil, PGPRs, Fertilizers

EFFECT OF DIFFERENT WASTE MATERIAL AS GROWING MEDIA ON GROWTH AND FLOWERING OF CARNATION (*Dianthus caryophyllus*) CV.'MORA SANT'

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ABSTRACT

Carnation (*Dianthus caryophyllus*) is an important and popular cut flower grown all over the world. In present work, effect of different growing media was studied on growth and development of carnation cv Mora sant in green house. Four growing media comprising silt, farm yard manure (FYM), leaf compost (LC) and spent mushroom compost (SMC) in different combinations were used. Experiment consisted of twelve treatments with three repeats arranged in Completely Randomized Design. Several parameters like plant height (cm), number of branches per plant, length of branches (cm), days to flower emergence (days), number of flowers per plant, flower diameter (cm), and flower quality were examined among other parameters. The nutrition level (NPK) along with EC and pH of each medium were also determined. Vegetative growth indices of carnation plants were significantly improved by treatment T_{10} comprising silt, FYM, and leaf compost. Likewise, increased number of flowers per plant and bigger sized flowers with better quality were also produced in combination of silt, FYM, and leaf compost (T_{10}). The chemical analysis of growth media for determination of nutrition level (NPK) showed that combination of silt, FYM, and leaf compost (T_{10}) had more available nutrients which contributed in better vegetative and floral growth of carnation plants and can be added to potting media for commercial production of carnation. Leaf compost and FYM provided positive results for vegetative and reproductive growth of plants, therefore, recommended as a standard potting media for commercial production of Carnation.

Keywords: Organic media, Carnation, Flowering, Growth

EVALUATION OF DIFFERENT ROOTSTOCKS AND GRAFTING TECHNIQUES IN WATERMELON FOR CLIMATE RESILIENCE

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ABSTRACT

Watermelon is profoundly nutritive natural product. Its development and improvement is sensitive to different biotic and abiotic stresses such as nutrient, drought, salinity, pathogens and insect pest. Vegetable grafting is a futuristic technique to address such climate change related issues. An experiment was conducted to assess different cucurbits as rootstocks and grafting methods for optimize grafting technique and rootstock for vegetative propagation of watermelon. Five rootstocks including RS_1: Pumpkin (*Cucurbita pepo* L), RS_2: Kachri (*Cucumus melo* L. ssp. Agrestis), RS3: Bitter gourd (*Momordica charantia*), RS4: Bottle gourd (*Lagenaria siceraria*) and RS5: Luffa (*Luffa aegyptiaca* and *acutangula*) were subjected to three diverse grafting systems G_1: Tongue uniting G_2: Cleft grafting and G_3: Splice/Single cotyledon grafting. The execution assessment was done on the basis of different growth parameters. Overall, bottle gourd (RS_4) had significantly higher germination percentage. Among the grafting techniques, cleft grafting was found better and showed high compatibility with bottle gourd rootstock. This paper provides detailed account of investigations based upon vegetative growth.

Keywords: *Citrullus lanatus,* Vegetable grafting, Scion, Propagation, Salinity, Climate change

OPTIMIZATION OF INDOLE-3-BUTYRIC ACID (IBA) FOR INDUCING ROOTING: IN VITRO GROWN PLANTS OF ORCHIDS (*Dendrobium sabin* H.)

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ABSTRACT

Orchids are widely grown around the world with 8% share in world floriculture industry and they are commercially propagated by tissue culture. In vitro grown plants have usually problems with root regeneration. The present study was aimed to study the role of plant hormones in root initiation of in vitro grown orchids (*Dendrobium sabin* H.). Different concentrations of indole-3-butyric acid (IBA) (0, 0.5, 1.0, and 1.5, 2.0, 2.5 and 3 mM) on basal Murashige and Skoog (MS) medium were used. 1 mM IBA was found to be the best as significantly higher root length (0.96 cm) was achieved 40 days after culturing. It also required less days (11.0 days) for root initiation in orchids (*Dendrobium sabin* H.) plantlets on MS medium supplemented with 1 mM IBA. It is concluded that 1 mM IBA is effective in inducing rooting in orchids (*Dendrobium sabin* H.) as compared to other treatments.

Keywords: Orchard, IBA, Rooting media

EFFECT OF ZINC NANOPARTICLES ON SEED PRIMING, GROWTH AND PRODUCTION OF CUCUMBER

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ABSTRACT

Cucumber (*Cucumis sativus* L.) is an important vegetable and its demand remains around the year. High quality and yield are desired quality for both grower and consumers. Therefore, influence of seed priming and foliar application of zinc nano particles was checked on yield and quality of cucumber. ZnO nano particles are non-toxic and recently listed as "Generally Recognized as Safe (GRAS)" safe material by food and drug administration and use as food additive. Due to interaction of nano particles with plant, many physiological and morphological changes take place depending on the characteristic of Nanoparticles. By the exploitation of new application of nanotechnology crop yield can be increased. In plants, nano particles as a zinc fertilizer with small size and large surface area are predicted to be an ideal material to use. Zinc is one of the vital nutrients required for plant growth Result indicate that zinc nano particles at 20 ppm concentration increased seed germination as well as physical parameters plant height, number of leaves, leaf area, number of flower, yield, fruit weight, fruit length, fruit diameter, average single fruit weight, fruit firmness and fruit color was increased. Furthermore, chemical parameters like total soluble solids, ascorbic acid and titratable acidity was increased at 20 ppm zinc nano particles as compared to control and other treatments. Present research proves that seed priming and foliar application of zinc nano particles are effective for improving fruit physical and chemical characteristics. The finding of this research work will be helpful in future research on utilization of nano particles for vegetable crops.

Keywords: Cucumber, Zinc, Qaulity traits

EFFECT OF COPPER NANOPARTICLES ON QUALITY ENHANCEMENT OF SWEET PEPPER

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ABSTRACT

Sweet pepper (*Capsicum annum* L.) is a main group of Solanaceous family. Sweet peppers are a great source of vitamin C. Sweet pepper found in different colors and vary in flavor. It is used in culinary and salads. Nanotechnology is capable of enhancing agricultural production and food security insurance. The present study was conducted for determination of possible role of copper nanoparticles for increasing germination of sweet pepper while copper nanoparticles were use as foliar sprays to enhance the growth and production of sweet pepper. Regarding germination percentage, the application of 20 ppm Cu NPs gave (95%) best results as compare to 30 ppm (85%), 40 ppm (60%) and control (40%). In preharvest treatment, among different concentrations of Cu NPs, it was noted that 20 ppm Cu NPs had the most significant affects. It considerably enhanced of all pre and post-harvest parameters as compare to 30 ppm, 40 ppm and control except then weight loss. It was minimum at 20 ppm Cu NPs other concentrations. The finding of this research would be helpful for future studies regarding the quality enhancement of commercially grown vegetables.

Keywords: Sweet pepper, Copper nano-particles, Qaulity attributes

F. ALLELOPATHY

USE OF ALLELOPETHIC EXTRACTS FOR INCREASING WHEAT PRODUCTIVITY

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ABSTRACT

Allelopathy is an eco-friendly science which has emerged as a vital area of research during last few decades. We have conducted series of experiments at various experimental stations and progressive farmers' fields. In these experiments, we have used sorghum, garlic and brinjal extracts at low concentrations on wheat crops (2 to 3%). These extracts were sprayed at tillering and booting stage. Results showed increase in growth of the crop in terms of more tillering, spikelets and more and heavier grains. Wheat grain yield was increased by 15 to 30%. In conclusion, use of allelopathic plant water extracts is highly economical and environmental friendly option to boost wheat productivity.

Keywords: Allelopathy, Wheat yield, Growth promotion, Farmer field

HORSE PURSLANE AND JUNGLE RICE MANAGEMENT THROUGH THE APPLICATION OF SORGHUM AND BRASSICA WATER EXTRACT

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ABSTRACT

This study was investigated to control the most problematic weeds, Horse purslane and Jungle rice of cotton through exploiting the natural herbicides. These two are major weeds in all the cotton growing areas of Pakistan. Allelopathy has been well documented natural phenomenon offering fair weed control in our agro-ecosystems. Sorghum and brassica are most potent allelopathic crops, which possesses a wide range of allelochemicals. Herbicidal potential of sorghum and brassica water extracts (SBWE) against the major weeds, Horse purslane and Jungle rice of cotton were investigated in a field experiment at Agronomic research area, University of Agriculture, Faisalabad. Combinations of SBWE each at 16 L ha^{-1} were sprayed alone and in combination as a tank mixture with $1/3^{rd}$ and $1/4^{th}$ doses of two commercial herbicides, pendimethalin (0.625 and 0.416 kg a.i ha^{-1}) and s-metolachlor (1.075 and 0.716 kg a.i ha^{-1}). For the purpose of comparison, recommended doses of pendimethalin (1.25 a.i. ha^{-1}) and S-metolachlor (2.15 a.i. ha^{-1}) were also sprayed. Whereas, as a control as weedy check treatment where nothing was sprayed was also included in the experiment. Reduced doses ($1/3^{rd}$) of both herbicides in combination with SBWE gave nearly the same level of Horse purslane and Jungle rice density and biomass reduction as given by the recommended doses of herbicides. Furthermore, sole dose of combination of SBWE each at 16 L ha^{-1} also gave a fairly good result to be used for the purpose. So, it is concluded that allelopathy can be engaged for efficient management of Horse purslane and Jungle rice weeds of cotton in agro-ecological conditions of Faisalabad. Ultimately, allelopathy provides a good alternative to synthetic herbicides for weed management in a sustainable agriculture system.

