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Original article

Determination of the Important Quality Properties of Some Sunflower Varieties and Candidate Genotypes

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Abstract

The main objective of the experiment was determined suitable sunflower candidate genotypes. The experiment was conducted under Konya-Ilgın conditions in 2018 growing seasons in Randomized Complete Block Design with three replications. The experiment materials were the sunflower candidate genotypes which were developed by Associate Proffessor Rahim Ada and some sunflower varieties. The observations were made hull ratio (%), oil content (%), protein content (%). According to the results of the experiment, significant differences were found in all properties among the varieties and candidate genotypes statistically. The hull ratio values were obtained from 4CMS X SARM 6, 4CMS X NP, Bosfora, 4CMS X SB and 4CM X C75 as 28.57 %, 27.53 %, 27.35 %, 26.84 %, 26.38 % respectively. In addition to, the oil content values were obtained from 4CMS X CO, 4CMS X C21, 4CM X C75 as 48.29 %, 47.65 %, 46.75 % respectively. Finally, the highest protein content was obtained from 4CMS X YK-YRKKY with 20.84 %. The increase in sunflower production will be possible by expanding plantation areas, increasing the yield per unit area and producing varieties with high yield. In addition to high yield, improvement of important quality properties is also comprised of the important yield components. The experiment results indicated that in terms of the important quality properties of 4CMS X CO was a promising candidate genotype for sunflower production in Turkey.

Keywords: Sunflower, Helianthus annuus L., breeding, oil content.

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INTRODUCTION

Oilseed Plants are of great importance in the nutrition of living beings in terms of the fat, protein, carbohydrate, vitamins and minerals they contain. Sunflower plant, which is one of the most preferred vegetable oil sources in the world and in our country, is an oil plant with an important nutritional value due to its high oil content of 22-50 % and its high rate of polyunsaturated fatty acids (69 %) (Arioglu et al.., 2010 and Kaya, 2005). In 2018, 51.9 million tons of sunflower seeds were produced on 26.7 million hectares of land in the world. Sunflower oil is seen as the most important vegetable oil source in many countries, especially in Russia, Ukraine and many European countries. In our country, 1.9 million tons of production was realized in 734 thousand ha cultivation area in 2018 (Anonymous, 2020a). Sunflower seed is considered as a good animal feed in addition to the high percentage of oil it contains. Its pulp contains 30 % protein, 5 % fat, 19 % carbohydrate. (Gecit et al., 2009). The vegetable oil deficit of our country increases in parallel with the increase in population and the expansion of oil usage opportunities and maintains its position among net importer countries. In 2019, 3.8 million tons of oilseeds ($ 1.5 billion), 2 million tons of crude oil ($ 1.4 billion), 3.5 million tons of pulp ($ 658 million), totaling 8.1 million tons of vegetable oil, oilseed and pulp imported (Anonymous, 2020b). In this sense, and with the effect of consumption habits, our country mostly prefers sunflower oil among the vegetable oil groups and producers often plant hybrid varieties. Producers prefer hybrid varieties; because of their high yield performance, quality and uniformity (Kaya, 2005). There is important genetic variability for seed yield in sunflower. Hybrid varieties obtained using lines developed based on heterosis are resistant to diseases and pests in addition to giving high yield, and they are also preferred because they have a high oil content. The inheritance of seed yield in sunflower is closely related to yield components such as the number of seeds per head, thousand seed weight and head diameter (Miller and Fick, 1997). But for breeders, the main purpose is the oil rate in the seed and the seed yield. Considering that the import of hybrid varieties and hybrid seeds cannot be used in other years, it is of great importance to create and develop local hybrid varieties with high yield and high oil content (Merren and Champolivier, 1992; Muhammed et al., 2012). The effect of the environment on seed yield and yield factors varies. Because the share of genetic effects on quantitative characters with low heritability is low, they are highly affected by environmental conditions (Tan, 1993). For this reason, it is of great importance to grow the materials in different climatic conditions during the breeding process, to evaluate the yield and yield components. In sunflower farming, inbred parental lines with different genetic resources are required for high yield (Kaya, 2004). The aim of this study was to evaluate the important quality characteristics of some sunflower varieties and candidate genotypes in Konya-Ilgın ecological conditions and to determine the prominent candidate genotypes in terms of these characteristics.

