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Determination of Sowing Date of Crambe (*Crambe abyssinica* L.) in Northern Türkiye

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Abstract

This research was carried out by sowing it in the winter season in 2019-2020 in order to determine the effects of sowing dates on some agricultural and technological characteristics of the crambe in Samsun ecological conditions. The research was carried out with 3 replications of divided plots in randomized blocks and crambe genotypes (NSL-74257 and PI-384530) were placed in main plots and sowing dates (October 17, November 1, November 16, December 1) were placed in subplots. Research result; the plant height was 72.28-83.62 cm, the number of seeds per plant was 668.73-842.54, the weight of 1000 seeds was 7.34-8.54 g, the seed yield per plant was 4.84-8.54 g. In addition, it was determined that the oil yield per plant was between 1.72-3.26 g and the oil ratio was 35.00-36.17%. Considering all the characters evaluated; It was determined that the first sowing date (17 October) is more advantageous than other sowing dates (1 November, 16 November and 1 December). However, since the data obtained are the results of field conditions and only a one-year study, it was found very early to establish a definite opinion on the effects of sowing dates on the characters studied. For this reason, it has been decided that it would be beneficial to continue the research for at least one more year in order to make an evaluation about the sowing date of the crambe in Samsun ecological conditions.

Keywords

Crambe, Sowing time, Agricultural characters, Technological characters

Introduction

Approximately 14% of the total oil and oil products production in the world are used in the oil industry. Vegetable oils are used as raw materials or supplementary products in the production of many products such as cleaning agents, soaps, skin creams, surface coaters, cosmetics, shampoo, resin, foam, ink (Mungan, 2005). Vegetable oil is produced industrially in Turkey from plants such as olive, sunflower, rapeseed, soybean, cotton, corn and hazelnuts. The oilseed production of Turkey, which was 1.1 million tons in 1990, increased 3.2 times (327%) and reached 3.6 million tons in 2020 (Anon, 2021). Despite this increase, oilseed production is not enough in Turkey today and Turkey imports crude oil and oilseeds by paying a significant amount of foreign currency each year. Therefore, it is necessary to follow a national agricultural policy that can support the production of oilseeds more, provide sufficient inputs and activate the production of alternative oil crops.

Crambe, a member of the *Brassicaceae* family, is a one-year industrial plant with high adaptability that can be grown both in winter and summer (Grombacher et al., 1993). Crambe seeds contain 35% oil and 26% protein. Crambe fatty acids composition consists of more than 56% erucic acid, 10.6-24.0% oleic acid, 6.2-14.2% linoleic acid, 7.2-15.8% linolenic acid and 2.3-9.4% eicosenoic acid (Yaniv et al., 1994). Crambe seed oil is not used for cooking due to its high content of erucic acid. However, oils rich in erucic acid are used in many industrial areas (Falasca et al., 2010). In recent years, crambe has been used in the production of industrial

products such as biodiesel, engine and machine lubricants, lubricant, bioplastic, nylon, cosmetics and paint industry for industrial purposes. Fixed oil obtained from crambe seed is used in adhesive, lubricant, synthetic rubber, motor oil, textile, perfume, detergent, pesticide industries, printer ink production and plastic industry (Erickson and Bassin, 1990). Glaser et al. (1997) reported that crambe oil is a very good hydraulic oil and cultivation of crambe in suitable areas is commercially important.

It has been reported that high performance is achieved in the cultivation of crambe in the region with an annual rainfall of less than 350 mm, and since it is a self-fertilizing plant, it can be grown in areas where rapeseed is grown without any problems (Castleman et al., 1999). Johnson et al. (1995) reported that the seed yield of crambe is higher in early sowing, decreases in seed yield in late sowing and that crambe is less sensitive to temperature and moisture stress than rapeseed. In addition, Köybaşı (2008) found that the plant height was 80.4-87.0 cm, the seed number per plant was 379.0-1885.8 and the oil content was found to be 22.50-34.62% in crambe. In another study, it was determined that thousand seed weight of crambe was 6.6 g, seed yield per plant was 2.3 g and oil content in seed was 13.4% (Arslan et al., 2015).