Keywords: Horse purslane, Jungle rice, Cotton herbicides, Sorghum and brassica water extract

PHENOTYPIC PLASTICITY OF CHICKPEA ASSOCIATED WEEDS UNDER VARYING DENSITIES OF CHICKPEA

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ABSTRACT

Chickpea (*Cicer arietinum* L.) is an important legume crop which is grown all over the world and it is third most important legume crop around the world. In Pakistan, production of chickpea is less due to different agents like disease, insect pest attack and weeds. The weeds compete with crop for light, water, nutrients and space. The density of crop and weed growth stage are inter related with each other. This study was conducted to check the effect of chickpea density and weed duration on production and yield of chickpea crop. Five plant densities of chickpea viz. 0, 4, 8, 12, 16 plants in each plot were maintained. Besides, the seeds of four weeds viz. littelseed canarygrass, broadleaf dock, red pigweed and sinji were sown on different durations of time viz. 0, 2, 4, 6 and 8 weeks after sowing of the chickpea crop. The results of this study showed that number of leaves, plant height, number of branches per plant, leaf biomass, shoot weight and root weight for weed plants was more in control plots where no chickpea seed was sown; while weeds perform very poor where the density of chickpea was more than 16 plants per plot. The performance of chickpea plants was also effect by the density and duration of weeds. The plant height of chickpea plants was more where the chickpea plant density was 8 plants per plot. The number of pods per plant, number of branches per plant, plant biomass, number of grains per plant and grain weight was found more where chickpea plant density was 12 plants per plot. The weed seed which were sown during 0, 2 and 4 weeks after sowing of chickpea crop affected the chickpea crop more than the weed seed sown during the 6 and 8 weeks after sowing.

Keywords: Weeds, Chickpea, Allelopathy

ROLE OF ALLELOPATHY IN ABIOTIC STRESS TOLERANCE IN WHEAT

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ABSTRACT

The present study was conducted to unravel the mechanism of terminal drought and heat tolerance in wheat induced by AWEs applied alone or in various combinations, through foliar spray or seed priming. The seeds of two wheat cultivar (Mairaj-2008 and Faisalabad-2008) were sown in 10 kg soil filled pots. Experiment 1 and III were sown on November 22, 2013, whereas experiments II and IV were sown on November 25, 2013. In experiment I and II, both wheat cultivars were raised under ambient condition in the wire house till leaf boot stage by maintaining pots at 75% water holding capacity (WHC; -15 kPa soil water potential). Then managed drought stress was imposed by maintaining pots at 35% WHC (-25 kPa soil water potential), at booting and anthesis stage. In experiment III and IV, both wheat cultivars were raised under ambient condition in the wire house till leaf boot stage by maintaining pots at 75% WHC (-15 kPa soil water potential). Then heat stress was imposed at booting and anthesis stage by shifting pots in glass canopies, maintaining their moisture level at 75% WHC (-15 kPa soil water potential). In experiment I and III, seeds were primed with 3% aqueous solution of AWEs [sunflower (SunWE), sorghum (SWE), brassica (BWE) and moringa (MWE)] before sowing and then drought and heat stress was applied at booting and anthesis stage. In experiment II, and IV, drought and heat stress was imposed at booting and anthesis stages after one week of application of 3% aqueous solution of AWEs (sunflower, sorghum, brassica and moringa) alone or in various combination. The results indicated that seed priming or foliar application of AWEs was effective for improvement in biochemical and yield related traits under terminal drought or heat stress. In crux, exogenous application of allelopathic water extracts might improve terminal drought and heat tolerance in bread wheat.

Keywords: Heat, Drought, Wheat, Allelopathy, Phenolics, Proline, Stay green, Grain filling

EVALUATING THE RESPONSE OF EUCALYPTUS EXTRACT AGAINST THE SEEDLING DEVELOPMENT OF WHEAT AND CHICKPEA

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ABSTRACT

Effect of eucalyptus extracts (EE) on seedling growth of wheat and chickpea was investigated at Department of Agronomy, Bahauddin Zakariya University, Multan. Various eucalyptus species release sufficient quantities of allelochemicals like terpenes, phenylpropanoids, quinones, coumarins, flavonoids, tannins and phenolic acids that show inhibitory effects on the neighboring plants. Eucalyptus extract at different concentrations 1%, 1.5%, 2%, 2.5% and 3% were foliar sprayed on the two test species from monocot and dicot family i.e. wheat and chickpea respectively. Seeds were sown in pre-washed sand filled pots in completely randomized design with three replications. For the purpose of comparison water and 5 ppm *6-Benzylaminopurine* (BAP) solution were also sprayed. Different parameters regarding shoot length, root length, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight and number of leaves were recorded after 20 days of foliar spray. All the applied EE foliar sprays exhibited inhibitory effects in all parameters except number of leaves where there was no difference among all the applied treatments. Inhibitory effect was increasing as we were increasing the concentration from 1% to 3%. While BAP also showed non-significant results in all the seedling parameters when compared to control (water spray) treatment. From the results we can conclude that EE has strong negative impact on the seedling development of crops.

Keywords: Allelopathy, Eucalyptus extract, Seedling establishment, Chickpea, Wheat

EXPLORING THE ALLELOPATHIC POTENTIAL OF PLANTS

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ABSTRACT

Indiscriminate pesticide usage has fabricated harsh effects on environment, human and animal health. Employing allelopathy for pest management in cropping system may give safe, economical and environment friendly substitute to heavy pesticide usage. Allelopathic plants affect the growth of pests through release of plant secondary metabolites (allelochemicals). Therefore, a study was conducted to screen out the allelopathic potential of plants. For this study, 382 plants from 88 families were collected from different locations of including Faisalabad, Layyah, Peshawar and Bahawalpur. Allelopathic potential of selected plants were evaluated using bioassays including plant sandwich method, water extract agar method and acetone extract agar method. It was noted that root inhibition was higher than that of the shoot inhibition in all the tests. Fifteen plant species including *Helianthus annuus*, *Melaleuca leucaderdendla*, *Epipremnum aureum*, *Brassica oleracea* –leaves, *Flacourtia indica*, *Sorghum bicolor*, *Rosa indica*, *Peganum harmala*, *Carica papaya*, *Avena sativa*, *Solanum melongena*, *Polyalthia longifolias*, *Tinospora Cordifolia*, *Allium sativum*, *Heliotropium Indicum*, and *Psoralea corylifolia* exhibited highest allelopathic activity. Eighty-eight plants showed more than 70% inhibition in all three bioassays and 136 plants showed more than 70% inhibition in at least two bioassays and 108 plants showed more than 70% inhibition in at least one bioassays. Only 37 plants could not cause more than 70% inhibition in any bioassay. The results also show that out of 191 plant extracts having higher phenolic contents than average extracts of 172 species displayed more than 70% inhibition on cress radicle in at least one bioassay which may be attributed to the involvement of phenolic in radicle inhibition. Further studies are required to explore the bioactive compounds in screened plant.

Keywords: Allelopathy, Allelopathic potential, Screening, Plant sandwich method

SUPPRESSIVE POTENTIAL OF SOME KHARIF SEASON CROPS AGAINST WEEDS

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ABSTRACT

In all cropping systems, weeds are a key biotic constraint. In weeds, the rapidly increasing, phenomenon is herbicide resistance is major factor contributing towards higher production cost. The ability of crops or cultivars to suppress weed growth has become cost-effective in current pressures. The present study was designed to explore the possible suppressive potential of different crops. During field study, different crops i.e. maize, sorghum, pearl millet, mung bean and mashbean were sown under the natural weeds pressure at farmer's field, Dera Ghazi Khan, Punjab Pakistan. For comparison, non-crop plot was also included. Weeds flora of experimental site comprised of *Cyperus rotundus, Euphorbia granulata, Echinochloa colonum, Echinochloa crusgalli, Corchorus tridens, Trianthema portulacastrum, Physalis minima, Convolvulus arvensis, Mukia maderaspatana,* and *Dactyloctenium aegyptium.* At experimental site, dominant weed was *Echinochloa colonum*. These weeds were significantly suppressed by the trial crops i.e. maize, sorghum, pearl millet, mung bean and mashbean compared to control. Sorghum and pearl millet inhibited all weeds effectively (73% *E. colonum* control a dominant weed), however, other crops showed lower suppressive potential but significant than control (9-59% *E. colonum* control). Highest inhibition was noted in density, shoot length, fresh and dry weights in sorghum and millet treatments. In crop inhibitory potential, maize was the least effective for controlling above weeds parameters (9% *E. colonum* control). Millet and mashbean reasonably inhibited various weeds. *E. colonum* has competitive ability with crops. Maize and mashbean were found least affective against these weeds.

Keywords: Allelopathy, Autumn crops, Suppression, Weeds

INFLUENCES OF DIFFERENT WHEAT (*Triticum aestivum* L.) AND EGYPTIAN CLOVER (*Trifolium alexandrinum* L.) BASED ROTATIONS ON PEST PRESSURE, SOIL HEALTH, AND SYSTEM PRODUCTIVITY

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ABSTRACT

Monocropping system have negative impact on the ecology that not only decreases yield but also badly affect the soil health/soil biota, increase the pest population and provide the habitat to weeds on the same crops. Although this system produce high yields they cause considerable environmental harm, including soil degradation reduction in soil organic matter emission of greenhouse gases and negative effects on natural ecosystems due to pesticides and fertilizers.. Interactions between crops are an important component of how changes in cropping systems impact on their agro-economic and environmental performance. Fertilization, nitrogen mineralization, nitrate leaching, greenhouse-gas emissions, infestations with pests, diseases, weeds, and eventual crop yield are all affected not only by the management of the individual crops but also by long-term processes that are influenced by crop sequence. Crop rotation improve the soil structure, enhance the production levels, to reduce the effect of soil microbial or fungal populations and plant disease pressure and also minimize weed infestation or allelopathic effects, interactions of different crops release allelochemicals that have positive or negative impacts on crops, enhance the activity of soil biota and increase the productivity of the crops. A series of experiments will be conducted to study the effect of different wheat and Egyptian clover based rotations on the soil health, system productivity and pest pressure. Moreover, allelochemicals produced from roots of different crops will be identified. This study will help in selection of suitable crop rotation with berseem and wheat on the basis of low weed density, insect and disease attach. Moreover, it will help in identification and isolation of allelochemicals responsible for promotion /inhibition of pest growth.