MATERIALS and METHODS

Experimental location, design and treatments/varieties

The experiment was conducted under Konya-Ilgın conditions in 2018 growing seasons. Twelve candidate genotypes of sunflowers (4CMS x ALP57, 4CMS x NP, 4CMS x ALPTEM, 4CMS x SARM6, 4CMS x MHMD, 4CMS x CO, 4CMS x C21, 4CMS x EMRDG, 4CMS x SB, 4CMS x YK-YRKKY, 4CMS x TRHL, 4CM x C75) which were developed by Associate Professor Rahim Ada and three varieties of sunflowers (Bosfora, Napoli, Cadix) have been investigated for their important quality properties by using Randomized Complete Block Design with three replications.

Experimental methodology

The experiment was conducted in 6 m long, 3 row plots with a 70 x 35 cm plant density. It was sown on April 20, 2018 and the harvest time was on September 20, 2018. Recommended cultural practices were followed from sowing till harvesting. Fertilizers in the form of DAP and urea was applied at the rate of 120 and 60 kg ha^{-1} respectively. All phosphorous and half nitrogen was applied at the time of seedbed preparation, while the remaining half of nitrogen was applied at first irrigation.

Data collection

The data were collected on hull ratio (%), oil content (%), protein content (%). Hull ratio (%) was germinated in parallel with the dry shell of 100 seeds in each repetition and dried at 65^{o}C for 12 hours and the average value was calculated as % from the difference of dry shell weights (Nur, 1969). Oil content was determined by Soxhlet method (AOCS, 1993) and protein content was determined by Kjeldahl method.

Statistical analysis

Statistical analysis has been performed using JMP Version 7, SAS Institute Inc. Cary, NC programs.

RESULTS and DISCUSSION

Weather data of the experimental area

The weather data of the experimental area in 2018 with growing seasons for the sunflower with the long-term climatic data were depicted in Table 1. Data showed that the average temperature was 14.5 ^{o}C, 18.1 ^{o}C, 21.8 ^{o}C, 24.8 ^{o}C, 24.1^{o}C and 20.3 ^{o}C; whereas, the total amount of rainfall was 17.9 mm, 49.6 mm, 53.6 mm, 11.5 mm, 6.6 mm and 3.5 mm during the month of April, May, June, July, August and September, 2018 respectively (Table 1).

Table 1. Weather data of the experimental areas (Ilgın-Konya)

The long-term*	**April**	**May**	**June**	**July**	**August**	**September**
Max. T. (ºC)	25.5	29.1	32.9	36.5	36.1	32.9
Min. T. (ºC)	-2.3	3.2	6.7	10.3	9.4	4.1
Avg. T. (ºC)	12.1	21.0	24.4	24.0	19.6	13.5
T. Rain. (mm)	43.6	50.4	38.4	15.9	13.1	22.2
Humd. (%)	58.9	59.1	53.6	45.8	47.2	51.9
2018	**April**	**May**	**June**	**July**	**August**	**September**
Max. T. (ºC)	27.9	28.6	32.4	34.2	35.3	33.9
Min. T. (ºC)	-1.4	6.6	9.3	12.6	10.3	5.8
Avg. T. (ºC)	14.5	18.1	21.8	24.8	24.1	20.3
T. Rain. (mm)	17.9	49.6	53.6	11.5	6.6	3.5
Humd. (%)	47.3	56.3	49.9	39.8	37.2	40.7

Anonymous,2020c. General Directorate of Meteorology-Ankara.* 2000-2017.

Hull ratio (%)

The data regarding hull ratio (%) was shown in Table 2 and Table 3. The variance analysis of hull ratio in sunflower varieties and candidate genotypes showed that the means of all candidate genotypes and varieties were statistically highly significant ($p<0.01$) (Table 2). The data presented in Table 3 explains that the mean value was 25.24 % for hull ratio. The maximum hull ratio (28.57 %) was taken by 4CMS X SARM 6 followed by 4CMS X NP, Bosfora, 4CMS X SB and 4CM X C75 taking 27.53 %, 27.35 %, 26.84 % and 26.38 %, respectively. The minimum hull ratio (21.56 %) was taken by 4CMS X MHMD followed by Napoli, 4CMS X ALP57 and 4CMS X ALPTEM having 23.14 %, 23.49 %, 23.50 %, respectively. In sunflower seeds, generally the seed coat constitutes 21-30 % of the total weight and the shell contains substances such as cellulose, hemicellulose and lignin (Wan et al., 1979; and Dorrell and Vick, 1997). Since there is a negative relationship between the oil ratio and the shell ratio in sunflower seeds, reducing the shell ratio is one of the important breeding purposes. Reducing the shell ratio below 25% is one of the important breeding goals (Evci et al., 2011; Erbas and Senates, 2020). The hull ratio values obtained from this study was lower than the values obtained by Tan et al. (2017) as 35.95-44.62 %, it was close to the lower limit from of Erbas and Senates (2020) as 26.6-31.9 %.