In addition to closing the vegetable oil deficit in Turkey, it is necessary to conduct researches to determine the production potential of the crambe plant in the ecological conditions of the country in order to evaluate the possibilities of use in different areas. Besides, it is extremely important to determine the effects of researches to be carried out in the conditions of that region in order to include the plant to be grown in a region in the cultivation system and to grow it efficiently and with high quality. Therefore, this research was carried out to determine the effects of sowing date as cultivation factor on some agricultural and technological characters of the crambe plant.

Materials and Methods

Plant Material and General Information about the Experimental Area

As plant material, two crambe genotypes were used which NSL-74257 (USA origin) and PI-384530 (Ethiopia origin). The soil structure of the research area is clayey, salt-free, rich in phosphorus and potassium, lime-free medium in organic matter and neutral with pH 7.0 (Table 1).

It has been showed that the average temperature in all months of the trial period is higher than the average of long years; the total amount of precipitation is lower than the values of long years in all months except April, May and June; sunny time is higher than the values of long years in all months except October and November, and there is no certain stability in terms of average relative humidity (Table 2).

The experimental area was plowed before sowing and the land was made ready for planting by pulling a rake to break up the clods after plowing. The field research was conducted with 3 replications according to the Split Blocks Design. In the research, 2 crambe genotypes (NSL-74257 and PI-384530) were placed in main plots and 4 sowing times (17 October, 1 November, 16 November, 1 December) sub plots. Each parcel has 6 rows of 5 meters in length, 40 cm between rows and 5 cm between plants in each row. During the field research period, practices such as weed control and irrigation were carried out as recommended in accordance with the crambe growing technique. Research data were taken from 10 plants randomly selected from each row before harvest. In the research; plant height, number of seeds per plant, 1000 seed weight and seed yield per plant analyzed as agricultural characters; oil content and oil yield per plant were evaluated as technological characters. Oil content analysis was performed using the Ankom XT15 Soxhlet Extraction System according to the method reported by AOCS 5-04 (Anon, 2021). Oil yield was recorded in grams by multiplying the oil rate determined as a result of the analysis for each parcel with the grain yield of that parcel. Statistical analysis of the agronomic and technological characters in the research was made using the MSTATC statistics program.

Results and Discussion

Agronomical Characters

As a result of the research, it was determined that the effect of sowing date was statistically significant ($p < 0.01$) on plant height (Table 3). When evaluated in terms of sowing date, the longest plant height was obtained at the 3rd and 4th sowing date (83.43 cm and 83.62 cm, respectively). On average, it was determined that the plant height increased as the sowing date was delayed (Figure 1a). In previous studies; It has been reported that the plant height in crambe is 40.00-120.00 cm (Davis, 1982), 68.00-128.00 cm (Wolf, 2000), 71.40 cm (Tansi et al., 2003) and 42.90-90.70 cm (Özyılmaz, 2019). These reported results are in line with the results obtained from this research. However, the results obtained for plant height in this research (72.20-83.62 cm) are shorter than the results which plant height is reported as 163.70 cm (Laghetti et al., 1995) and 93.07-103.90 cm (Huang et al., 2013).

In the research, it was determined that the effects of sowing dates and genotypes were insignificant on the number of seeds per plant (Table 3). It was determined that the average number of seeds per plant was 761.74. When evaluated in terms of sowing date, the maximum number of seeds per plant was obtained with 842.54 at the 1st sowing date. It was determined that, on average, the number of seeds per plant decreased after the 1st sowing date, increased again in the 3rd sowing date and decreased again after the 3rd sowing date (Figure 1b).

The number of seeds positively affects the climatic conditions, flowering status and seed formation on the plant. Proper humidity in seed formation in crambe has an extremely high effect on plant growth, and humidity affects seed formation time and seed number (Wolf, 2000). Findings reported by various researchers in previous studies that there were 5250.2 (Tansi et al., 2003) and 1003.7-2397.8 (Huang et al., 2013); although higher than the findings obtained from this research (668.73-842.54), this research's results are higher than the data reported as 379.0 (Köybaşı, 2008) and 58.0-377.0 (Özyılmaz, 2019).

