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DETERMINATION OF POTENTIAL SUNFLOWER (*Helianthus annuus* L.) CULTIVARS FOR THE IRRIGATED CONDITIONS OF DIYARBAKIR

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SUMMARY

This study was conducted in 2009 at the experiment field of the South East Anatolian Agricultural Research Institute in Diyarbakir in order to determine potential sunflower cultivars for irrigated conditions in the region. The cultivars Sanay, P-4223, Alhasa, Pactol, Armada, Sirena, C-70165, Tunca, Isera, Tarsan-1018, and Tr-3080 were tested in the experiment. Important characteristics such as plant height, head diameter, 1000-seed weight, seed yield, oil content and oil yield were investigated. According to the results, statistical differences were found between the cultivars for 1000-seed weight, seed yield, oil content and oil yield at the 5% probability level. The highest seed yield per hectare (4,110.7 kg) was obtained from Pioneer-4223, while the highest oil yield per hectare (139.3 kg) was produced by C-70165. The lowest oil yield per hectare was found in Tr-3080 (610.6 kg), while the lowest seed yield per hectare was found in Tr-3080 (1,790.6 kg). The highest oil content (40.1%) was obtained from Armada and the lowest from Pioneer-4223 with 34.4%. The highest 1000-seed weight (83.7 g) was obtained from Isera and the lowest from Armada with 56.1 g. The highest plant height (249.9 cm) was obtained from C-70165 and the lowest from Tr-3080 (181.4 cm). The largest head diameter was found in Tunca (17.4 cm) and the smallest in Armada (13.9 cm). Results from this study indicate that Pioneer-4223, Pactol, Isera. C-70165, Tarsan, and Armada can be potential cultivar in terms of yield and the other important characters investigated under the irrigated conditions in Diyarbakir.

Key words: sunflower, cultivar, seed yield, adaptation, oil content

INTRODUCTION

Food and nutrient demand of the world has increased with the rising population of the world. Oil is one of the five basic nutrients for human beings. Therefore, vegetable oil production is as important as that of animal fat, which is limited and

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expensive. Furthermore, sunflower seed meal is a good feed for animals, and sunflower is also an important industrial crop because of its oil. It is also used in soap making, cosmetic products, and plastic paints, and sunflower straw is used in the paper industry. Therefore, sunflower oil has found widespread acceptance as a high quality, edible oil throughout much of the world (Demirer *et al*., 2004).

Turkey has been facing a recurring shortage of vegetable oils for many years due to fluctuations in the production of oilseeds. The major edible oilseeds are grown as irrigated and rainfed crops. To stabilize the production of vegetable oils, there is an urgent need to increase potential oilseed sowing areas. Sunflower is a potential oilseed crop for irrigated areas of the South East Anatolian Region of Turkey (Killi and Altunbay, 2005).

On a world scale, sunflower is the most important oilseed crop after soybean, cotton, rapeseed and groundnut. Sunflower has the widest distribution of any oilseed and offers advantages in crop rotation systems, such as high adaptation capability, suitability for mechanization, and low labor needs (Sedghi *et al*., 2008).

Meanwhile, vegetable oil accounts for 86% of the world's and 80% of Turkey's oil production. Sunflower meets 14% of the world's and 57% of Turkey's oil production demand (FAO, 2002). Total sunflower production in the world is 30 million t (FAO, 2008). Last year in Turkey, sunflower was cultivated on 557,958 ha and 992,000 t of the crop were produced in total (FAO, 2009).

According to FAO data for the years 1961-2004, the biggest cropping area of this plant is found in Russia and Ukraine (formerly the USSR). Last year, the acreage in those countries reached 4,500,000 and 3,320,000 ha, respectively. In the period for which the statistical data were collected, Argentina ranked next, followed by India, the USA, and China. Relatively large cropping areas were also reported in Romania, Bulgaria, Spain, Turkey and the Republic of South Africa (FAO, 2004). These seven countries produce about 68.8% of the world's production (Kluza-Wieloch, 2005).

Various studies have been conducted to evaluate the agronomic performances of commercially available sunflower cultivars in different areas of Turkey and other countries (Ilisulu and Arslan, 1973; Robertson *et al*., 1984; Potter *et al*., 1985; Kara, 1988; Oral and Kara, 1989; Kara, 1991; Gür *et al*., 1997; Killi, 1997; Karaaslan *et al*., 1999; Göksoy, 1999; Önder *et al*., 2001; Özer *et al*., 2003; Demirer *et al*., 2004; Coskun and Ulukan, 2005; Killi and Altunbay, 2005; Kluza-Wieloch, 2005; Tunçtürk *et al*., 2005; Özden *et al*., 2008 and Sedghi *et al*., 2008). These studies suggested that the cultivars showed wide differences in their agronomic characteristics and seed yield. Although a large number of commercial sunflower cultivars have recently been released, the yield capabilities of these new genotypes have not been studied under climatic conditions of the South East Anatolian Region. Therefore, this study was initiated to evaluate the agronomic performances of some commercially available oilseed sunflower cultivars in Diyarbakir irrigated conditions.