Oil content

The data regarding oil content (%) was shown in Table 2 and Table 3. The variance analysis of oil content in sunflower varieties and candidate genotypes showed that all candidate genotypes and varieties were statistically highly significant ($p<0.01$) regarding oil content (%) (Table 2). The data presented in Table 3 explains that the mean value was 43.83 % for oil content (%). The maximum oil contents (48.29 % and 47.65 %) were taken by 4CMS X CO and 4CMS X C21 followed by 4CM X C75

which took 46.75 %. The minimum oil content (39.34 %) was taken by 4CMS X ALP57 followed by 4CMS X SARM 6 and 4CMS X YK-YRKKY having 40.58 %, 41.91 % respectively.

Oil and protein content in sunflower is an important selection criterion in breeding programs. For this reason, sunflower varieties with high oil and protein content are used in breeding programs (Hassan et al., 2012). More than 85 % of the oil found in sunflower seeds constitutes oleic acid, which is called beneficial for health (Monotti, 2004). Oil content values obtained from this experiment were in harmony with Kaya et al. (2007)'s values as 40.0-45.0 %, Caliskan and Kevseroglu (1997)'s values as 36.4-41.6 %, Katar et al. (2012)'s values as 36.83 - 46.13 %, Baydar and Erbas (2005)'s values as 44.4-45.6 %, Siddiqi et al. (2012)'s values, 35-42 %, Gur et al. (1997)'s value as of 36.5-45.3 %, while it remained lower than the values of obtained by Alpaslan and Gunduz (1999) (44.1-51.2 %) and was also higher than the values of obtained by Tan et al. (2017) (16.70-31.90 %). Different environmental factors, including the diversity of varieties used in sunflower, temperature, irrigation frequency, and drought, seriously affect the oil content values (Connor and Hall, 1997). The differences between the values obtained in this experiment and the results found by the researchers can be explained in this way.

Protein content

The data regarding protein content (%) of studied candidate genotypes and varieties of sunflower was presented in Table 2 and Table 3. The variance analysis of protein content in sunflower candidate genotypes and varieties showed that the means of all candidate genotypes and varieties were statistically highly significant ($p<0.01$) (Table 2). The data presented in Table 3 explains that the mean value was 16.33 % for protein content. The highest protein content (20.84 %) was recorded in 4CMS X YK-YRKKY candidate genotypes and it was at par with the group (b) 4CMS X EMRDG and 4CMS X ALP57 having 18.25 % and 17.98 %, respectively. The lowest protein content (13.53 % and 13.54 %) was recorded in the varieties and candidate genotypes named Napoli and 4CM X C75. It is stated that there are 17.0-18.3 % protein in the raw form of sunflower seeds and 32.3-46.8 % in the part after the oil is taken (Arioglu, 2007). Protein content values obtained from this experiment; was closer to the lower limit than Khan et al. (2018)'s limits as 18.72-23.41 % and lower than Day (2011)'s limits as 26.37- 32.33%. The reason for these differences may vary depending on the variety and ecological conditions.

Table 2. Variance analysis of characteristics examined in sunflower varieties and candidate genotypes

Sources of Variation	D.F.	Hull ratio (%)	Oil content (%)	Protein content (%)
		Mean square	Mean square	Mean square
Total	44	-	-	-
Replication	2	1.1919	0.49316	0.811775
Genotypes	14	11.63491**	17.93743**	11.06427**
Error	28	1.1716	1.6230	1.01041
$LSD_{Genotypes\ (0.01)}$		2.442	2.874	2.268