As a result of the statistical analysis, it was determined that the effects of sowing dates and genotypes were insignificant on a thousand seed weight

(Table 3). In addition, it was determined that the thousand seed weight was 7.49 g on average.

When thousand seed weight is evaluated in terms of sowing date, it was obtained on the 1st sowing date with a maximum of 7.90 g of thousand seed weight. It was determined that the thousand seed weight decreased from the 1st sowing date and there was a partial increase in the 4th sowing date (Figure 1c). Thousand seed weight is greatly affected by the number of seeds per plant and seed size. In previous studies conducted by various researchers, thousand seed weight in crambe reported that 6.90 g (Vollmann and Ruckenbauer, 1993), 6.00 g (Laghetti et al., 1995), 6.84 g (Fontana et al., 1998), 5.70 g (Wang et al., 2000), 6.38 g (Lara-Fioreze et al., 2013), 6.86 g (Huang et al., 2013) and 2.60-8.50 g (Arslan et al., 2015). The results obtained in this research (7.34-8.54 g) are in line with the results reported previously.

When the data were evaluated in the light of statistical analysis, it was determined that the effects of sowing dates and genotypes were insignificant on the seed yield (Table 3). Besides, it was determined that the average seed yield was 6.22 g. When the seed yield was evaluated in terms of sowing date, maximum seed yield was obtained with 8.54 g at the 1st sowing date. It was determined that the seed yield decreased after the 1st sowing date, then it increased again in the 3rd sowing date and decreased again after the 3rd sowing date (Figure 1d). It has been previously reported by various researchers that the seed yield in crambe is 85.1-98.75 g (Tansi et al., 2003), 12.5-17.5 g (Çömlekçioğlu, 2005), 20.61-31.07 g (Köybaşı, 2008) and 33.78 g (Acar, 2015). These reported results are higher than the results from this research (4.84-8.54 g). This difference in seed yield may have resulted from different growing seasons and genotypes used in research.

Technological Characters

As a result of the research, it was determined that the sowing date and genotype effects were insignificant on the oil content (Table 3). In addition, it was determined that the average oil content was 35.75%. When the oil content was evaluated in terms of sowing date, the highest oil content was obtained at the 2nd sowing date with 36.17%. In general, it was found that the oil content increased until the 2nd sowing date, decreased a little in the 3rd sowing date and then increased again at the 4th sowing date (Figure 2a). In the researches made by various researchers on crambe; oil content reported as 31.3% (Vollmann and Ruckenbauer, 1993), 30.6% (Bondioli et al., 1998), 32.8-37.9% (Fontana et al, 1998), 34.48% (Wang et al., 2000) and 16.17-39.02% (Özyılmaz, 2019). These reported data are in parallel with the data obtained in this research (35.00-36.17%). However, the findings of the researchers who reported the oil content as 28.78% (Lara-Fioreze et al., 2013) are higher than the findings obtained as a result of this research.

Table 1. Soil analysis results of the experimental area

Chemical Analysis						
	pH	% Limy ($CaCO_3$)	% Total Salt	Phosphorus (P_2O_5) kg da^{-1}	Potassium (K_2O) kg da^{-1}	% Organic matter
Result	7.00	1.22	0.052	293.00	10.34	2.71
Degree	Neutral	Non-calcareous	Salt-free	High	High	Medium

Physical Analysis		
Clay (%)	47.45	Clayey
Sand (%)	29.40	Sandy
Silt (%)	23.15	Light silty

Table 2. Some climate data of the experimental area (2019-2020 and last 55 years) (Anon, 2020)

Months	Temperature (°C)		Precipitation (mm)		Relative Humidity (%)		Sunny Time (hour)	
	2019-2020	Long-term	2019-2020	Long-term	2019-2020	Long-term	2019-2020	Long-term
October	18.5	16.3	71.4	81.5	69.2	74.3	4.5	4.5
November	13.4	12.6	67.9	82.4	69.5	68.7	2.9	3.7
December	9.9	9.3	76.0	82.6	64.4	65.6	1.9	2.6
January	9.1	7.1	63.6	66.8	56.3	66.3	3.2	2.7
February	8.5	7.2	37.5	52.8	69.2	68.7	3.9	3.1
March	8.7	8.2	36.0	62.7	64.7	74.5	4.6	3.5
April	11.7	11.3	66.3	58.2	73.4	77.8	5.3	4.6
May	17.1	15.5	67.1	51.3	81.5	78.9	7.9	6.1
June	23.7	20.1	80.4	47.8	77.4	74.3	8.3	8.0
Average	13.4	11.9	62.9	65.1	69.5	72.1	4.7	4.3