Keywords: Sequential cropping, Weed infestation, Biotic stresses

APPLICATION OF SORGHUM AND MULBERRY WATER EXTRACTS SUPPRESS WEEDS IN WHEAT CROP

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ABSTRACT

Wheat is an important cereal crop which has been used since ancient time as main food because of its nutritional importance as most of the human body needs are met by this crop. Weed infestation in wheat crop not only reduce the yield but also affects efficiency of other production factors but it is not possible to absolutely avoid from weed infestation. Allelopathy is sustainable and environmental friendly approach for controlling weeds, diseases and other abiotic stresses. Field experiment was conducted to evaluate allelopathic effect of sorghum water extract (SWE) and mulberry water extracts (MWE) applied at 18, 27 and 36 L ha^{-1} against noxious weeds like *Phalaris minor* Retz., *Chenopodium album*. L., *Avena fatua* L. and *Convolvulus arvensis* L. in wheat crop at University of Agriculture, Faisalabad. Experiment was conducted in randomized complete block design having four replications. Weedy check plot was kept for comparison. All treatment combinations controlled weed density, dry weight and improved grain yield of wheat and provided relatively higher net benefits and maximum marginal rate of returns. Application of SWE at 18 L ha^{-1} and MWE at 18 L ha^{-1} showed 51-55% weed control and increased wheat grain yield up to 28% as compared to control treatment. This trend was followed by application of SWE at 27 L ha^{-1} and MWE at 9 L ha^{-1} with 44-48% weed control and increase in yield up to 20% while standard herbicide (Atlantis) gave weed control by 66-68% with 32% increase in crop yield. SWE relatively better to suppress total weed biomass and enhance grain yield then MWE. Combination of SWE at 18 L ha^{-1} and MWE at 18 L ha^{-1} was the best treatment with highest net benefit and marginal rate of return while herbicide and hand weeding were uneconomical due to higher cost and lower net benefits.

Keywords: Allelopathy, Wheat, Water extracts, Weeds, Yield

Parthenium hysterophorus: AN INVASIVE WEED NEEDS ATTENTION

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ABSTRACT

Parthenium hysterophorus is an aggressive, ubiquitous and invasive weed having allelopathic effect belongs to Asteracaea family. It is emerging as threat to agriculture, contributing degradation of ecosystem, biodiversity and land drastically. It has been spreading like wildfire in different parts of world due to its high adaptability towards climate, high germination rate, prolific seed production and seed dispersal dynamics. It is enormously detrimental to heath of flora and fauna. It may reduce productivity of crops thus a serious threat to food security in long run. Management strategies for this weed are not enough fruitful yet, that is why its population is increasing at alarmingly rate. However, recent studies revealed that it is boon instead of curse due to its industrial (bioremediation of heavy metals and dyes), agricultural (insecticidal, nematicidal, herbicidal properties, high quality animal feed and composting etc.) and medicinal (antidiabetic, antioxidant, antitumor and antimalarial) applications. Although a large number of agricultural and environmental scientists reported adverse effects of parthenium on crops and ecosystem, yet many of the researchers have put up its merits for the betterment of the human society, crop production and improvement of ecology. Henceforth, one can conclude that abundantly growing weed has considerable benefits for humanity and it should be used after in-depth study and research.

Keywords: Congress weed, Invasion, Extension approach

APPLICATION OF MORINGA LEAF EXTRACT IMPROVES THE GROWTH OF MORINGA SEEDLINGS UNDER CHILLING STRESS

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ABSTRACT

Chilling temperatures result in various physiological and metabolic disturbances in cells of plants which are sensitive to low temperatures. Moringa is getting popularity as a field crop for its multidimensional uses. Present study was planned to test the performance of moringa seedling under chilling stress in response to foliar application of moringa leaf extract (3%), hydrogen peroxide (50 ml L^{-1}), ascorbic acid (50 ml L^{-1}) and salicylic acid (50 ml L^{-1}). The experiment was conducted in completely randomized design with factorial arrangements having three replications at old Botanical Garden, Department of Botany, University of agriculture, Faisalabad, Pakistan. Seeds of six accessions of moringa were collected from different locations and seedlings were grown in polythene bags filled with equal ratio of compost, sand, silt and soil. All foliar treatments were applied twice after one and two months of sowing. Growth traits and biochemical parameters were recorded after one week of second round of treatment application by using standard procedures. Number of branches, number of compound leaves per plant and number of leaflets of compound leaf were improved by 39%, 39% and 54% respectively by foliar application of moringa leaf extract at 3% as compared to control. Leaf total chlorophyll contents, leaf phenolic contents and membrane stability index were also improved by 73%, 53% and 57% respectively by foliar application of moringa leaf extract. There was no significant difference among different accessions. Vigorous growth of moringa seedlings under chilling stress ensures the defensive potential of moringa leaf extract against chilling stress.

Keywords: Moringa, Allelopathy, Chilling stress

MORPHOLOGICAL AND PHYSIOLOGICAL RESPONSE OF MAIZE BY APPLYING VARIOUS PLANTS AQUEOUS EXTRACTS

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ABSTRACT

An experiment was conducted at Research Laboratory of Department of Agronomy, Faculty of Agriculture to investigate the allelopathic response of various plants extracts on the morphology and physiology of maize. The experiment was laid out in completely randomized design having three replications. Ten treatments applied were -neem (*Azadirachta indica* L.), eucalyptus (*Eucalyptus camaldulensis* L.), tobacco (*Nicotiana tobacum* L.), backyn (*Melia azadirach* L.), acacia (*Acacia arabica* L.), poplar (*Populous deltoids* L.), sunflower (*Helianthus annuus* L.), jaman *(Syzygium cumini* L.), kreeta (*Capparis decidua* L.) and distilled water (control) for irrigation. Tobacco and sunflower extracts was prepared by grinding the mature dry leaves while all other plants extracts were prepared by grinding the mature dry stem peel and their 20% solution was obtained. The extracts were applied after 72 hours according the water needs of plants till 30 days. The data was recorded after 15 and 30 days of sowing regarding the parameters like germination percentage, root shoot ratio, root length, stem length, fresh weight of plants, dry weight of plants, plant height, chlorophyll content, number of leaves per plant and leaf area. The statistical analysis showed that all the parameters studied were influenced badly by the application of neem, sufaida and tobacco aqueous extracts which means that maize plants showed poor morphological and physiological growth against these solutions after 15 and 30 days of sowing. Least allelopathic response was noted by the use of Jaman and Kreeta extract after control.

Keyword: Plants extracts, Allelopathic response, Maize growth inhibition

INVIGORATION OF CHICKPEA AND WHEAT SEEDLING BY FOLIAR APPLICATION OF BRASSICA EXTRACT

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ABSTRACT

Brassica spp. are considered as strong allelopathic plants due to the presence of active allelochemicals. Brassinolide is naturally occurring allelochemical present in brassica which promote growth at very low concentration. So, stimulatory allelopathic effect of brassica can be exploited to develop cheap, eco-friendly and active growth promoters. To study the effects of brassica extract (BE) on the seedling development of chickpea (*Cicer arietinum* L.) and wheat (*Triticum aestivum* L.), an experiment was conducted at Department of Agronomy, Bahauddin Zakariya University Multan Pakistan. Both plant species were sown in small pots filled with pre-washed sand and were arranged in completely randomized design with eight treatments and three replications. Foliar applications of BE at 1%, 1.5%, 2%, 2.5% and 3% were done at 15 days after sowing. For comparison, a water spray and 5 ppm *6-Benzylaminopurine* (BAP) solution was also applied. Parameters regarding shoot length, root length, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight and number of leaves were recorded after 20 days of foliar spray. All the foliar sprays showed significant variation among the recorded parameters however; best results were observed where 3% BE was sprayed on both chickpea and wheat crops. From the results, we may conclude that brassica extract can play a vital role in seedling establishment of field crops that ultimately lead towards better crop growth.

Keywords: Allelopathy, Brassica extract, Seedling establishment, Chickpea, Wheat

SEED PRIMING WITH SORGHUM WATER EXTRACTS AND CALCIUM CHLORIDE IMPROVES THE STAND ESTABLISHEMENT AND SEEDLING GROWTH OF SUNFLOWER AND MAIZE

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ABSTRACT

This study investigated that potential of seed priming with sorghum water extract in improving the seedlings establishment and early seedling growth of sunflower and maize. The experiments consisted of following treatments viz. i) control, ii) hydropriming, iii) seed priming with 1% sorghum water extract (SWE), iv) seed priming with 1.5% SWE, v) seed priming with 2% SWE, vi) seed priming with 2.5% SWE, vii) seed priming with 3% SWE, and viii) seed priming with calcium chloride (1%). This study indicated that various seed priming treatments significantly affected the number of leaves per plant, plant height, root length, shoot length, root dry weight and shoot dry weight of sunflower and maize. Seed priming with 1-1.5% sorghum water extract and calcium chloride was beneficial for improvement in root/shoot dry weight in maize. In sunflower, root dry weight was the highest when seeds were primed with 2.5% sorghum water extract; root dry weight was the highest with calcium chloride seed priming, while seed priming with either concentration of sorghum water extract was equally beneficial for improvement in shoot dry weight in sunflower. In crux, seed priming with calcium chloride and sorghum water extract (1-3%) should be opted to improve the seedling growth of maize and sunflower. The choice of seed priming osmotica can be made on the basis of source of osmotica easily available at farmer field.

Keywords: Sorghum water extract, Seed priming, Sunflower, Maize, Germination

G. MISCELLANEOUS

DISCLOSOUR OF THE ISLAMIC BELIEVES IN LIFE SPAN, DEATH, RESURRECTION AND ACCOUNTABILITY IN THE LIGHT OF FASCINATING DISCOVERIES OF SCIENCE

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ABSTRACT

The study of modern science has assisted humanity in understanding many of the basic believes of Islam, in death, resurrection, accountability, and the storage capacity of body cells, organs, parts; and their retrieval on the Day of Judgment. Quran being the last Divine Revelation has foretold many of searchable areas to be explored over time including the huge storage capacity of human body cells, parts and its retrieval on the Day of Judgment. Quran has exemplified this huge reservoir as a Divine design of human being. Knowledge of modern science has assisted us in exploring and understanding this capability associated with DNA of human cells for carrying on lifelong instructions in a well-organized manner. The decoding of DNA from prehistoric carcasses and fossils has thus compelled the contemporary biologists, geneticists, and evolutionist for thinking in lines with Divine instructions as revealed by the Glorious Quran. Herein this article, few reference on the storage and retrieval capability of human body cells has been quoted from the Glorious Quran and explained in the terminology of modern science for the guidance of scientific community in particular and humanity in general.