**= Significant at p< 0.01

Table 3. Average values and groups for the characteristics examined in the study

Genotypes	Hull ratio (%)	Oil content (%)	Protein content (%)
BOSFORA	27.35 ab	43.18 cd	15.44 cdef
CADIX	25.60 bcd	42.34 cd	16.31 bcde
NAPOLI	23.14 ef	44.69 bc	13.53 f
4CMS X ALP57	23.49 def	39.34 e	17.98 b
4CMS X NP	27.53 ab	43.18 cd	17.65 bc
4CMS X ALPTEM	23.50 def	44.18 bc	15.66 cdef
4CMS X SARM 6	28.57 a	40.58 de	16.95 bcd
4CMS X MHMD	21.56 f	43.67 c	15.50 cdef
4CMS X CO	23.67 cdef	48.29 a	14.66 ef
4CMS X C21	25.20 bcde	47.65 a	17.25 bcd
4CM X C75	26.38 ab	46.75 ab	13.54 f
4CMS X SB	26.84 ab	42.65 cd	15.07 def
4CMS X YK-YRKKY	25.82 bcd	41.91 cde	20.84 a
4CMS X TRHL	23.85 cdef	44.67 bc	16.31 bcde
4CMS X EMRDG	26.10 bc	44.38 bc	18.25 b
Mean	25.24	43.83	16.33

Conclusion

There are many significant changes in the seed, oil and protein of sunflower during seed maturity or development. Our results could be improved by proficient including more genotypes, years and locations. In conclusion, maximum oil contents (48.29 % and 47.65%) were taken by 4CMS X CO and 4CMS X C21 followed by 4CM X C75 which took 46.75 %. The highest protein content was obtained from 4CMS X YK-YRKKY with 20.84 %. The increase in sunflower production will be possible by expanding plantation areas, increasing the yield per unit area and producing varieties with high yield. In addition to high yield, improvement of important quality properties is also comprised of the important yield components. The experiment results indicated that in terms of the important quality properties of 4CMS X CO was a promising candidate genotype for sunflower production in Turkey.

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REFERENCES

Anonymous, (2020a). FAOSTAT. http://www.fao.org/faostat/en/#data/QC (Date of access: 01.08.2020).

Anonymous, (2020b). BYSD. http://www.bysd.org.tr/Dis TicaretRakamlari/ (Date of access: 01.08.2020).

Anonymous, (2020c). General Directorate of Meteorology, Ankara. https://www.mgm.gov.tr/ (Date of access: 01.08.2020).

AOCS, (1993). Official methods and recommended practices. The American Oil Chemists Society, Champaign, IL.

Alpaslan, M. and Gunduz, H. (2000). The effects of growing conditions on oil content, fatty acid composition and tocopherol content of some sunflower varieties produced in Turkey. Food/Nahrung, 44(6), 434-437.

Arioglu, H.H., (2007). Yağ Bitkileri Yetiştirme ve Islahı. Çukurova Üniversitesi Ziraat Fakültesi Yayınları No: 220 Ders Kitapları Yayın No: A-70, Adana, 160-290.

Arioglu, H.H., Kolsarıcı,O., Goksu, A.T., Gulluoglu, L., Arslan, M., Caliskan, S., Soğut, T., Kurt, C. and Arslanoglu, F. (2010). Yağ bitkileri üretiminin artırılması olanakları. Türkiye Ziraat Müh. Bir. VII. Teknik Kong. Bildiri Kitabı I.: 361-377. Ankara.

Baydar, H. And Erbas, S. (2005). Influence of seed development and seed position on oil. Fatty acids and total tocopherol contents in sunflower (*Helianthus annuus* L.). Turk. J. Agric. For.: 29: 179-186.

Connor, D. J. And Hall, A. J. (1997). Sunflower physiology. Sunflower technology and production, 35, 113-182.

Caliskan, O., Kevseroğlu, K. (1997). Değişik vejetasyon dönemlerinde uygulanan azotlu gübrenin ayçiçeğinin (*Helianthus annus* L.) verim ve önemli tarımsal özelliklerine etkisi. Türkiye II. Tarla Bitkileri Kong.: 222-226.

Day, S., (2011) .Ankara Koşullarında Yerli ve Hibrit Çerezlik Ayçiçeği (Helianthus annuus L.)Genotiplerinde Farklı Sıra Üzeri Aralığı ve Azot Dozlarının Verim ve Verim Ögelerine Etkisi. Ankara Üniversitesi Fen Bilimleri Enstitüsü Tarla Bitkileri Anabilim Dalı.Doktora Tezi 89 sayfa.

Dorrell, D. G., and Vick, B. A. (1997). Properties and processing of oilseed sunflower. Sunflower technology and production, 35, 709-745.

Erbas, S., and Senates, A. (2020). Ayçiçeği (*Helianthus annuus* L.)'nde azot ve kükürt gübrelemesinin verim ve kaliteye etkileri. Journal of Natural & Applied Sciences, 24(1).