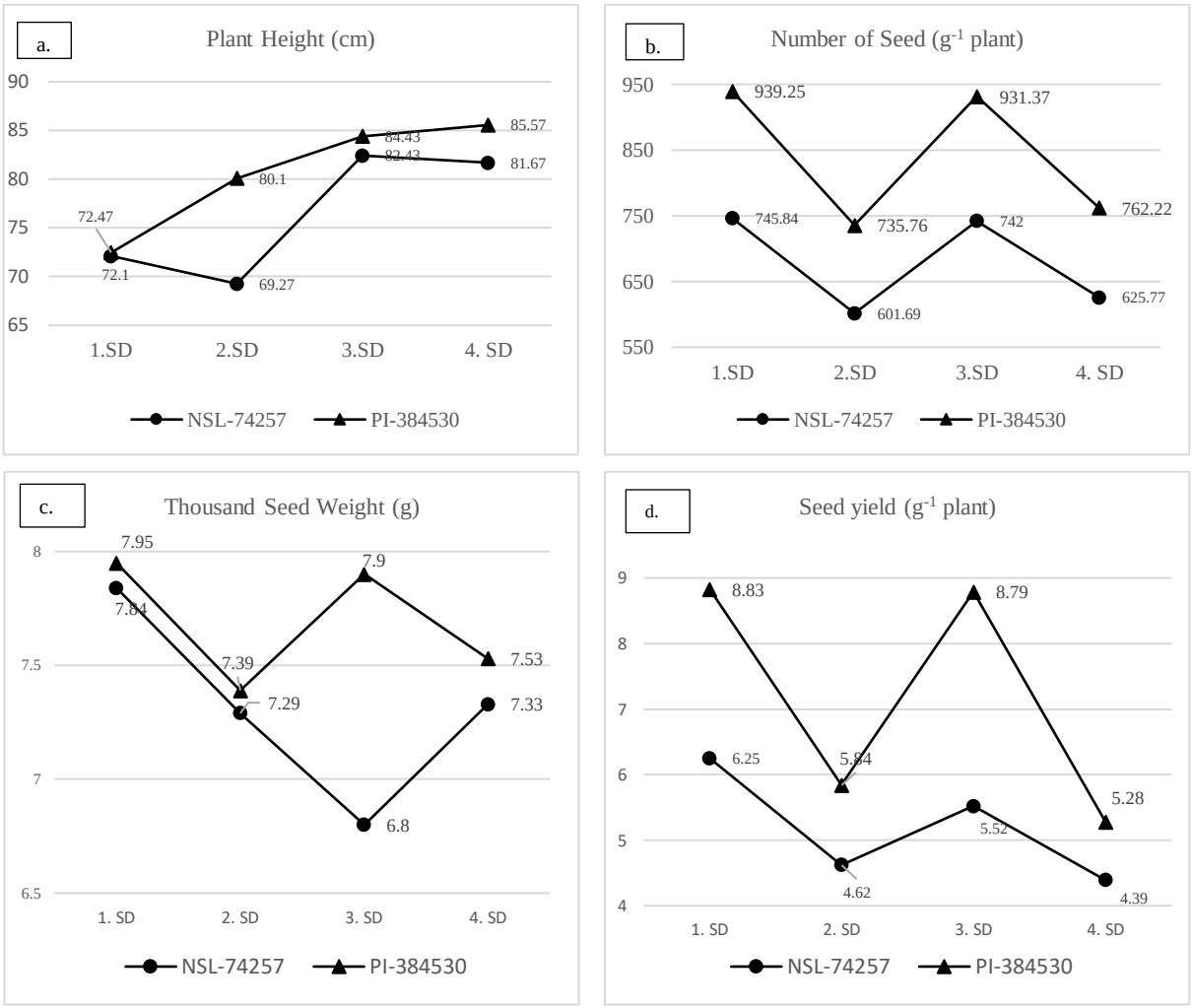

Figure 1. Change of agronomic characters of crambe genotypes at different sowing dates, a. Plant height, b. Number of seed, c. Thousand seed weight, d. Seed yield