Keywords: Belief, DNA, Exploration, Quran, Science, Religion, Torah, VMAT2

CLIMATE CHANGE PERCEPTION AND ADAPTATION BEHAVIOUR AMONG RURAL COMMUNITY OF KOT ADDU, SOUTH PUNJAB

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ABSTRACT

Climate change has been emerged as most critical issue globally and therefore, need of proper mitigation methods has become imminent to remit the issue worldwide. For controlling and mitigating the hazards effects of climate change, awareness and perception of public is essential. Climate change mitigation strategies cannot be successfully adaptable without the perception and awareness of rural people community. Reasons of climate change are well known, as the greenhouse gases and anthropogenic activities are warming our planet and resulting in change in climatic patterns. The paper analyzes the public perception and adaptability regarding the climatic change in the rural areas of Kot Addu, Southern Punjab, Pakistan. A questionnaire survey was designed to investigate the opinion of rural people of lower Punjab on climate change and its effects on their daily life. The questionnaire covers, effect on weather fluctuations, drought, flood, food scarcity and it impacts on growing seasons or mitigation strategies. The results indicated that rural people are well aware of changes in climatic patterns, and it effects on their daily household and farming activities. Adaptation of mitigation strategies will not only reduce the extremity of climate change effects on crop production but also improve the environment of rural areas.

Keywords: Climate change, Mitigation, Greenhouse gases, Anthropogenic activities

EATING GREEN AND CLEAN: MOTIVATION FOR ORGANIC FOOD FARMING

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ABSTRACT

Organic farming has become the center of attention for policy-makers, consumers, environmentalists and farmers in Europe and Asia, since the mid-1980s. Growing consumer concern for environment issues and health has resulted in increased attention towards the purchase and consumption of organic food. This has led to an increase in organic research to understand the motivations behind consumer purchases of organic goods. This study explored the effects of health consciousness, environment protection concern, organic knowledge, availability, quality, and price consciousness on organic attitudes, organic purchase intentions and organic purchase behaviour. A sample of 220 was used for data analysis. The results show that health consciousness, organic knowledge have significant impact on organic purchase intention and behaviour. While environment protection concern has less significant impact, which shows that people are less anxious about environment protection issues. So there is need to create awareness among people about this issue.

Keywords: Organic food, Environment protection, Health consciousness, Organic purchase

A STUDY TO REVEAL THE POTENTIAL ROLE OF SPIRITUAL LEADERSHIP IN MOBILIZATION OF THE COMMUNITIES REGARDING TREE PLANTATION

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ABSTRACT

Worldwide, spiritual leadership has an important role in social mobilization. Some researchers connected the role of spiritual leadership with social mobilization and development. In the movement of Pakistan, religious and spiritual leaders mobilized thousands of their followers to support two nations theory. Currently In Pakistan, there is a network of spiritual leaders and they are being followed by their followers with enthusiasm. Spiritual leaders, in Pakistan generally focus on spiritual development but their contribution in development and social mobilization of their followers is negligible. Spiritual leadership has a potential to improve all aspects of life, as it can also mobilize the people for tree plantation. Tree plantation is also supported by all the religions. Islam put great emphasizes on tree plantation and it considers tree plantation a virtue. Although, some institutions are working regarding tree plantation but their efforts are not up to the mark and if one look at decades back there is no significant increase in forest cover. According to FAO report, Pakistan's forest cover is only 2.2% of its total area. Owning to this situation, it is necessary to use the spiritual leadership to promote plantation. Promotion of tree plantation is necessary for environmental protection, food security and economy of the country. By engaging spiritual leadership in this sacred task, one can eliminate the environmental issues like, global warming, greenhouse effect, air pollution etc. It can also uplift the economy of country through timber export. It is therefore, suggested that before utilizing the role of spiritual leaders for social mobilization, the research should be conducted to explore the potential role of spiritual leaders in tree plantation through community mobilization.

Keywords: Spiritual leadership, Social mobilization, Tree plantation, Environmental issues

THE PROMOTION OF PULSES CULTIVATION AND AWARENESS FOR ITS NUTRITIVE VALUE AMONG THE FARMERS OF DISTRICT FAISALABAD

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ABSTRACT

With the increase of population in Pakistan, there is the dire need of producing food grains which are compulsory in the nourishment of the human body. In the countries where food is deficient such as in Pakistan, there is major problem of quantity and quality of nutritional protein. The experts are tied up day and night to resolve the issues of good quality and quantity of food. In this regard, experts get attention towards animals and different pulse crops to feed the better quality of nutritional protein to human being since long time. Pulses are full of protein and are easily available to the poor families very cheaply who cannot manage to pay for meat as a source of protein. As a result, these are also recognized as "poor men meat" in underdeveloped countries. In developed countries, on the other hand, where the public knows the significance of pulses, they considered them as healthy diet. The single way out to this issue is to furnish farmers with modern technologies and stimulate them to create more food within accessible resources. Most recent high quality research is impractical, until it is accurately spread to the farming community. Pakistan is one of the largest pulses producing country but still production per acre is very low than developed countries. The need of the hour is the provision of inputs at subsidized rates on equality basis and proper monitoring and evaluation of project staff should be made to make the process transparent. Proper marketing facilities should be maintained by government so that farmers can sale their pulse produce at proper rate on proper time. More extension campaigns should be launched for better understanding of latest pulses production technology so that production of pulses can be enhanced.

Keywords: Pulses, Information, Awareness, Adoption, Marketing, Entrepreneurship

AN EFFECTIVE ROLE OF MASS MEDIA IN THE DISSEMINATION OF AGRICULTURAL INFORMATION AMONG THE FARMING COMMUNITY

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ABSTRACT

Agricultural production is an important activity for livelihood of the rural people. Mass media can play an effective role in the dissemination of agricultural technologies among the farmers through various extension organizations. This study was conducted in Union Council Jaman Shah Tehsil Layyah. Data were collected from 108 randomly selected respondents with the help of Interview Schedule. Collected data were analyzed through computer software SPSS. The results showed that respondents were the owners of electronic devices i.e. mobile phones, radio and TV. Farmers generally used mobile phones to make telephone calls with AOs and FAs when and if needed. Farmers own solo radio set, as well as built in radio set with mobile phones. Farmers were used to, to listen agricultural programs on radio sets and on mobile phones. Little percentage of farmers generally watched the agri. messages and other programs delivered by Government of Punjab. The outcomes of the study exposed that awareness level among the farming community regarding modern agricultural technologies, agricultural websites and help lines was low. Farmers were seemed interested in using the electronic media as compare to print media for receiving modern agricultural information. Farmers did not use android cell phones and internet due to lack of education and technical knowledge. Currently, Government of Punjab is embarked upon Connected Agricultural Platform Punjab (CAPP) to empower farming community for the use of ICTs in agriculture. However, the formal education and technical know-how are the major barriers in the success of the program. It is therefore suggested that the focus should be remained on electronic media i.e. radio and television in addition to face to face extension. After addressing desirable educational indicators, advisory services may be shifted from one paradigm to other.

Keywords: Rural livelihood, Mass media, Agricultural information and technologies

VALUE ADDITION AND PRODUCTION OF HIGH VALUE CROPS: AN APPROACH TO MAKE SMALL LAND UNIT ECONOMICALLY VIABLE

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ABSTRACT

Currently, in Pakistan more than 90% farmers are considered small and their small units of land are not economically viable and didn't have potential to feed a family under the traditional farming system. In future, the land under the inheritance law of Islam will be further divided. So, there is a dire need to make this unit viable through value addition of traditional crops and production of high-value crops. Farmers can maximize their product outcomes through proper processing and marketing. Processing of wheat into flour, preparation of tomato ketchup, cooking oil extraction from sunflower and mustard seeds, jaggery production from sugarcane juice, powder formation from turmeric, garlic, ginger and processing of fruits and vegetables for juices, pulps, jams and pickles etc., can be helpful in boosting the farmers' economy. Furthermore, modern preservation techniques i.e. canning, and aseptic packaging can also enhance the market value of these products. Moreover, cultivation of high value crops like psyllium (isphghol), chia seed (tukhm banangu), turmeric, saffron, moringa and teak (sagwan) trees having medicinal and economic importance should be encouraged. One counter argument in this regard is that the farmers are too busy in the field to manage such activities. The agriculture in the mechanized era is not so time consuming as it was in the 60s or earlier. Thus, the farmers can easily manage their agricultural related enterprise however, the role of food engineers and technologists is critical in this scenario for developing innovative and cost-effective processing machineries and processing technologies needed for storage, processing, packaging and distribution. Agri. extension should be a core of this system to motivate and educate the farmers for the adoption of high value crops and value addition entrepreneurship in order to make their small unit of land economically viable.

Keywords: Traditional farming, Inheritance laws, High-value crops, Processing, Marketing

SMALLHOLDER FARMER OF PAKISTAN PERCEIVED EFFECTS OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTIVITY AND ADAPTATION STRATEGIES

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ABSTRACT

The agriculture sector is sensitive to climate change and the capacity of smallholder farmers in developing countries to adapt technologies is limited. Similar to adoption of any development-oriented strategies, perception is pre-requisite to the successful adaptation of agricultural strategies against climate change effects. This study was conducted in the semi-arid area of Pakistan to sensitize smallholder farmers on climate change and to establish their perceptions of the projected climate of Pakistan by 2050. Data were collected during 2011 from a total of 60 farmers drawn from six villages in Sargodha and Faisalabad. Farmers were selected using systematic random sampling from a households list and grouped into three wealth groups: resource rich, resource poor and intermediate. Focus Group Discussions were conducted with each group to investigate their perceptions of the projected climate by 2050 and their proposed adaptive strategies. Farmers perceived the projected climate to have negative effects on their livelihoods and there were no outstanding differences in the nature of responses across the three categories of farmers. Farmers' responses showed that they were concerned about crop and livestock productivity as well as availability of water resources, food and nutrition security and about their general well-being. The intermediate wealth group, which had more than half of its members above 70 years of age provided the least number of ideas for adaptations. Farmers also suggested how they could possibly counteract some of the predicted negative effects or maximize on positive effects. Strategies that were suggested by the farmers were largely concerned with cropping and tended to address water shortages. It was concluded that almost all strategies suggested by farmers were self-directed, rather than directed at authorities like government or donors to do something for them thus showing that farmers had the will power to deal with climate change themselves.

