Selcuk J Agr Food Sci, 29(2):44-50

Selcuk Journal of Agriculture and Food Sciences

Determination of Some Agricultural Characteristics in The Sunflower Genotypes Developed as Second Crop

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ARTICLE INFO

Article history:

Received 07 June 2015
Accepted 09 September 2015

Keywords:

Oil content
Second crop
Seed yield
Sunflower

ABSRACT

Turkey is an insufficient country to itself by means of oil production and the country is importer clearly. For this reason, new sunflower genotypes should be developed by taking care of the existing conditions. Growing sunflower as second crop in Central Anatolian conditions is a potential to solve oil need problem. This research was conducted in the augmented experimental design in research field of Agricultural Faculty, Selcuk University, Konya-Turkey during the both years of 2010 and 2011. In this research, 3 commercial hybrid varieties (control), 26 of pure lines (F_7) and 13 hybrid variety candidates were used as material. Results of the study implicated that the new developed pure lines and hybrid variety candidates (new genotypes) showed following anges: plant height 38.0-153.0 cm, head diameter 5.0-24.0 cm, stem diameter 0.78-3.01 cm, seed yield 352.0-3345.5 kg ha^{-1}, oil content 29.18-55.27% and oil yield 168.3-1195.6 kg ha^{-1}. According to statistical analysis, some of the new genotypes were better than commercial hybrids in terms of seed yield, oil content and oil yield.

1. Introduction

The most important contributions to the development of sunflower were made by Pustovoit and Jdanov in the Soviet Union, who increased the oil concentration in sunflower seed above %50. Leclercq of France discovered the first usable source cytoplasmic male sterility in a cross *H. petiolaris* Nutt. × *H. annuus* L. and Kinman of the United States developed fertility restorer lines RHA 265 and RHA 266 which allowed practical development of sunflower hybrids (Škorić, 1992). Various breeding works on sunflower are still continue in several countries of the world. Examples of a desirable characteristics are through the hybridization of sunflower are faster maturity (Johnson, 1983).

In recent years, sunflower planted areas have increased because of moderate cultivation requirements and high oil yield. Due to the sunflower ability to tolerate short periods of water deficit (Hattendorf et al., 1988) the potential exists for it to become an important crop also in sub-arid environments (Flagella et al., 2002). Beside that, as second crop, sunflower can be double-cropped with wheat. Sojka et al. (1989) showed a high yield potential for sunflower by using planting dates suitable for double cropping in South Carolina and planting either early in spring or mid-summer.

Turkey has been facing a constant shortage of vegetable oils for many years due to fluctuations in the production of oil seeds. The major edible oil seeds are grown as irrigated and drought crops. To stabilize the production of vegetable oils, there is urgent need to increase potential oilseed sowing areas. The oil extracted from this crop is used for either human consumption or industrial purposes (Kıllı and Altunbay, 2005).

Cultivation areas of oilseed crops should be increased in Turkey. Oil plant that has the most cultivation area and production quantity is sunflower (*Helianthus annuus* L.) with 609 784 ha and 1 523 000 tons (Anonymous, 2013).

Irrigated area in Central Anatolian Region is about 1 500 000 ha which 1 000 000 ha of it planted by cereals.

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After harvest, these areas are free for 90-120 days. It is estimated that growing of sunflower as second crops could act significantly to eliminate the insufficiency problem. Therefore, there is need to the sunflower genotypes which are able to be second crop.

Former studies in Turkey showed that, the growing period of sunflower is indicated as 132.0-137.0 days by Kara (1991), 123.9-141.8 days by Karadoğan and Özgödek (1994), 131.0-131.0 days by Ergen and Sağlam (2005), 106.47-114.33 days by Kümeağaç and Sağlam (2005).

In Turkey, there is a high need for breeding works in order to increase the volume of sunflower genotype and to develop the sunflower genotype in compliance with Central Anatolian conditions that has short vegetation period. Consequently, this study was conducted to determine the compatibility among sunflower lines and hybrids to be second crop in Konya conditions.