Table 3. Variance analysis table of some agricultural and technological characters

Sources of variation	DF	Plant Height (cm)	Number of Seeds (g^{-1} plant)	Thousand Seed Weight (g)	Seed yield (g^{-1} plant)	Oil Content (%)	Oil yield (g^{-1} plant)
Block	2	3.676 NS	0.345 NS	0.58 NS	0.306 NS	0.053 NS	0.441 NS
Genotype (G)	1	9.090 NS	1.249 NS	11.68 NS	2.371 NS	2.367 NS	4.136 NS
Error1	2						
Sowing Date (SD)	3	7.160**	2.207 NS	1.83 NS	3.215 NS	0.607 NS	3.291 NS
G x SD	3	1.098 NS	0. 094 NS	1.78 NS	0.689 NS	1.550 NS	0.884 NS
Error2	12						
CV (%)		6.86	10.57	6.68	13.77	4.56	13.20

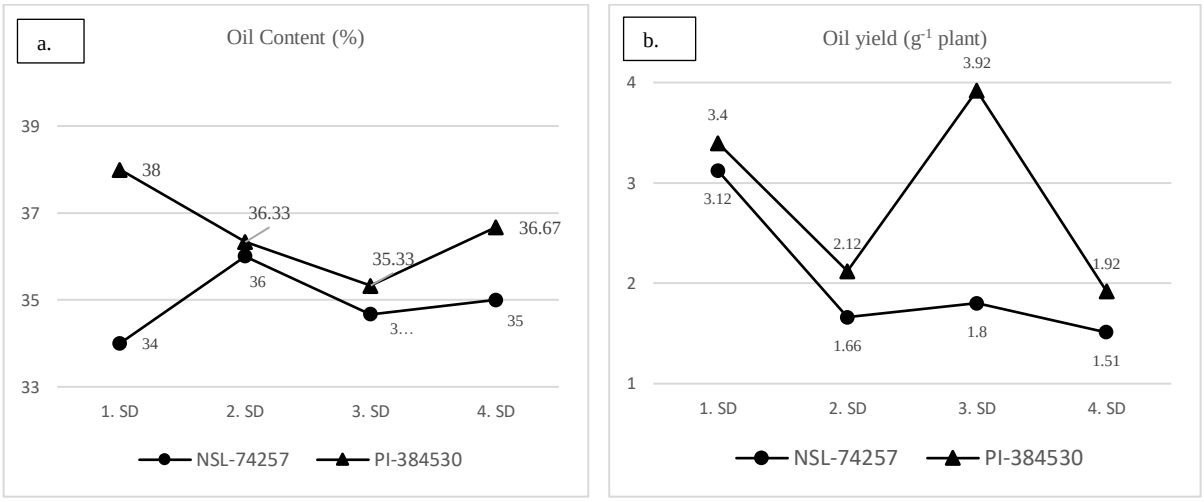

Figure 2. Change of technological characters of crambe genotypes at different sowing dates, a. Oil content, b. Oil yield

As a result of the research, it was determined that the sowing date and genotype effects were insignificant on the oil yield per plant (Table 3). In addition, it was determined that the average oil yield per plant was 2.437 g. When the oil yield per plant was evaluated in terms of sowing date, it was determined that the highest oil yield was obtained in the 1st sowing date with 3.262 g. In general, it was determined that the oil yield per plant decreased at the 1st and 2nd sowing date, increased again at the 3rd sowing date and decreased again at the 4th sowing date (Figure 2b). It was reported that the oil yield per plant varied between 0.096-1.018 g in a study conducted in crambe (Özyılmaz, 2019). In this research, it was determined that the oil yield per plant was between 1.72-3.26 g, which is higher than the value for oil yield per plant reported previously.