Keywords: Future climate, Smallholder farmer, Perceived effects, Adaptation strategies

CLIMATE CHANGE TRANSFORMATIONS IN SOUTH ASIAN AGRICULTURE

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ABSTRACT

Climate change is expected to have negative impacts but also to bring potential opportunities for agriculture and crop productivity in the South Asian countries. Little research has been conducted at the farmer level to identify what adaptation measures are being considered or already taken and transformative these are. Based on semi-structured interviews with farmers and extension officers from two of the most fertile agricultural areas of Pakistan and India, this study examines to what extent South Asian farmers are engaged in transforming their farming systems. The results showed that some transformational changes are taking place already but most changes are incremental. Currently, agricultural policies and regulations are perceived as a greater adaptation challenge than climate change.

Keywords: Agriculture, Vulnerability assessment, Adaptation, Climate change, South Asia

PERCEIVED EFFECTIVENESS OF PUBLIC SECTOR EXTENSION ADVISORY SERVICES PERTINENT TO CONTROLLING FRUIT FLY IN DISTRICT FAISALABAD

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ABSTRACT

The importance of plant protection is obvious in the context of insect pest management for the production of quality fruit. In this milieu, fruit fly has become a challenge to combat in various countries like Pakistan. The research study was about perceived effectiveness for the government project dealing with the administration of fruit fly through advisory services of extension department. The study focused on determining the effectiveness of this project in district Faisalabad. Tehsil Faisalabad and Tandlianwala were chosen as the study area. A list of registered orchards growers was obtained. The data were collected from 120 randomly selected respondents with the help of interview schedule and analyzed through SPSS. The results revealed that primary source of information for growers was extension field staff but they are moderately satisfied with the performance of extension field staff because they did not address their problems on time properly. Satisfaction level was not prominent. Moreover, there was also reflection of adoption of techniques like Bait Application Technique, Pheromone Trap and Male Annihilation Technique. It is suggested that there should be subsidies for small farmers. Moreover, there is a dire need to make the advisory services more effective to overcome the dilemma of fruit fly.

Keywords: Extension advisory services, Fruit fly, Perceived effectiveness

ROLE OF SHAKARGANJ SUGAR MILLS IN ENHANCING THE SUGARCANE PRODUCTION IN DISTRICT JHANG, PUNJAB PAKISTAN

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ABSTRACT

Sugarcane is an important cash crop of Pakistan that plays a vital role in uplifting the socio-economic conditions of growers. Rapid growth of sugarcane industry has great impact on economic development of the country. This study was carried out in order to find out the role of Shakarganj Sugar Mills in enhancing the sugarcane production in district Jhang. There are 99 villages in the radius of 20 km of Shakarganj Sugar Mills. Out of 99 villages, 4 village viz., Habib, Pacca walla, Ashaba and Lakh Badhar were selected purposively which had the highest number of registered farmers. There were 432 registered growers in the village Habib, 402 in Pacca walla, 492 in Ashaba and 428 in Lakh Badhar. By keeping the confidence level interval of 8 using the software of sample size calculator www.surveysustem.com, a sample size of 139 was selected from the population of 1754 registered growers. The proportionate number of sample size 32, 34, 34 and 39 were selected from 4 selected villages and then data were collected from the selected growers and information was recorded. The results revealed that majority of the respondents were aware of the proper seed production technology of sugarcane as describe by Shakarganj Sugar Mill (SSM) while near about half of the respondents were un-aware of the services offered by the SSM to narrow the gap e.g., call center, SMS services, loans etc. as it was observed that majority of the respondents (51.8%) had no awareness about the SMS service which was used by SSM. Moreover majority of the respondents were unaware of the machinery available for harvesting the cane. Hence, it is recommended that SSM should not only establish a proper connection with its growers but also should improve their information sources in order to create awareness among them about the latest production trends of sugarcane. Moreover, they should make necessary arrangements so that availability of fertilizer and pesticides will be improved for the farmers and proper management could be carried out appropriately in order to get maximum yield.

Keywords: Sugarcane production, Shakarganj industry, Farmer benefits

FOOD SECURITY AND ITS CHALLENGES: PRODUCTION AND DISTRIBUTION GAP IN PAKISTAN

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ABSTRACT

Food security is prevailing just like wildfire of forest in Pakistan. Due to diverse issues alike flooded situations, socio-political and environmental changes in the last few years, this situation is moving toward its peak. It is the slackness of the governmental policies to overcome factors and meet the solution of these problems in the current scenario. The present situation could worsen in the future if suitable think tanks of state will not take actions regarding food security issues and implementation of food laws. The burden of the human and agricultural land, climatic variation and the governmental policies regarding public supply are also causes of food insecurity. Improper marketing challenges and lack of participatory tactic are improving the food insecurity in the current situation. In adding, plant productivity appears to be very unmaintainable. The situation must be tackled by all possible means and safety of food for citizens should be ensured. This report précises numerous strategies for crop production and food distribution and underlines the need for a second green revolution in Pakistan in the agriculture sector.

Keywords: Food security, Food distribution, Climate change, Pakistan

FARMERS' PERCEPTION REGARDING INFORMATION SOURCES HELPFUL IN SUPPORTING RISK MANAGEMENT STRATEGIES

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ABSTRACT

Information is always considered as key to change. Information is also considered as first step in adoption on innovation process. Different information sources are available to farmers including local farming community, mobile phones, internet portfolios, mobile apps and different type of print media. The present study was planned to access the information sources being used by the farmers for managing agricultural risks. For this purpose, farmers of Tehsil Sheikhupura were selected as research population. From Tehsil Sheikhupura, 10 villages were selected purposively and 10 farmers from each village were selected randomly to make a sample size of 100 respondents. The data was analyzed by using SPSS and weighted score of each of information source was calculated by multiplying the frequency of responses with their respective score. The results depicted that progressive farmers/ neighbors were considered as most appropriate source of information by farmers. Agricultural suppliers (Private sector sales agent) and dealers were placed on second and third positon respectively among the list of information sources. It was recommended that these type of influential peoples should be properly equipped with agricultural knowledge. They should also encourage the influential farmers regarding adoption of latest agricultural technologies so that these latest technologies may spread like wildfire among farmers.

Keywords: Risk management strategies, Perception, Information sources

ROLE OF PRIVATE AND PUBLIC SECTOR REGARDING AGRI-RISK MANAGEMENT: WITH SPECIAL REFERENCE TO RICE GROWERS IN TEHSIL SHEIKHUPURA

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ABSTRACT

Risk management is set of activities performed to minimize the extent of any risk. Private and public sector have always a key role regarding risk management in agriculture. Different activities and liabilities are being offered by the different private and public departments. These facilities include free seed distribution, agricultural loaning, and training of farmers, soil surveys and providence of information to the farmers. The present study was planned to access the extent of role of public and private sector regarding their perceived role in risk management among rice growers of Tehsil Sheikhupura. For this purpose, farmers of Tehsil Sheikhupura were selected as research population. From Tehsil Sheikhupura, 10 villages were select purposively and 10 farmers from each village were select randomly to make a sample size of 100 respondents. The results depicted that training related to crops was first ranked facility provided by the public and private sector. Awareness regarding risk management was ranked on second position, and land and soil surveys to improve soil health were ranked on the third position. Furthermore, it is suggested that farmers should also provide and insurance facilities as the response for these facilities was very poor.

Keywords: Agri. risk management, Rice growers, Rice belt

CONSTRAINS RESPONSIBLE FOR LESS ADOPTION OF SISAL FIBER BY INDUSTRIES IN PUNJAB, PAKISTAN

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ABSTRACT

Sisal is one of the first-born natural fiber crop having enough potential to survive under harsh climatic conditions. Its leaf contains one of the strongest fibers of the world which has multidimensional uses in different industries. Due to its efficient use of nutrients, it is also known as model CAM plant. In order to identify different constrains which were responsible for less adoption of sisal by Industries, 14 fiber consuming industries (6 jute and 5 carpet and one automobile parts manufacturing industries) were selected as sample of the study. Data from the respondents were collected by using reliable and valid interview schedule and their responses were recorded by using Likert scale. The results of the study revealed that most of the industries were not using sisal fiber due to unavailability of sisal fiber in bulk, due to having less skills for treatment and proper handling of sisal fiber and high cost of sisal fiber as compared to available alternative fibers. Government should pay its attention to save the deteriorating fiber industry in Pakistan and should make steps like distribution of sisal nurseries among farmers. Agricultural institutions should organize training workshops to spread awareness about its production technology, proper handling and should promote use of natural fibers instead of using synthetic fibers by law forming to minimize the risk of climate deterioration by decrease in the use of non-biodegradable fibers.

Keywords: Sisal, Natural fiber, Constrains, Bio-degradable fiber

ASSESSMENT OF KNOWLEDGE LEVEL OF FARMERS REGARDING PRESENT CLIMATIC CHANGES: A CASE STUDY OF DISTRICT SAHIWAL

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ABSTRACT

The average temperature and precipitation ratio during last few years has been changed owing to climate change. These environmental changes are named as climate change. The direct impact of climate change can be observed on farm income/ crop production as this business is closely associated with the environmental conditions. The present study examined the possessed knowledge level of farmers regarding different variables of climate change in Pakistan. The study described that farmers were fully aware about the recent changes in climatic parameters like rainfall and relative humidity. The results depicted that use of ICTs and extension agents were major source for farmers to cope with the existing climatic issues. On the basis of findings, it was suggested that climate resistant varieties and resource conservation techniques (RCTs) such as zero tillage and direct seeding should be introduced to farmers and government should also subsidies the mechanization used in RCTs.

Keywords: Climate change, Resource conservation technologies, Precipitation, Zero tillage

AWARENESS LEVEL OF FIBER USING INDUSTRIES REGARDING SISAL FIBER IN PUNJAB, PAKISTAN

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ABSTRACT

Sisal (*Agave sisalana*) is a natural fiber crop. It is native crop of Central America and it can be searched back to three to four centuries. Sisal got its name by tracing back to a harbor town named as "Sisal" in Yucatan, Mexico. Presently, there are about 275 varieties including sisal hybrids spread throughout sub-tropical and tropical areas of world. There are many potential ways in which sisal can be utilized. Its fiber is being used in manufacturing of ropes, automobile parts, rugs, carpets, clothing, handicrafts and heavy duty packing materials. After fiber extraction, it can be used for manufacturing of natural fertilizer, bio-gas, bio-fuel, animal feed, paper pulp and pharmaceutical products. A study to check the awareness level of fiber using industries regarding sisal fiber was conducted in district Chakwal. The data thus collected was analysed by using SPSS software. The results depicted that fibre using industries had very low awareness level regarding different characters of sisal because industries had no experience in using of sisal as raw material. Industries have to face different constrains regarding adoption of sisal as fiber crop. The major constrains responsible for low adoption of sisal by industries were non-availably of sisal in bulk, less awareness level regarding sisal fiber and more cost of sisal fiber than other available fibers. Industry should provide training and should facilitate farmers regarding use of sisal as fiber crop. Government should establish proper market for sisal. Government and research institutes should provide training to farmers regarding production technology of sisal and its uses.