2. Materials and Methods

Field trials of the present study were set up according to "Augmented Experimental Design" in the both years of 2010 and 2011. All inbred pure lines (number of 3, 4, 5, 6, 8, 9, 10, 12,13, 14, 17, 18, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 33, 34, 36) and hybrids (number of 1, 2, 7, 11, 15, 16, 19, 22, 23, 31, 32, 35, 37) of sunflower have been developed at Selcuk University Faculty of Agriculture, Department of Field Crops, Konya- Turkey (Table 1). Additionally, three commercial hybrids (Sanbro, A; TR-83, B; TR 3079, C) cultivars were used as material.

In research area, total precipitation was 104.6 mm, average temperature was 19.0 ^{o}C for long period (1991-2009; April-August). Total precipitation was 327.3 mm from November 2008 to August 2009. Monthly average temperatures from July to November were 26.5, 27.7, 22.3, 13.2, 11.0^{o}C, respectively for 2010 and, 26.4, 24.3, 20.6, 11.7 and 3.4 ^{o}C, respectively for 2011. Furthermore, monthly total precipitations were 2.4, 0.7, 0.8, 75.2, 2.8 mm for 2010 and, 4.0, 3.6, 0.8, 45.0 and 8.7 mm for 2011, respectively.

Research area soils had a pH 8.03 and soil characteristics were as following: phosphorous, potassium, iron, zinc, calcium and organic matter were 55.9 kg ha^{-1}, 17.9 kg ha^{-1}, 14.74 ppm, 0.32 ppm, 37.6% and 2.25%, respectively.

Sunflower seeds were sown on 12th of July 2010 and 16th of July 2011. Each row had 5 m long and rows spaced with 50 cm apart. In both of the research years, the plants were thinned by hand the seedling stage to uniform density. For fertilizing, diammonium phosphate (DAP; 18-46-0 %) and urea (46 %) were applied at rates of 100 and 70 kg ha^{-1}, respectively, in both years. The entire dose of nitrogen and phosphorus were applied as basal at planting.

Data were collected on plant height (cm), head diameter (cm), stem diameter (cm), seed yield (kg ha^{-1}), oil content (%) and oil yield (kg ha^{-1}).

The data were analyzed using the GLM procedure in SAS computerized based program.

Table 1
New developed pure lines and hybrids that used in the research

1	(82448x47) X (82398-4)	14	81810-2	27	83018-5
2	(82836-1) X (81895x93-3)	15	(82568) X (82665x65-2)	28	81482
3	81798-5	16	(83018-2) X (81621-2)	29	81680x72
4	81565	17	81535x36-1	30	82315-3
5	P2 black	18	82827x28-3	31	(84248x47) X (82326)
6	81503-4	19	(81202x01x02x01-2) X (81540x36-3)	32	(82921-2) X (81736-2x36-1)
7	(82361-1) X (81895x97-3)	20	81831-1	33	81963-1x63-2
8	81810-1	21	81004x05x04	34	81128
9	81503-3	22	(81005) X (B4)	35	(81655) X (81632x31-1)
10	82792-2	23	(82566) X (82503-4)	36	82984x85-2
11	(81544x41) X (81777)	24	82287	37	(82425-2) X (82416x20)
12	81289-2	25	82877	38	71692
13	81935x36-1	26	82923x22-1	39	82176

3. Results

Table 4 and 5 shows the importance level of probability between the sunflower genotypes.

As we can understand from the evaluation of Table 4, the genotype 15 left behind of the Sanbro cultivar while the genotype 16 left behind of the TR-83 cultivar in 2010 from the point of plant height. In 2011, only the genotype 15 left behind of the Sanbro and TR-83 cultivars (Table 5).

Diameter of the head showed that, none of the new genotypes could surpass the commercial hybrid type used as statistically replicate. Especially most of the genotypes used in the second year (2011) decreased behind of the commercial types.

In the study, there was no statistically importance between the most of the new genotypes and commercial types in terms of stem diameter. However the genotypes 15 and 12 stayed over the three commercial types with the importance level of 1% in 2010. The only genotype 5 was over the Sanbro cultivar with the level of 5% (Table 4).