The objective of this study was to determine the production possibilities of some sunflower cultivars under irrigated conditions in Diyarbakir province, or South East Anatolian Region climate.

MATERIALS AND METHODS

The experiment was conducted in the trial area of the Southeast Anatolia Agricultural Research Institute. The experimental design was a randomized complete block with three replicates. Eleven oilseed sunflower cultivars (Sanay, P-4223, Alhasa, Pactol, Armada, Sirena, C-70165, Tunca, Isera, Tarsan-1018 and Tr-3080) were used. The experiments were performed on a silty-clay soil with a pH of 7.65 to 7.80 and a lime content of 8.67%. The experiment site is located in the Southeast of Turkey at an altitude of 650-700 m above sea level. Air temperatures, precipitation, and relative moisture values were collected from a meteorological station about 7 km west of the test site and are presented in Table 1. The seeds were sown by the sowing machine at a spacing of 0.30 and 0.70 m within and between the rows, respectively.

Table 1: Monthly and growing season precipitation, temperature and relative humidity in Diyarbakir in 2009 and the long-term average (LTA)

Months	Average temperature (°C)		Precipitation (mm)		Relative humidity (%)	
	2009	LTA	2009	LTA	2009	LTA
March	7.9	8.2	63.9	67.9	73.8	66
April	11.8	13.8	43.7	70.5	71.3	63
May	18.2	19.2	9.1	42.1	51.8	56
June	25.7	26	0	6.9	32	31
July	29.5	31	1.6	0.6	26.1	27
August	28.6	30.3	0	0.4	19.8	28
September	22.9	24.8	25.2	2.7	33	32
October	18.5	17.1	62.4	31.1	42	48
Total or mean	20.3	21.3	211.9	222.2	43.7	43.8

The experimental plots were 2.8 m wide and 6 m long and consisted of 4 rows. Seeding occurred on 1 April 2009. Before sowing, nitrogen fertilizer in the form of ammonium sulfate was broadcast and incorporated at a rate of 100 kg ha^{-1}. All plots received 80 kg P_2O_5 kg ha^{-1} as triplesuperphosphate before sowing (Ülgen and Yurtsever, 1995). Weeds were controlled mechanically and by hand-hoeing. All plots were furrow irrigated regularly to avoid drought stress. A total of 6-7 irrigations were applied. The sunflower cultivars were hand-harvested at the stage of physiological maturation when the back of the head had turned from green to yellow and the bracts were turning brown. At harvest, 10 plants from each plot were selected for determining plant height, head diameter, 1000 seed weight, and seed oil content (% dry matter). Determination was done using the Soxhlet method. At maturity, head samples for yield were harvested from the two central rows of each

plot. They were then dried and threshed mechanically. All data were analyzed by one-way ANOVA using the JMP package program (SAS Institute *Inc.*, 1990). Means were compared using the LSD test at the 5% probability level.

RESULTS AND DISCUSSION

In this study, according to the results of variance analysis shown in Table 2, statistical differences were found between cultivars for 1000-seed weight, seed yield, oil content, and oil yield at level a probability of 5%.

Table 2: Analysis of variances for the agronomic traits of some oilseed sunflower cultivars grown in 2009 in Diyarbakir

Source of variance	Degrees of freedom	Plant height	Head diameter	1000-seed weight	Seed yield	Oil content	Oil yield
		(cm)	(cm)	(g)	(kg ha^{-1})	(%)	(kg ha^{-1})
Cultivar	10	1111.7	3.53	197.8*	12467.2**	17.07**	1663.8**
Replicate	2	111.6	7.23	224.5*	12734.3*	0.36	1694.0*
Error	20	1197.2	1.73	52.7	2590.3	2.75	337.6
C. Total	32	-	-	-	-	-	-

(*) P<0.05; (**) P<0.01

No statistically significant differences in plant height and head diameter were found among the cultivars. The results regarding the yield components of the sunflower cultivars grown under Diyarbakir irrigated conditions are summarized in Tables 3 and 4.

Table 3: The average of plant height, head diameter and 1000-seed weight of some oilseed sunflower cultivars grown in 2009 in Diyarbakir

Cultivars	Plant height	Head diameter	1000-seed weight
	(cm)	(cm)	(g)
Sanay	204.3	15.5	66.3 cde
P-4223	189.8	15.0	65.5 de
Alhasa	198.6	15.9	72.4 abcd
Pactol	190.1	17.2	74.3 abcd
Armada	188.3	13.9	56.1 e
Sirena	194.8	16.6	73.9 abcd
C-70165	249.9	17.1	80.0 ab
Tunca	185.7	17.4	78.5 abc
Isera	187.1	16.1	83.7 a
Tarsan-1018	182.2	15.2	69.1 bcd
Tr-3080	181.4	13.3	63.2 de
Mean	199.8	15.7	71.2
L.S.D. (at 5% level)	N.S.	N.S.	12.36*
C.V. (%)	17.68	8.25	10.19