Evci, G., Pekcan. V., Yılmaz M.I. and Kaya, Y., (2011). Ayçiçeğinde (*Helianthus annuus* L.) Yağ kalitesi ve verim öğeleri arasındaki ilişkilerin belirlenmesi. Türkiye IX. Tarla Bitkileri Kongresi, 12-15 Eylül, Bursa, 2,815-820.

Hassan, S. M., Iqbal, M. S., Rabbani, G. and Shabbir, G. (2012). Genetic variability, heritability and genetic advance for yield and yield components in sunflower (*Helianthus annuus* L.). Electronic journal of plant breeding, 3(1), 707-710.

Gecit, H.H., Ciftci, C.Y., Emeklier, H.Y., İkincikarakaya, S., Adak, S., Kolsarıcı, O., Ekiz, H., Altunok, S., Sancak, C., Sevimay, C.S. and Kendir, H. (2009). Tarla Bitkileri. Ankara Üniversitesi Ziraat Fak. Yay.: 1569, Ders Kitabı: 521. Ankara.

Gur, M.A., Kılıc, H., Özel, A. And Copur, O. 1997. Harran Ovası koşullarında farklı ayçiçeği (*Helianthus annus* L.) çeşitlerinin verim ve verim unsurlarına etkisi üzerine bir araştırma. Türkiye II. Tarla Bitkileri Kong., 217-221.

Kaya, Y. (2004). Ayçiçeği biyoteknolojisinde son gelişmeler ve ıslahında kullanım olanakları. Trakya Üniversitesi Fen Bilimleri Dergisi, 5(2), 141-147.

Kaya, Y. (2005). Determining combining ability in sunflower (Helianthus annuus L.). Turkish Journal of Agriculture and Forestry, 29(4), 243-250.

Kaya, Y., Evci, G., Durak, S., Pekcan, V. and Gucer, T. (2007). Determining the relationships between yield and yield attributes in sunflower. Turkish Journal of Agriculture and Forestry, 31(4), 237-244.

Khan, H., Safdar, A., Ijaz, A., Khan, I., Hussain, S., Khan, B. A. and Suhaib, M. (2018). Agronomic and qualitative evaluation of different local sunflower hybrids. Pakistan Journal of Agricultural Research, 31(1).

Merren A. and L. Champolivier. (1992). Applications of ethephon on sunflower to prevent lodging. Proceedings of 13th International Sunflower Conference, Pisa, Italy, 593-596.

Miller, J.F. and G.N. Fick. (1997). Sunflower Genetics. In: A.A. Schneiter (ed.) Sunflower Technology and Production. Agron. Monogr. 35. ASA. CSSA and SSSA. Madison, WI, USA. 441-495.

Muhammad, H.S., A. Sardar, B. Jehan, K. Ayub,A.S. Sher and K. Nadir. (2012). Evaluation of sunflower lines and their crossing combinations for morphological characters, yield and oil contents. Pak. J. Bot., 44, 687-690.

Nur, I. M. (1969). A rapid method of determining the hull content of safflower and sunflower seeds. Argonomy Journal 61: 336-338.

Steel, R.G.D. and J.H. Torrie. (1997). Principles and Procedures of Statistics. McGraw Hill Book Company Inc., New York.

Siddiqi, M. H., Ali, S.., Bakht, J.., Khan, A., Khan, S. and Khan, N. (2012). Evaluation of sunflower lines and their crossing combinations for morphological characters, yield and oil contents. *Pak. J. Bot*, *44*(2), 687-690.

Tan, A. S. (1993). Ayçiçeğinde (*Helianthus annuus* L.) melez varyete (F1) ıslahında kendilenmiş hatların çoklu dizi (Line x Tester) analiz yöntemine göre kombinasyon yeteneklerinin saptanması üzerine araştırmalar. Doktora Tezi. Ege Üniversitesi, Ziraat Fakültesi. Bornova, İzmir.

Tan, A. S., Memiş, A. A. and Aldemir, M. (2017). Bazı Çerezlik Ayçiçeği Çeşit Adaylarının Menemen, İzmir Ekolojik Koşullarında Verim Potansiyelleri. Anadolu Ege Tarımsal Araştırma Enstitüsü Dergisi, 27(1), 1-16.

Wan, PJ., G.W Baker, S.P. Clark, and S.W Matlock. (1979). Characteristics of sunflower seed and mea!. Cer. Chern. 56:352-355.