According to the results of seed yield in 2010, most of the new genotypes fell behind the commercial hybrids. The genotype 5 was over the Sanbro (1%) and TR-3079 (5%) cultivars while the genotype 11 was over all three commercial hybrids (Sanbro, 5%; TR-83, 1% and TR-3079, 1%). None of the new genotypes were statistically over the commercial hybrids in 2011. However, the genotype 10 fell behind the TR-83cultivar with the 5% level of importance.

Oil content of seeds showed that, three genotypes (15, 27 and 35) left statistically behind all three fixed hybrid cultivars while five genotypes (1, 4, 25, 26 and 12) left behind Sanbro and TR-83 cultivars in the first year of the study (2010). Additionally, only Sanbro cultivar fell behind the genotypes 22 and 32. In 2011, the lines numbered 1, 15, 28, 9 and 12 left behind the all standard cultivars. Sanbro and TR-83 cultivars, TR-83 and TR-3079 cultivars, Sanbro cultivar and TR-3079 cultivar fell behind the genotypes numbered 32, 33, 22 and 36, and 16 respectively as well.

In 2010, the most of cultivar used under the study in terms of oil yield fell behind the witness cultivars. Only the genotype 11 left behind all three cultivars, the genotype 27 left behind Sanbro and TR-83 cultivar and finally the genotype 25 left behind Sanbro cultivar. In the second year of the study, 10 of the genotypes in total (2, 23, 21, 24, 25, 28, 31, 35, 11 and 37) fell behind the TR-83 cultivar with the 5% level of importance.

Table 2
Means square of the investigated characteristics

Year	DF	Plant Height	Head Diameter	Stem Diameter	Seed Yield	Oil Content	Oil Yield
2010	41	509.31208	13.19870	0.18042	37.994	29.094	584.941
2011	41	724.31803	11.24860	0.19368	34.638	18.216	695.408

Table 3
Results of the observation in the genotypes

Year	Genotype	Plant Height (cm)	Head Diameter (cm)	Stem Diameter (cm)	Seed Yield (kg ha^{-1})	Oil Content (%)	Oil Yield (kg ha^{-1})
	Control						
	Sanbro	114.7	19.7	1.45	1542.6	39.85	614.9
	TR-83	108.9	20.1	0.92	2036.0	41.39	829.8
	TR-3079	131.1	23.1	1.17	1836.2	47.57	873.8
2010	Mean	118.2	20.9	1.18	1804.9	42.94	772.8
	New Genotype						
	Minimum	57.0	9.0	0.78	352.0	30.32	168.3
	Maximum	145.0	24.0	3.01	3345.5	55.27	1108.0
	Mean	84.4	17.9	1.19	1171.1	43.52	500.2
	Control						
	Sanbro	105.6	13.4	1.43	1617.7	44.19	714.0
	TR-83	122.6	14.5	1.87	2378.0	45.38	1080.1
	TR-3079	92.6	15.5	2.01	1731.4	45.69	791.0
2011	Mean	106.9	14.5	1.77	1909.0	45.09	861.7
	New Genotype						
	Minimum	38.0	5.0	0.80	468.2	29.18	214.7
	Maximum	153.0	18.5	3.00	2397.8	51.36	1195.6
	Mean	68.92	10.0	1.49	1000.6	44.06	437.0
General Average		83.42	14.69	1.37	1230.4	43.83	534.0

Table 4

Comparison of the used genotypes and control groups (commercial varieties) for the importance level of the investigated characteristics