Table 4: The average of oil content, seed yield and oil yield of some oilseed sunflower cultivars grown in 2009 in Diyarbakir

Cultivars	Seed yield (kg ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})
Sanay	323.8 bc	33.6 d	108.7 ab
P-4223	411.7 a	33.4 d	137.5 a
Alhasa	330.0 abc	38.4ab	127.0 ab
Pactol	383.7 ab	35.5 cd	136.1 a
Armada	299.5 bc	40.1 a	120.0 ab
Sirena	257.3 cd	37.2 bc	95.8 b
C-70165	354.1 ab	39.4 ab	139.3 a
Tunca	347.8 ab	37.5 abc	130.3 a
Isera	369.2 ab	35.5 cd	131.5 a
Tarsan-1018	356.7 ab	37.9 abc	134.1 a
Tr-3080	179.6 d	33.7 d	61.6 c
Mean	328.5	36.5	120.1
L.S.D. (at 5% level)	86.68**	2.82**	31.29**
C.V. (%)	15.49	4.53	15.28

The plant height values of the sunflower cultivars are presented in Table 3. There were no statistically significant differences among the cultivars with regard to this trait. The cultivar with the highest plant height was C-70165 with 249.9 cm, while the lowest plant height was found in Tr-3080 (181.4 cm). Differences (not important in statistical terms) that were observed among the cultivars were probably related to genotype variation, as reported by Kara (1986) and Oral and Kara (1989). No significant genotypic difference was observed among the cultivars for head diameter (Table 3). The differences between the cultivars were largely caused by weather conditions, particularly rainfall (Table 1).

Head diameters ranged from 13.3 in the cultivar Tr-3080 to 17.4 cm in the cultivar Tunca. Most of the head diameter differences (statistically not important) can be attributed to genotype variation, which is in agreement with several other reports (Sezer and Atakisi, 1993; Killi, 1997). A significant genotype differences was found between the cultivars for 1000-seed weight (Table 3). Genotype had a strong impact on 1000-seed weight, and the cultivar Isera had the highest seed weight with 83.7 g. The lowest 1000-seed weight was observed in Armada with 56.1 g. This variation in 1000-seed weight most likely resulted from genotype differences (Ilisulu and Arslan, 1973; Oral and Kara, 1989; Ilbas *et al.*, 1996; Yilmaz and Bayraktar, 1996). The potential seed yield of sunflower is highly dependent on environmental conditions during the vegetation cycle of the crop (Bange *et al.*, 1997). In the present study, seed yield was substantially influenced by both genotype and environmental conditions.

The yields of the cultivars varied from 1,790.6 to 4,110.7 kg ha^{-1}. The cultivars P-4223, Pactol, Isera, Tarsan-1018, Tunca and Alhasa had the highest seed yields.

The lowest seed yields were obtained from Tr-3080 with 1,790.6 kg ha^{-1} (Table 4). The seed yields of the cultivars investigated in the present study were comparable to those reported for this region in previous studies (Karaaslan *et al.*, 1999; Karaaslan *et al.*, 2001; Karaaslan and Hakan, 2007). The sunflower cultivars produced higher seed yields in 2007 (4,580.5 kg ha^{-1}) than in either 2001 (344.5 kg ha^{-1}) or 1999 (295.8 kg ha^{-1}). However, the higher yields in 2002 compared to those in 2001 were due to more favorable weather conditions, particularly rainfall.

A differential response occurred among the cultivars in 1999 and 2002. Seed oil content was significantly influenced by genotype (Table 4). Seed oil content depends on genotype but is also affected by environmental conditions and cultural practices (Harris *et al.*, 1978; Dedio, 1985; Amir and Khalifa, 1991; Esechie *et al.*, 1996). Previous studies reported that seed oil content could vary widely with plant variety and growing conditions (Biberdžić *et al.*, 1998; Stanojević *et al.*, 1998). The cultivar Armada had the highest oil content (40.1%), while the lowest was found in Tr-3080 (33.7%), Sanay (33.6%) and P-4223 (33.4%). Oil yield results from this experiment revealed that highly significant differences were present among the oil yields of the cultivars (Table 4). Similar results were reported by Ilbas *et al.* (1996) and Yilmaz and Bayraktar (1996), who conducted studies on sunflower cultivars. Consequently, the ranking of the oil yield of the cultivars differed with the study year.

CONCLUSION

This study was carried out to determine the production possibilities of some sunflower cultivars under irrigated conditions in Diyarbakir. Cultivar adaptation is important for regions. No problems regarding the needs of the growth and development of the sunflower cultivars in this region were encountered. The growing season period at the experimental site was favorable for all cultivars. According to the results of the current study, it can be concluded that Pioneer-4223, Pactol, Isera, C-70165, Tarsan, and Armada, with their high seed and oil yields and good values of the other important characters, can be suggested as the best cultivars for the irrigated conditions of Diyarbakir. However, we see a need for conducting additional cultivar performance studies that would include the recently developed sunflower cultivars.

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