Keywords: Sisal, Industry, Awareness, Natural fiber, Fiber industry

DEVELOPMENT OF YOGHURT FORTIFIED WITH VITAMIN D3 AND CALCIUM AND STUDY OF ITS EFFECT ON CHARACTERISTICS OF FAT CONTENT DURING STORAGE

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ABSTRACT

Vitamin D and calcium play vital roles in skeletal system to maintain bone remodeling. Previous studies revealed insufficient consumption of these two major nutrients in various age groups. Enrichment and fortification of food acts as a best elucidation to this problem. Incorporating vitamin D and calcium in different foods may elevate the level of living by resolving the issue of inadequate intake of these nutrients. For this purpose a study was conducted to develop the yoghurt as a functional food fortified with vitamin D_3 and calcium. Five formulations with different quantities of fat containing regular fat (RF), reduced fat (RDF), light (L), low fat (LF), and fat free (FF) were design (8%, 6.5%, 5.5%, 3% and <0.625% fat content, respectively). As a fat replacer, an inulin was used in LF and FF formulas. 150 mg of elemental calcium and 150 IU of vitamin D3 per serving were fortified in each formula. During storage study, physical and microbiological properties were evaluated on day 0, 10, 20, and 30. Clogged of L and FF were higher than RF, RDF and FF ($p < 0.05$). Hardness tended to increase as decrease in fat content of yoghurt and as the longer the products stored. Yoghurt formulated with the inulin had lower viscosity ($p < 0.05$) compared to non-containing inulin formulas. Calcium was preserved; however, the amount of cholecalciferol was inconsistent. Other techniques of vitamin D fortification may be needed to increase the stability.

Keywords: Fortification, Bone remodeling, Reduced fat, Cholecalciferol

GROWTH PERFORMANCE OF MAJOR CARPS DURING CHRONIC EXPOSURE OF ZINC AND ITS BIOACCUMULATION IN FISH BODY ORGANS

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ABSTRACT

In recent years, due to awareness about pollution, programmes for monitoring and abatment of river pollution including heavy metal pollution has been initiated. Discharging of all sorts of highly obnoxious matter into freshwater is an affront to civilized values and damaging sustainability to the environment. The disastrous effect in different fishes and animals were found due to heavy metals. Therefore, this investigation was aimed to determine growth responses of major carps viz. *Catla catla*, *Labeo rohita* and *Cirrhina mrigala* during sub-lethal exposure to zinc. The variations among fish age, fish species, treatment (zinc) of the growth parameters viz. weight increment, fork lengths, and condition factor were statistically significant at $p < 0.01$. However, the variation among fish age and fish species of the growth parameter and total length were statistically significant at $p < 0.01$, whereas non-significant for treatment (zinc). Moreover, interactions (fish age × fish species × treatment) were significant for all growth parameters at $p < 0.01$ and condition factors showed non-significant differences. The control fish showed better feed conversion ratio as compared to that of zinc exposed fish. The accumulation of zinc, in the liver of all three fish species was significantly higher than other organs. However, kidney appeared to be an organ that followed the accumulation trend of liver in the fish. *Labeo rohita* showed significantly higher tendency for accumulation of zinc in its body than that of *Cirrhina mrigala* and *Catla catla*. Among the fish organs, the skin, muscle and scales showed significantly lesser tendency for accumulation of zinc.

Keywords: Bio-accumulation, Chronic sub-lethal exposure, Growth, Zinc

ANTIDIABETIC EFFECT OF ALIUM SATIVUM, AZADIRACHTA INDICA AND TRIGONELLA FOENUM IN ALLAXON INDUCE DIABETIC RABBITS

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ABSTRACT

The major objectives of the present experimentations were to determine the effect of bromoxynil on blood, liver and kidney enzyme activities in birds/Japanese quail. For this study, 60 Japanese quails (45 days old) were taken and divided into five groups *i.e.*, 1 control and 4 treatment groups with 12 birds in each group. Bromoxynil was administered to quails at the rate of 1mg/kg body weight/day with one drop of pure water. Blood parameters that were tested include total RBCs count, hemoglobin concentration, packed cell volume (PCV) mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration and mean corpuscular value (MCV). RBCs count, PCV and hemoglobin concentration were decreased at significant level with increasing dose. MCV was found significantly decreasing with increasing the dose. MCH was first significantly increased then decreased. MCHC was significantly increased. Other parameters that were tested include creatinine, Aspartate aminotransferase (AST) and urea. These parameters showed a significant increase with increasing the dose. Thus, it was concluded that bromoxynil served as a disturbing substance for liver, kidney and hematological factors tested in the present study.

Keywords: Bromoxynil effect, Quail, Blood parameters, Hematology

PREVALENCE AND ANTIBIOTIC RESISTANCE OF SALMONELLA ISOLATED FROM RAW POULTRY MEAT AND ITS PRODUCT

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ABSTRACT

From recent decades, increasing antibiotic resistance of *Salmonella* appeared as a critical problem globally. Poultry meat impart as major source to origin of *Salmonella* and act as vehicle for its transmission in human via food chain. In Pakistan, antibiotics are fed to poultry birds regarding prophylaxis measure, growth promoter and disease management but usually in both ways misuse and over dose due to weak logistic system, which are raising antibiotic resistance in *Salmonella.* To perform the research, samples of raw poultry meat and poultry product (chicken shawarma) were collected randomly from different sites of Faisalabad and *Salmonella* were isolated along with recording prevalence. The *Salmonella* isolates were analyzed to check antibiotic resistance profile against various antibiotics. The prevalence of *Salmonella* was observed 100% in raw poultry while chicken shawarmas were also found highly contaminated with *Salmonella*. The *Salmonella* bear resistant against Streptomycin and Ciprofloxacin isolated from both raw poultry meat and chicken shawarma. The Ampicillin and chloramphenicol were found effective to kill *Salmonella*. Conclusively, *Salmonella* is transferred from raw poultry meat to its product chicken shawarma and got resistance against Streptomycin and Ciprofloxacin due to false administration of drugs during poultry production. Thus, the carious usage of antibiotics should be adopted during poultry production and strong legislation is required according to scientific knowledge.

Keywords: Salmonella, Poultry meat, Antibiotics

FARMERS' PERCEPTION REGARDING USE OF WATER EFFLUENTS FOR VEGETABLE PRODUCTION IN TEHSIL FAISALABAD

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ABSTRACT

In Pakistan, wastewater is use for irrigation purpose in many peri-urban regions where growers have small agriculture lands and water effluents are easily available generally in very cheap prices or even free of cost. Wastewater is considered beneficial to plant growth as a result effluents are extensively used for irrigation of crops. According to latest estimates, about 85% used water in towns ultimately adopts the form of discarded water. However, industrial waste water get mixed with urban sewage may contain unnecessary quantities of heavy metals like zinc, manganese, nickel etc. If these metals are present in soil in excessive amount, they go in the food chain thus becoming poisonous for humans and plants. Vegetables are the important food which are essential for maintaining health. The vegetable consumption has shown increasing trend due to good source of vitamins. However, In Pakistan, vegetable consumption per capita is still below the recommended level of World Health Organization (WHO). The availability of canal water have become scarce, and tube well water is so expensive that small farmers could not afford that. The study was conducted in peri-urban areas of Faisalabad in 4 towns (Jinnah town, Madina town, Lyallpur town, Iqbal town). 30 respondents were sampled for interview from each town. The soil and water samples were also collected from these sites and tested in laboratory to check the contamination in the soil and in water which was being used for agriculture production. The results reveals that there is a need of educating farmers about the hazards of waste water and the factories should bound to eliminate the waste water after proper treatment. Waste water should be regularly monitored to make sure the quality of water fit for vegetables. The reasons of wastewater use in vegetable production were the unavailability of canal water which was ranked as 1st. All time availability, high cost of tube well water, cheap source of irrigation, load shedding, increased soil fertility, improved plant growth, increased yield, best way of dispose of wastewater was ranked as 2nd, 3rd, 4th, 5th, 6th, 7th, 8th and 9th respectively. Research also concluded that excess amount of toxic matters found in waste water can make soil unfertile and cause metabolic problems to humans and plants as well.

Keywords: Waste water, Peri-urban areas, Vegetables

MONITORING THE CHANGES OF RBCS IN *Labio rohita* UNDER SALINE CONDITIONS

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ABSTRACT

Aquatic pollution has become a serious problem throughout the world. The purpose of this study was to diagnose the useful of salinity on morphology of red blood cells (RBCs) in *Labio rohita*. The phenotypic alteration in the shape of erythrocytes was studied under the stress of salinity. The fish specimen was divided randomly into 2 groups (five fishes in each). Natural salt (8 g) was added to increase the salinity of water. The physiological changes were observed by calculating the formula of volume (V) of both groups. Peripheral blood sample were collected from each fish specimen by puncturing the caudal vein with 0.4 ml syringe. Blood smear for each blood sample was prepared, stained with Gimsa and observed under the microscope. The erythrocytes of *L. rohita* in first aquarium (control group) was in the original condition, while changes have been observed in the erythrocytes of 2nd aquarium (treated group). The volume of normal cells and stressed cells were 375.840 μm^3 and 240.580 μm^3, respectively. RBCs were shrinked or were of irregular shaped. The modification observed in the shape and size of the erythrocytes due to the effect of the salinity could be explained as a common morphological abnormality that occurred in the physiological conditions.