		Genotypes																			
		Plant Height																			
Yıllar		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	A	-1	-1	-1	-1	+1	ns	-1	-1	-1	-1	ns	-5	-1	-5	ns	-1	-1	-1	-1	-1
2010	B	-1	-1	-5	ns	ns	+1	-5	-1	-1	-1	ns	ns	-1	-5	-5	-1	-5	-1	-1	-1
	C	-1	-1	-1	-1	ns	ns	-1	-1	-1	-1	-5	-1	-1	-1	-1	-1	-1	-1	-1	-1
	A	ns	-5	-1	-1	+1	-1	-5	-1	-1	-1	-5	-5	ns	ns	-5	-1	-1	-1	-5	-1
2011	B	ns	-1	-1	-1	+1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	C	-5	ns	-5	-1	-1	-1	ns	-5	-5	-5	ns	ns	-1	-1	ns	-1	-5	-1	ns	-5
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
	A	-5	-1	-5	-1	-1	ns	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	ns	
2010	B	-5	-5	ns	-1	-1	ns	-1	-1	ns	-1	-1	-1	-1	-5	-1	-5	-1	-1	ns	
	C	-1	-1	-1	-1	-1	-5	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-5	
	A	-5	-5	ns	-5	-1	-1	-1	-5	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	ns	
2011	B	-1	-1	-1	-5	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	ns	
	C	ns	ns	ns	ns	-1	-1	-1	ns	-1	-1	-1	-5	-1	-5	-5	-1	-5	-5	ns	
		Head Diameter																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	A	ns	ns	ns	-5	ns	ns	ns	ns	-5	ns	ns	ns	ns	ns	-5	ns	ns	ns	ns	-1
2010	B	ns	ns	ns	-5	ns	ns	ns	ns	-5	ns	ns	ns	ns	ns	-5	ns	ns	ns	ns	-1
	C	-5	ns	ns	-1	ns	ns	ns	-5	-1	-5	ns	ns	ns	ns	-1	ns	ns	-5	ns	-1
	A	ns	ns	-1	-1	-1	-1	-1	-1	-5	ns	ns	ns	-1	-5	ns	-1	-5	-5	-5	-1
2011	B	ns	-5	-1	-1	-1	-1	-1	-1	-5	ns	-5	ns	-1	-5	ns	-1	-1	-1	-5	-1
	C	-5	-5	-1	-1	-1	-1	-1	-1	-1	-5	-5	ns	-1	-1	ns	-1	-1	-1	-1	-1
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
	A	-5	ns	ns	ns	ns	ns	-5	ns	ns	ns	-1	-5	ns	ns	ns	ns	ns	ns	ns	
2010	B	-5	ns	ns	ns	ns	ns	-5	ns	ns	ns	-1	-5	ns	ns	ns	-5	ns	ns	ns	
	C	-1	ns	ns	ns	ns	ns	-1	ns	ns	ns	-1	-1	ns	ns	-5	-5	ns	ns	ns	
	A	-1	-5		-5	ns	-5	-5	ns	ns	-5	ns	ns	ns	-5	-5	-1	-5	-5	ns	
2011	B	-1	-5	-5	-5	-5	-5	-5	ns	ns	-5	-5	ns	ns	-1	-5	-1	-1	-1	ns	
	C	-1	-1	-5	-1	-5	-1	-1	ns	-5	-1	-5	-5	ns	-1	ns	-1	-1	-1	ns	
		Stem Diameter																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	A	ns	ns	ns	-5	+1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	-5	ns	ns	ns
2010	B	ns	ns	ns	ns	+1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
	C	ns	ns	ns	ns	+1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
	A	ns	ns	ns	ns	+5	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
2011	B	ns	ns	ns	ns	ns	-5	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	-5	ns	ns
	C	ns	ns	ns	-5	ns	-5	ns	ns	-5	ns	ns	ns	-5	ns	ns	ns	ns	-5	ns	ns
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
	A	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	+1	ns	ns	
2010	B	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	+1	ns	ns	
	C	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	+1	ns	ns	
	A	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
2011	B	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	C	ns	ns	-5	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	

A: Sanbro, B: TR-83, C: TR-3079 (control cultivars); 1-39: The newly developed sunflower genotypes; -1: $p < 0.01$ and at low value from control cultivar, +1: $p < 0.01$ and at high value from control cultivar, -5: $p < 0.5$ and at low value from control cultivar, +5: $p < 0.5$ and at high value from control cultivar, ns: non-significant.