Conclusion

According to the results of the research, it was determined that the plant height varied between 72.28-83.62 cm, number of seeds per plant between 668.73-842.54, thousand seed weight between 7.34-8.54 g, seed yield per plant between 4.84-8.54 g, oil content between 35.00-36.17% and oil yield per plant between 1.72-3.262 g. Considering all the characters analyzed; it was determined that the 1st sowing date (17 October) is more advantageous than other sowing dates (1 November, 16 November and 1 December). Since the research is conducted in field conditions for only one year, it is not enough to show a definite opinion about the effects of sowing date on the characters analyzed. For this reason, it was decided that it would be beneficial to continue the research for at least one more year in order to make an evaluation about the sowing date of the crambe in Samsun ecological conditions.

Compliance with Ethical Standards

Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

Author contribution

O.K designed the research. K.K carried out field experiments. M.G analyzed the data. O.K and M.G wrote the manuscript. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

Ethical approval

Not applicable.

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Data availability

Not applicable.

Consent for publication

Not applicable.

References

Acar, C.G. (2015). Niğde ilinde doğal yayılış gösteren crambe türlerinin teşhisi ve kalite özelliklerinin belirlenmesi, Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Adana. 150 p. URL: http://libratez.cu.edu.tr/tezler/8321.pdf (in Turkish).

Anonymous, (2020). Meteoroloji 10. Bölge Müdürlüğü Rasat Raporları. URL: https://samsun.mgm.gov.tr /. (in Turkish)

Anonymous, (2021). Türkiye İstatistik Kurumu, İstatistik Veri Portalı. URL: https://data.tuik.gov.tr. (in Turkish)

Anonymous, 2021. AOCS 5-04 Soxhlet Extraction System. URL: https://www.ankom.com/ product-catalog/ankom-xt15-extractor.

Arslan, Y., Subaşı, İ., Keyvanoğlu, H. (2015). Crambe (*Crambe hispanica* subsp. *abyssinica*) genotiplerinin bazı bitkisel özelliklerinin belirlenmesi. Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi, 24 (1):16-23. Doi: https://doi.org/10.21566/tbmaed.62352. (in Turkish).

Bondioli, P., Folegatti, L., Lazzeri L., Palmieri, S. (1998). Native Crambe abyssinica oil and its derivatives as renewable lubricants: an approach to improve its quality by chemical and biotechnological processes.

Industrial Crops and Products, 7:231-238. Doi: https://doi.org/10.1016/S0926-6690(97)00053-8.

Castleman, G., Paymer, S., Greenwood, C. (1999). Potential for Crambe (*C. abyssinica*) in Mallee/Wimmera of Australia. In: Proceedings of the 10th international rapeseed congress, Canberra, Australia pp. 26-29. Retrieved from http://www.regional.org.au/au/gcirc/2/155.htm

Davis, P.H. (1982). Flora of Turkey and East Eagen Islands. Edinburgh at the University Press, 1: 272-273.

Erickson, D.B., Bassin, P. (1990). Rapeseed and Crambe: Alternative crops with potential industrial uses, agricultural experiment station, Kansas State University, Manhattan, Bulletin 656. Retrieved from https://www.ksre.k-state.edu/historicpublications/pubs/SB656.pdf

Falasca, S.L., Flores, N., Lamas, M.C., Carballo, S.M., Anschau, A. (2010). Crambe abyssinica :An almost unknown crop with a promissory future to produce biodiesel in Argentina, International Journal of Hydrogen Energy, 35: 5808 -5812. Doi: https://doi.org/10.1016/j.ijhydene.2010.02.095

Fontana, F., Lazeri, L., Malaguti, L.,Galletti, S. (1998). Agronomic characterization of some crambe abyssinica genotypes in a locality of Po Valley. European Journal of Agronomy, 9(2): 117-126. Doi: https://doi.org/10.1016/S1161-0301(98)00037-9

Glaser, L.K., 1996. Crambe: an economic assessment of the feasibility of providing multiple-peril crop insurance. Washington, DC: Economic Research Service for the Risk Management Agency, 1996. Retrieved from https://legacy.rma.usda.gov/pilots/feasible/PDF/crambe.pdf

Grombacher, A., Nelson, L., Baltensperger, D., (1993). Crambe production. field crops: Miscellaneous Crops, Institute of Agriculture and Natural Resources, Nebraska, USA. Retrieved from https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1776&context=extensionhist