Keywords: Aquatic pollution, Salinity, Morphological abnormality

PARTICIPATION OF RURAL YOUTH IN RICE PRODUCTION IN TEHSIL SHAKARGARH

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ABSTRACT

Rice crop has a vigorous importance as a source of major food all over the world. It plays an important role in the economy of the country. Rice crop production in last year was about 5536 thousand tonnes which was not enough to fulfill the target according to needs. The low yield of rice is due to lack of information and awareness about latest rice production technology. For an increased production of rice, we need the participation of farmers in agricultural practices of this crop. The focus of study is to determine the participation of youth in production technology of rice. The present study was conducted in tehsil Shakargarh which is consist of 35 union councils; of which 32 union councils are rural. From rural union councils, 3 union councils were selected randomly. From each selected union council, 2 village were selected and 20 respondents were selected from each selected village thus making a sample size of 120 respondents randomly. The results of study showed that 80.3% respondents had participation in land preparation for nursery and 81.7% were interested in nursery sowing methods. It also showed that 44% had used chemical fertilizer and 49% had awareness regarding pesticides application. Advisory services or any innovation about agriculture through electronic media, especially all public and private channels of radio and television should be broadcasted via Government of Pakistan.

Keywords: Participation, Rural youth, Rice production

AWARENESS LEVEL OF FARMERS REGARDING DIFFERENT WEEDS OF COTTON-WHEAT CROPPING SYSTEM AND THEIR EXTENT OF DAMAGE IN DISTRICT SAHIWAL (PUNJAB), PAKISTAN

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ABSTRACT

Present study was conducted to explore the awareness level of the farmers of district Sahiwal regarding different weeds of cotton-wheat cropping system and their damage extent. Weeds are unwanted plants that compete with the crops grown for economic purpose and are responsible for severe losses in crop production. In this study, multistage random sampling technique was used for the selection of sample of 130 respondents. The data were collected through a reliable and validated interview schedule. Data were analyzed using SPSS statistical package. Descriptive and inferential statistical techniques were used for data analysis. Results indicate that Lehli, Dumbi sitti, Jangli Javi, Madhana Ghass, It sit and Chibber were known to all of the respondents among weeds of cotton-wheat crop system. However, Kallri Booti and Phullan Booti were not known to any of the respondents. It sit, Lehli, Tandla and Bathu were found most harmful among broad leaf weeds of cotton-wheat cropping system with mean values of 4.7, 4.0, 3.93 and 3.90. Dumbi Sitti, Swanki Ghass, Jangli Javi and Khabbal Ghass were found most harmful among narrow leaf weeds of cotton-wheat cropping system with mean values of 4.70, 4.61, 4.10 and 3.99. It was suggested that there is need to ensure the supply of pure, effective and low cost weedicides. There is need to develop a strong linkage between the farmers and EFS. It was also suggested that there is need to train the farmers about proper weed control measures specially, spraying methods.

Keywords: Cotton-wheat cropping system, Weeds, Farmers' awareness, Damage extent

AGRITOURISM: A POTENTIAL ENTREPRENEURSHIP FOR THE FARMERS IN PAKISTAN

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ABSTRACT

Agritourism is a series of activities which attracts the farmers towards agriculture. It is one of the types of entrepreneurship, which benefits the farming community with relatively less expenditures. The concept of Agritourism as an entrepreneurship is a new trend in Pakistan. Agri-tourism has different shades in different countries. In some countries, it attracts people to see extinct and endangered species of plants and animals, while in other countries, traditional food items, historical buildings and handicrafts of that area are the major attraction for the people. Agritourism is being considered a supplement source of income for the farmers and there is an increasing trend to adopt agritourism as an entrepreneurship. In Australia, 70% of people who are involved in Agritourism activities as entrepreneurs are earning average $5000 per month, by giving full time to the farm. In America, 51% of the population is earning $50,000 per annum by conducting different activities of agritourism. In Asia, most of the countries are taking the initiative of agritourism to connect farmers and people in order to increase the income of the farmers. In India, small farmers practiced different activities of agritourism and earn reasonable livelihood. Average 500 farmers visited the farms of the Agritourism operators who owned the land not more than 8 acres. In Philippine, 32 agritourism sites exist which prefer to grow organic fruits and vegetables. Different fairs and events are hosted by Philippines and nearly 64,000 tourists visited those sites. In Pakistan, idea of agritourism is relatively new. However, Agritourism Development Corporation-Pakistan and University of Agriculture-Faisalabad have embarked upon to promote agritourism as an entrepreneurship. In current circumstances, there is need to identify the potential role of agritourism for aggressive awareness campaign about Agritourism.

Keywords: Agritourism, Entrepreneurship, Agricultural information, Education

SUSTAINABLE AGRICULTURE IS AN IMPORTANT KEY FOR REGIONAL DEVELOPMENT

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ABSTRACT

Sustainability means the utilization of natural resources in ecological balance for future prospective. Sustainable agriculture means the utilization of farm techniques that protect the human communities, environment and animal welfare. Pakistan is an agricultural country and its economy is fully based on agricultural productivity. Pakistan's 63% population live in rural area which are directly or indirectly linked with agriculture. In regional development, it is concluded that rural areas cannot dependent on exogenous development in their quest for sustainable growth and employment. From a sustainability point of view, we should focus on local and regional development rather than exogenous development. Such an active and social economy approach to regional development can be set alongside the sustainability in agriculture. Furthermore, the need to take a balanced approach to nature and society concerns have a particular resonance at the regional level. These arguments also suggest that action is needed at the national and regional levels.

Keywords: Sustainable agriculture, Regional development, Exogenous development

FARMERS' PERCEPTIONS ABOUT EFFECTS OF CLIMATE CHANGE ON SUGARCANE PRODUCTION AND MARKETING SYSTEM: A CASE STUDY OF TEHSIL CHISHTIAN

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ABSTRACT

Agriculture sector is the backbone of the economy in Pakistan as well as the source of livelihood for the rural people. Large majority of Pakistan farming community grow sugarcane for jaggery (gurr). The sugarcane has stake of 0.6% in current GDP and contributes 3.1% in agriculture value accumulation. The current study was conducted to investigate the effects of climate change on the production of sugarcane, growth, jaggery production and identified the constraints in jaggery production. The productivity of sugarcane in Tehsil Chishtian district Bahawalnagar is very low due to low access to sugar mills, less water availability, and hot weather condition. The present study was conducted in Tehsil Chishtian; One markaz dahranwala (8 union councils) was selected. A list of 350 sugarcane farmers was obtained from Agricultural Officer, Department of Agriculture (Extension wing) Chishtian. Structured interview schedule was arranged to collect quantitative data from 126 randomly selected respondents of Dahranwala Markaz, whereas qualitative data were carried out through key informants interview and observation. It was determined that jaggery (gur) has potential to recover food security and financial condition of growers because of its various customs and high nutritious importance. It was concluded that due to change in climate, every year the production of sugarcane is decreased as compared to previous year. Attack of diseases was also a challenge for farming community due to changing in the climate periods. Due to change in the weather conditions, notorious value of jaggery was also decreasing every year. The study mentions that government should provide improved and resistance varieties according to the local environmental condition, credit accommodations and training opportunities regarding change in climate and its adverse effects on different crops to improve yield and grower's profit. In the study, marketing system seemed as substandard which needs to be modified. Government should fix the price of sugarcane to boost up the growers. Government and other interconnected establishments must work out to recognized problems of the farmers to produce more sugarcane and make the quality products in direction to produce net profit.

Keywords: Climate change, Jaggery, Resistance varieties, Adverse effects, Food security

ANALYSIS THE ADVERSE EFFECTS OF CLIMATE CHANGE ON COTTON CROP GROWTH AND PRODUCTION IN TEHSIL CHISHTIAN, DISTRICT BAHAWALNAGAR

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ABSTRACT

Pakistan is agriculture-based country in which majority of the rural papulation is dependent on the agriculture sector for their livelihood. Around 25% of the growers cultivate cotton in rotation with wheat known as cotton-wheat cropping system. Pakistan is ranked on 4th position in the cotton cultivation after India, china, USA. Cotton is known as white gold. Changing in the climatic activities has adverse effects on the crops growth as well as the production level of the seasonal crop. The present study was conducted in tehsil Chishtian, district Bahawalnagar. Majority of the farming community in tehsil Chishtian grow cotton as the major crops. For this purpose, Dahranwala Markaz was selected purposively. Five union councils were selected, each having comprises 3-4 village used in this study. To analysis the effects of climate change on cotton crop, 165 respondents were selected purposively among five union councils through simple random sampling technique. The further results were analyzed by using statistics package for social sciences (i.e., SPSS). The study showed that hot weather in the summer season restricted the plant growth; the result was the wilting of the plant. More irrigation is needed in this scenario as compared to the recommended irrigation. The adverse effects due to change in the climatic patterns on cotton crop i.e. less germination rate, dwarf size of the plant, enhanced insect pest attack, necessities the use of more irrigated water in order to increase the size of the cotton Bolland to avoid bad quality of cotton, falling of bolls and less production of the cotton. For the betterment of the farmers, it is necessary to provide the training, awareness programs regarding change in climate. Approved and resistance varieties should be grown. There should be restriction on the burning of crops and use of fossils. Advance method of cultivation and new technology should be used for high production.

Keywords: Climatic activities, Production, Germination, Restrictions, Technology

ADAPTATIONS AND MITIGATIONS STRATEGIES FOR THE CLIMATE CHANGE IN THE AGRICULTURE SECTOR WORLDWIDE

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ABSTRACT

Agriculture sector is a major user of land and water resource worldwide. Worldwide, 200 million acres of arable land is facing water scarcity. Agriculture sector is utilizing 2500 billion cubic meters of water yearly; it represents 75% of total fresh water. Irrigation sustains a huge portion of food supply, about 40% in the form of cereals. Moreover, a huge quantity of chemicals (about 100 million ton of nitrogen is used yearly) is applied in the form of inputs for intensive farming. This all leads to a significant level of pollution. Because of such large-scale pollution activities, agriculture is significantly becoming land squalor. It is also a major contributor to greenhouse gases. It is emitting about 13-15 billion ton CO^2 per annum. If the emission of such greenhouse gases is not controlled in the upcoming decades, it will result in harsh climatic change right from 21st century. This dangerous anthropogenic interference needs to be avoided in coming decades and requires strict measures to be taken. This will cause a significant cut in the global emission. A number of alleviation strategies in the forestry and agriculture sectors are identified which can prove helpful in achieving the objective of atmospheric sustainability. A number of coping strategies have been identified to reduce the pollution and land degradation; these comprise reduced degradation, reforestation, control of deforestation in the tropical forest areas, and sustainable management of forests. In the agriculture sector, these strategies will help in lessening the emission of CO_2 gases as well as in the sequestration of these gases in the agricultural areas. Agro-forestry and social forestry is highly recommended for coping the climate change challenge worldwide.