Table 5
Comparison of the used genotypes and control groups (commercial varieties) for the importance level of the investigated characteristics

		Genotypes																			
		Seed Yield																			
Yıllar		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	A	-5	ns	ns	ns	+1	ns	ns	ns	ns	ns	-5	ns	-5	-1	-5	ns	ns	-5	ns	ns
2010	B	-1	-1	-5	ns	ns	-5	ns	-5	-5	-1	-1	-5	-1	-1	-1	-5	-5	-1	-1	ns
	C	-1	-5	ns	ns	+5	-5	ns	-5	ns	-5	-1	ns	-1	-1	-1	-5	ns	-1	-5	ns
	A	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
2011	B	ns	-5	ns	ns	ns	ns	-5	ns	ns	ns	ns	ns	-5	ns	ns	ns	ns	-5	ns	-5
	C	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
	A	-1	ns	ns	-5	-5	-5	ns	ns	ns	ns	-5	-5	-5	-1	+5	-1	-5	ns	ns	
2010	B	-1	ns	-1	-1	-1	-1	-1	-1	-1	-5	-1	-1	-1	-1	+1	-1	-1	ns	ns	
	C	-1	ns	ns	-1	-5	-5	-5	-5	-5	-5	-1	-1	-1	-1	+1	-1	-1	ns	ns	
	A	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
2011	B	ns	ns	ns	ns	ns	ns	-5	ns	ns	ns	-5	ns	-5	ns	ns	-5	-5	ns	ns	
	C	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
		Oil Content																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	A	+5	ns	ns	+5	ns	ns	ns	ns	ns	+5	ns	ns	+5	ns	ns	ns	ns	ns	ns	+1
2010	B	+5	ns	ns	+1	ns	ns	ns	ns	ns	+5	ns	ns	ns	ns	ns	ns	ns	ns	ns	+1
	C	ns	ns	ns	+1	ns	ns	ns	ns	-5	ns	-5	-5	ns	ns	ns	ns	-5	ns	ns	ns
	A	+1	ns	ns	+1	-5	ns	ns	-5	-1	ns	ns	-1	+5	ns	ns	ns	ns	ns	ns	ns
2011	B	+5	ns	-5	+1	-5	ns	ns	-1	-1	ns	ns	-1	ns	ns	ns	ns	ns	ns	ns	ns
	C	+5	ns	-5	+1	+1	ns	ns	-1	-1	ns	ns	-1	ns	ns	-5	ns	ns	ns	ns	ns
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
	A	+5	+1	ns	ns	ns	ns	ns	+5	ns	ns	ns	ns	+1	ns	ns	ns	+5	ns	ns	
2010	B	+1	+1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	+1	ns	ns	-5	+5	ns	ns	
	C	ns	+5	-5	-5	ns	ns	ns	ns	ns	ns	ns	-5	+5	ns	ns	-1	ns	ns	ns	
	A	ns	ns	ns	+1	ns	ns	ns	+5	ns	ns	+1	ns	ns	+5	ns	ns	+1	ns	ns	
2011	B	ns	ns	ns	+1	ns	ns	ns	+5	+5	ns	+1	ns	ns	ns	ns	-5	+1	ns	ns	
	C	ns	ns	ns	+1	ns	-5	ns	ns	+5	ns	+5	ns	ns	ns	ns	-5	+1	ns	ns	
		Oil Yield																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	A	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	-5	-1	ns	ns	ns	-5	ns	+5
2010	B	-1	-5	ns	ns	ns	-5	ns	-5	-5	-1	-1	-5	-1	-1	-1	-5	-5	-1	-5	ns
	C	-1	-5	ns	ns	ns	-5	ns	-1	-5	-1	-1	-5	-1	-1	-1	-5	-5	-1	-5	ns
	A	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
2011	B	ns	-5	ns	ns	ns	ns	ns	-5	ns	ns	ns	ns	-5	ns	ns	ns	ns	-5	ns	-5
	C	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
	A	-5	+1	ns	-5	ns	ns	ns	ns	ns	ns	-5	-5	ns	-5	-5	+1	-5	ns	ns	
2010	B	-1	+5	-5	-1	-1	-1	-5	-5	-5	-5	-1	-1	-1	-1	-1	+5	-1	ns	ns	
	C	-1	ns	-5	-1	-1	-1	-1	-1	-1	-5	-1	-1	-1	-1	-1	+5	-1	-5	ns	
	A	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
2011	B	ns	ns	ns	-5	ns	ns	-5	ns	ns	ns	ns	ns	-5	ns	ns	-5	-5	ns	ns	
	C	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	

A: Sanbro, B: TR-83, C: TR-3079 (control cultivars); 1-39: The newly developed sunflower genotypes; -1: $p < 0.01$ and at low value from control cultivar, +1: $p < 0.01$ and at high value from control cultivar, -5: $p < 0.5$ and at low value from control cultivar, +5: $p < 0.5$ and at high value from control cultivar, ns: non-significant.