Huang, B., Yang, Y., Luo, T., Wu, S., Du, X., Cai, D., Loo, E.N., Huang, B. (2013). Correlation, regression and path analyses of seed yield components in *Crambe abyssinica*, a promising industrial oil crop. American Journal of Plant Sciences 4(1): 42-47. Doi:10.4236/ajps.2013.41007

Johnson, B.L., Mckay, K.R., Scheiter, A.A., Hanson, B.K., Schatz, B.G. (1995). Influence of planting date on canola and crambe production. Journal of Production Agriculture, 8: 594-595. Doi: https://doi.org/10.2134/jpa1995.0594

Köybaşı Ö. (2008). Çukurova koşullarında bazı crambe türlerinin verim ve yağ oranlarının saptanması, Çukurova University, Adana. p.58. Retrieved from http://traglor.cu.edu.tr/objects/objectFile/KKvpRdFx-1292013-6.pdf. (in Turkish).

Laghetti, G., Piergiovanni, A.R., Perrino, P. (1995). Yield and oil quality in selected lines of *Crambe abyssinica* Hochst. Ex R.E. Fries and C. hispanica L. grown in Italy. Industrial Crops and products, 4:203-212. Doi: https://doi.org/10.1016/0926-6690(95)00033-9

Lara-Fioreze, A. C. C., Tomaz, C. A., Fioreze, S. L., Pilon, C., Zanotto, M. D. (2013). Genetic diversity among progenies of *Crambe abyssinica* Hochst for seed traits. Industrial Crops and Products, 50: 771-775. Doi: https://doi.org/10.1016/j.indcrop.2013.07.039

Lazzeri, L., De-Mattei, F., Bucelli, F., Palmieri, S. (1997). Crambe oil-a potential new hydraulic oil and quenchant. Industrial Lubrication and Tribology, 49(2):71-77. Doi: 10.1108/00368799710163893

Mungan, A. (2005). Kahramanmaraş ekolojik koşullarında farklı ekim zamanları ve ekim sıklıklarının *Lesquerella fendleri*'nin verim ve kalitsine etkisi, Çukurova University, Adana. p 116. Retrieved from http://libratez.cu.edu.tr/tezler/5502.pdf. (in Turkish).

Özyılmaz, T. (2019). Samsun ekolojik koşullarinda bazi crambe (*Crambe abyssinica* L.) hatlarının tarımsal ve teknolojik özelliklerinin belirlenmesi üzerine bir araştırma. Ondokuz Mayis University, Samsun. p. 102. Retrieved from http://libra.omu.edu.tr/tezler/127370.pdf. (in Turkish).

Tansı, S., Yanıv, Z., Karaman, Ş. (2003). Çukurova Koşullarında Crambe spp.'nin kültürü olanakları ile kalitesinin belirlenmesi üzerine bir araştırma, Adana Tarım Orman ve Gıda Teknolojileri Araştırma Grubu Tübitak,Proje No: TOGTAG-2665 S:63. (in Turkish).

Vollmann, J. Ruckenbauer, P. (1993). agronomie performance and oil quality of crambe as affected by genotype and environment. Retrieved from https://diebodenkultur.boku.ac.at /volltexte/band-44/heft-4/vollmann.pdf

Wang, Y.P., Tang, J.S., Chu, Q., Tian, J. (2000). Preliminary study on the introduction and cultivation of *Crambe abyssinic*a in China, an oil plant for industrial uses. Industrial Crops and Product, 12:47-52. Doi: https://doi.org/10.1016/S0926-6690(99)00066-7

Wolf, J. (2000). Oilseed Crops, Second Edition. Edited by EA Weiss, Blackwell Science, Inc. Malden, MA.p. 259-273. Doi: https://doi.org/10.1002/1097-0010(200008)80:10<1573::AID-JSFA679>3.0.CO;2-0

Yaniv, Z., Schafferman, D. Elber, Y., Ben-Moshe, E., Zur, M. (1994). Evaluation of Sinapis alba, native to israel, as a rich source of erucic acid in seed oil. Industrial Crops and Products, 2: 137-142. Doi: https://doi.org/10.1016/0926-6690(94)90095-7