Keywords: Tropical, Mitigation, Reforestation, Greenhouse gases, Anthropogenic

TRAINING NEED ASSESSMENT OF MAIZE GROWERS FOR THE PRODUCTION OF MAIZE IN TEHSIL SAHIWAL

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ABSTRACT

Maize occupies a distinct place in the existing cropping of Pakistan. The present research study was designed to determine the training needs of maize growers in Tehsil Sahiwal. Tehsil Sahiwal has 5 Markaz, out of two Markaz were selected purposively on the basis of the area under maize cultivation. From each selected Markaz, 3 union councils were selected randomly. From each of selected Union Council, 2 villages were selected randomly thus making a total 12 villages. List of 312 maize growers of these 12 villages was obtained from Assistant Director Agriculture (Agriculture Extension wing). 12 selected villages were used as study population from this population making a sample size of 144 maize growers with the help of website survey system .com. A well-structured interview schedule was prepared for the data collection under the supervision of respected supervisor. T Statistic showed that respondent had more training needs in all component of critical stages, e.g., for irrigation flowering stages, at stage of pollination and at milky stage. It means respondent had less knowledge about weeds control so they require more training needs in the field of weeds control. T value of 143.5 further showed a highly significant difference between possessed and required competencies related to use of soil management kits in favor of required level of competencies. T value of 6.1 indicated a highly significant difference between possessed and required competencies related to android apps in favor of required level of competencies. A fair majority (84.4%) of farmers needed availability of labor while three quarter (75.0%) of respondent needed transparency in marketing system. A great majority (88.2%) of the respondent needed construction of local markets a clear majority. 83.3% of farmers needed construction of shortage godam and great majority (92.2%) of respondent needed provision of turbine run by solar system. An over whelming majority (97.2%) of respondent told that agriculture department must provide heavy machinery for production of maize. A clear majority of 97.9% of the respondent reported that trained staff should arrange workshops on training regarding the maize production.

Keywords: Maize, Production, Agricultural extension

E-EXTENSION: A COPING STRATEGY FOR CLIMATE CHANGE

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ABSTRACT

Agricultural ecosystems require updated information system regarding weather predictions, in order to reduce vulnerabilities and risks related to adverse climatic conditions. Although, newspapers and television along with radio had played well in the last decade, but farmers need more efficient information sources regarding climate changes. Information and communication technology with the help of latest applications of cell phones and windows applications are helping farming communities in the current scenario. Unfortunately these applications are not common among the farming communities of developing countries. These apps should be modified in the local language and should be regularly updated. These apps will not only increase the production level of farmers but also results in the reduction of input costs. Public and private sectors which are providing advisory services to farming communities should be trained to the use of such applications and disseminate local weather conditions regularly in order to increase cooperation with the farmers and to improve their capacity building. This will not only help in early warning system but also help farmers to make plans in order to reduce the negative impact of harsh weather conditions on their crops. These apps will help to reduce the gap between metrological stations and faraway remote rural end users who have limited access to newspapers and broadcasting media. Farming communities demands quick access to these sources especially in the critical stages of crop growth e.g. during harvesting and sowing. This intervention will reduce the produce loss and field losses of inputs. Quick feedback from farming community will be a useful source for improving current cyber extension facilities.

Keywords: Vulnerabilities, Mitigation, Predictions, disseminate, Broadcasting media

CHANGING CLIMATIC IMPACTS ON CROP PRODUCTION AND FOOD SECURITY IN PAKISTAN

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ABSTRACT

Climate change is a rising issue of farming sector which have direct impact on the agriculture productivity. Climate has been constantly changing since the earth formation about 4.5 billion years before. These changes occur in two ways like astronomical and geological, and this is too slow to observe on a human scale. Mainly climate change is directly or indirectly associated with the human activity. Pakistan is ranked 28th among the severely affected countries due to climatic changes. Agriculture is considered as the food basket in Pakistan, while majority of the population in Pakistan is dependent on agriculture sector for their livelihoods. In 2012-13, agriculture sector was contributing 21.4% in the grass domestic product while in 2016-17 it has down to 19.5%. Climate change and crop production are interrelated. Climate change is alarming to crop productivity and cause food insecurity in the region. It is necessary to make agriculture sector well organized to coping with the food security issue, improve quality of life and to focus on economic growth. Climate productivity affected due to climate variability in two ways i.e., direct and indirect. Direct impacts include plant evapotranspiration rate, soil moisture, plant intake status, yield, respiration and photosynthesis process while indirect impacts include plants pest and disease influx processes which are triggered due to high humidity and temperature in atmosphere. During the last century, about only 1℃ raised due to deforestation and fossil fuel burning causing enormous negative effects on crop productivity as well as on environment. Flooding is distinguished symptoms of climate alteration that eventually schedules a meeting with disaster and poverty. Since last few decades, floods have caused dribbling trend in Pakistan economy. Recently, Pakistan faced two successive floods during 2010 and 2014, which leads towards malnutrition, hunger, food insecurity and poverty in the country. There is need to take immediate adoption measure (i.e. developing innovative farm production practices, changing cropping pattern and short duration and resistances verities should be introduce) to stable the agriculture growth rate and food security in the region.

Keywords: Climate change, Agriculture, Food security

EFFECT OF METHOTREXATE TREATMENT ON PROGRESSION OF RHEUMATOID ARTHRITIS IN PAKISTANI POPULATION

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ABSTRACT

Rheumatoid arthritis (RA) is a systemic autoimmune disease which mainly affects the synovium and leads to joint damage and bone destruction. Main symptoms involve morning joint stiffness, swelling in soft tissues of joint areas, symmetric swelling, rheumatoid nodules, positive rheumatoid factor and periarticular osteopenia and radiographic erosion. There are several demographic and clinical factors which determine the disease outcome. RA is managed by the use of several drugs. Demographic attributes of 71 RA patients were recorded and they were given the methotrexate (MTX) treatment in combination with folic acid and oral D3. ESR, hemoglobin, lymphocytes, neutrophils, platelets, eosinophils, monocytes and TLC level was measured before and after the medication. Results were statistically analyzed by t-test using Graph-Pad prism software and p-value <0.05 was considered to be significant. MTX, folic acid and oral D3 were found to have no effect on neutrophils and lymphocytes value, but these medicines are significantly effective on level of hemoglobin, ESR, total leukocyte count (TLC), platelets, eosinophils and monocytes.

Keywords: Rheumatoid arthritis, Methotrexate treatment, Bones

TO INVESTIGATE THE OCCURRENCE, ETIOLOGY AND ANTIBIOGRAM PROFILING OF CAPRINE MASTITIS IN NAGRI & FAISALABADI STRAINS OF BEETAL

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ABSTRACT

To elucidate the occurrence, etiology of caprine mastitis as well as their *In vitro* antibiotic susceptibility, a total of 58 and 45 positive milk samples from Faisalabadi and Nagri strain of beetal were collected respectively. Surf Field Mastitis test was used to determine the occurrence of subclinical mastitis. The obtained bacterial isolates were cultured and representatives' colonies were sub-cultured onto MacCkonkey, s agar and blood agar plates for purification. For antibiotics susceptibility determination, eight different antibiotics were used against the bacterial isolates. Furthermore, different risk factors including Age, Parity number, lactation number, type of housing, milking methods, drainage system, feeding system, teat length and teat injury were studied to evaluate their effects on caprine mastitis. The occurrence of caprine mastitis was 20% and 21% in Faisalabadi and Nagri strain of beetal respectively while occurrence of *Staphylococcus* spp. in Faisalabadi and Nagri strain was 48.88% and 43.01% respectively. Staphylococcus spp. was further confirmed by API staph kit which have revealed the *S. aureus, S. hyicus, S. simlinus, S. intermedius and S. xylosius* in Faisalabadi strain while in Nagri strain *S. aureus, S. hyicus, S. simlinus, S. intermedius and S. xylosius.* In terms of percent susceptibility, enrofloxacin 57(98.27%) was the most effective, followed by gentamicin 55 (94.82%), pencillin-G 35 (60.34%), chloramphenicol 30 (51.72%), kanamycin 20 (34.48%), lincomycin 15 (25.86%), streptomycin 10 (17.24%) and oxytetracycline 0 (0%) respectively in Faisalabadi strain while in Nagri strain, also Enrofloxacin was the most sensitive 43 (97.72%), followed by gentamicin 40 (90.90%), pencillin-G 34 (77.27%), Chloramphenicol 27(61.36%), kanamycin 18 (40.90%), lincomycin 12 (27.27%), Streptomycin 5 (11.36%) and oxytetracyclin 0 (0%) respectively.

Keywords: Mastitis, Beetal, Antibiotics, In-vitro, Oxytetracycline

THE EFFECTIVENESS OF EXTENSION METHODS IN THE SUGARCANE GROWING AREAS OF PAKISTAN

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ABSTRACT

Agricultural extension workers have a pivotal role in disseminating innovative and recommended technologies as well as farm practices information among farmers' community. The present research is conducted to determine the effectiveness of the extension methods in the sugarcane growing areas of Pakistan. A Multi-stage sampling technique (lottery method) was used to select two tehsils, i.e. Takhat bhai and Tangi from selected districts in Khyber Pakhtunkhwa. Similar technique was used for selection of union councils and Canegrower villages from each tehsil. Finally, 336 canegrowers were selected for study from ten union councils and villages. Primary information collected through pre-testing interview schedule. The results revealed that 70 growers were educated and had knowledge about field assistants from provincial agricultural extension department and were getting advice from them. Moreover, educated growers achieved average sugarcane yield up to 110 t ha^{-1}. Similarly, canegrowers appeared to get average yields up to 88.4 t ha^{-1} by getting information regarding sugarcane crop from provincial agricultural extension department on monthly and per year bases. Canegrower who had not gotten any extension services achieved average yield up to 59.6 t ha^{-1}. The public and private extension department and other concerned organisations should provide latest information of farming practices to illiterate and less motivated sugarcane growers to improve their yield per hectare by appropriate extension methods and techniques like farm home visit/field visit, office call as well as methods and result demonstration. The present research suggests that public and private government agencies should create more awareness among the farmer's community regarding application of new and recommended technologies and farm practices.

Keywords: Agricultural extension methods, Sugarcane, Farmer's community, Communication

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Printed by: Noori Printing Press Multan 0302-8637867