4. Discussion

Plant height is an important yield component and, characteristic of the variety which dealt by sunflower breeders (Miller and Hamond, 1991; İlbaş et al., 1996; Tunçtürk et al., 2005; Kıllı, 1997). Moreover, the plant height is an important character from the point of inclination and harvest mechanization (Karasu et al., 2006). There is a quadratic relationship between the height of the plant and yield of sunflower seeds (Kaya et al., 2009) and it is an undesired specification that the sunflower has an excessive height (Karaaslan, 1999). Because the most of the lines used for study is dwarfness because of the appropriation, they had a characteristic of considerable for the studies which will be done further. Heights of the plants were ranged from 38.0 cm to 153.0 cm (Table 3).

Head diameter was between 5 cm and 24 cm. The diameter of the head is an important indicator of yield in sunflower (Karasu et al., 2006; Vranceanu, 1998; Polat et al., 2011) and there is a quadratic relation between the diameter of the head and seed yield (Kaya et al., 2009). For the head of sunflower, it is an undesirable feature that being very small or very big (Öztürk et al., 2008). For that reason, sunflower breeders are focus on the balance of seed yield and head diameter.

Seed yield is being considerably affected by ecological factors and agricultural techniques in addition to the characteristic of genotype (İlbaş et al., 1996; Tunçtürk et al., 2005). Seed yield of the local genotypes were ranged between 352.0 kg ha^{-1} and 3345.5 kg ha^{-1}. The heritage level of the seed yield which is a complex characteristic (Bange et al., 1997) is generally at a low level. Due to that reason, some characters that have a higher heritage level related with the yield is going to reach the aim soon (Göksoy and Turan, 2003).

The oil content in seed is an important quality specification for sunflower and it is a quantitative character which is affected by environmental conditions significantly (İlbaş et al., 1996; Karaaslan, 1999; Karasu et al., 2007). As in many plants, when the yield of sunflower increases, deterioration is getting higher (Kaya et al. 2009). So, all elements which may affect the oil content are overemphasized. In the present research, the mean of the two years showed that the oil ratio of the local genotypes were between the ratio of 29.18% and 55.27%.

The oil yield which is a product of the seed yield and oil content comes out as a genotypic characteristic. Similarly, it is impressed by all cultivation conditions and ecological factors that determine the seed yield and the oil content (İlbaş et al., 1996). According to İlisulu (1970), the oil yield should be calculated in the researches. Because, a cultivar which has lower oil content in the seeds could have a higher seed yield and get higher oil from unit area as a result. Present research implicated that although most of the local genotypes had lesser values than the commercial hybrids which were used as control, the oil yields were ranged from 168.3 to 1195.6 kg ha^{-1}. Oil yield (i.e., the product of grain yield and grain-oil concentration) is the main selection criteria of most sunflower breeding programs, and best indicator to the real return for farmers. The relative magnitude of the impact of increases in grain yield and grain-oil concentration on the genetic gains achieved for oil yield may differ depending on the period of time considered (De la Vega et al., 2007).

Increase in production is provided by increasing of cultivation area or unit area yield. As is known, the yield is a result of common interaction and the environmental conditions are generated by factor such as climate, soil structure and growing techniques (Coşge and Ulukan, 2005). Therefore, plant breeding works appropriate for production areas are needed by considering present conditions. Morphological and physiological properties come to the forefront of second crop cultivation. Consequently, being earliness in the first place, the yield and quality clarifications of genotypes which selection will be implemented should be identified in detailed.

5. Conclusion

Consequently, most of the used genotypes in the study were better than the commercial varieties in terms of earliness, shorter and had higher oil content as a second crop in Konya conditions.

The developed genotypes are promising for the future breeding works that focus on developing new varieties by using together with different cytoplasmic male sterile sources.

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