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Evaluation of Seed, Oil Yields and Yield Properties of Different Sunflower (*Helianthus annus* L.) Hybrid Varieties in Van, Turkey

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Abstract: This research was carried out to determine some important agronomical properties of sunflower varieties in Van (Eastern), a high latitude site, Turkey. During 2001-2002, some sunflower varieties (NSH-01, NSH-712, NSH-43, NSH-111, TR-6149 and 64A52) were sown as main crop in late May in 60 cm apart and thinned 15-20 day after emergence to a stand density of 55 000 plants/ha and given 120 and 100 kg ha^{-1} of N and P_2O_5, respectively under irrigated conditions. Data were tabulated on mean plant height, stem diameter, head diameter, seed number per head, 1000 seed weight, seed yield, oil content and oil yield for each cultivar in both years. It was showed that the all analyzed features were affected by cultivars and years. Averaged over years, seed yields ranged from 1.74 to 3.17 t ha^{-1} and oil yields ranged from 0.66 to 1.58 t ha^{-1}. The TR-6149 cultivar had the highest seed yield (3.96 and 2.38 t ha^{-1}, respectively) and oil content (49.83 and 50.20%, respectively) in both years. It was concluded that TR-6149, NSH-43 and NSH-111 were considered the best cultivars, having high oil and seed yields under irrigated conditions.

Key words: Sunflower, variety, growth, yield, yield components

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the four most important annual crops grown for vegetable and industrial oils in the world. It is successfully grown over a widely scattered geographical area and considered a crop adapted to a wide range of environmental conditions as it can be grown from the 40th parallel South to the 55th parallel North and up to 2500 m above sea level[1]. Sunflower is also the most important oilseed crop in Turkey and it is grown around 0.5 M ha per year with average seed yields of 1.2-1.6 t ha^{-1}, a production insufficient for national seed and oil requirements[2]. Although sunflower production has mainly been performed in Marmara region under non-irrigated conditions, the crop is well adapted to the different climatic zones in Turkey, including Eastern Anatolia region, where the climate is characterized with a short growing season, cool temperatures and semiarid climate conditions.

Researcher[3-7] have been extensively study in the world concerning the seed yield and yield components of the standard and hybrid sunflower genotypes. However detailed studies on the irrigated sunflower hybrids are limited in Turkey, especially in Eastern Anatolia region[8-10]. Recently, there has been an interest in oilseed sunflower hybrid production, but no information was available concerning oilseed sunflower hybrid farming in this region.

Although sunflower can grow on almost all region of country, there are no statistical records of sunflower production in Van. It mostly cultivate as symbolic in garden agriculture. Herbal production of Van based mostly on cereals partly food plants, sugar beat and potato cultivation. Increasing the crop variety is come true, especially determining of superior variety based on yield and quality which adapted to the ecological conditions of this area for each plant. So, it should be possible to be help on the development of agriculture and heighten of welfare level who living in this area.

The aim of this study was to determine the irrigated sunflower hybrids which in high yield, quality and adaptable to the area.

MATERIALS AND METHODS

Field trials were conducted in 2001 and 2002 at a farm located in Van, Eastern Anatolia region (38°55'N and 42°05'E, 1725 m elevation). The soil were loamy and consist of 0.24% total nitrogen content (Kjheldhal method), 8.88 ppm phosphorus (Olsen method, P_2O_5), 1542.44 ppm available potassium (Ammonium acetate

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method, K_2O) and 2.24% organic matter (Walchey-Black method). The soil pH was 7.5. The typical rainfall pattern of Van is characterized with high rainfall in winter and spring and low rainfall from June to August. Accumulated rainfall during the crop cycle was 40.8 and 84.7 mm in 2001 and 2002, respectively. These values were lower than the average for 1948-1988, which was 87.3 mm. The precipitation occurred mainly towards the beginning of the cycle in 2002. Thus it was caused a better soil water status at sowing and a better first vegetative growth according to 2001. In general, the temperatures were above the average for 1948-1988 (18.2°C) in both 2001 and 2002. The obtained values were 21.0, 18.6°C in 2001 and 2002, respectively. Monthly mean relative humidity were also 46.4, 48.3 and 49.2% in 2001, 2002 and the long-term average, respectively.

The sunflower hybrid cultivars NSH-01, NSH-712, NSH-43 and NSH-111 supplied from Poljoprivrdni Institut Osijeck, Croatia; TR-6149 from the Thrace Agriculture Research Institute, Turkey and 64A52 obtained from Pioneer Seed Company were used as plant material. The experiments were designed in a Randomized Complete Block Design with four replications. Cultivars were sown as main crop in 25 May in 60 cm apart and thinned 15-20 days after emergence to a stand density of 55000 plants/ha. In this study, 60 kg N ha^{-1} as ammonium sulfate and 100 kg P ha^{-1} as triple super phosphate was applied prior to sowing and a further 60 kg N ha^{-1} as ammonium nitrate was added when the plants were 30-40 cm in height. The plots received common cultural practices for the area where the experiments were conducted. All plots were furrow irrigated regularly to avoid drought stress. A total of 4 irrigation's each year was applied. Harvest was performed on mid-September in both years. In this study, six oilseed sunflower hybrid cultivars was evaluated for plant height, stem diameter, head diameter, number of seed/head, 1000 seed weight, seed yield, oil content and oil yield. Oil content was determined by the Soxhalet extraction technique. Oil yield was calculated as a function of seed yield and oil content.

Data were analyzed using the ANOVA procedure of the MSTAT-C statistical package (version 2.1-Michigan State University, 1991) and differences between means were compared according to the Duncan's Multiple Range test that uses multiple ranges for testing differences between the means[11].

RESULTS AND DISCUSSION

The variance analysis results showed that all the characters were strongly influenced by year and cultivar. The year x cultivar interactions were found to be statistically significant at 1% level of probability for plant height, stem diameter, head diameter, number of seeds per head, 1000 seed weight, oil content and oil yield and at 5% seed yield. These interactions indicated that varieties responses to different according to the years (Table 1).

The cultivars differed significantly in plant height in both years. In 2002 plant heights were higher than in those in 2001 (Table 1). In 2001, plant height ranged from 155.92 (64A52) to 188.90 cm (NSH-43), whereas it ranged between 183.74 (64A52) and 218.84 cm (NSH-43) in 2002. The differences among cultivars and between years probably reflect the influence of environmental conditions that much of the year to year variability is associated with rainfall during the vegetative stages and flowering of the season. Previous studies indicated that the plant height ranged from 110 to 212 cm and results were in agreement with the results reported by Monotti *et al.*[3], Lauretti *et al.*[12], Akkaya *et al.*[13] and Tkachenko[14].

The stem diameter of sunflower cultivars varied with each year and this component was less in 2002, ranging from 18.32 (NSH-01) to 22.85 mm (NSH-43), than in 2001 when it ranged between 19.33 (64A52) and 26.90 mm (NSH-43) (Table 1). The superior stem diameter may be explained by the negative correlations between plant height and stem diameter in 2001. The reduction in mean stem diameter observed for the study, is mostly appeared with an increase observed in the plant height component. These findings are in accordance with Kluza and Musnicki[15].

Yield components: Head diameter is one of the most important yield components in sunflower. In 2001, head diameter ranged from 16.31 (64A52) to 23.64 cm (NSH-111), whereas it ranged from 14.03 (NSH-01) to 20.69 cm (NSH-43) in 2002 (Table 1). The superior head diameter may be explained by the negative correlations between plant height and head diameter in 2001. It is known that head diameter is increase in which plant height is short and an increase in head diameter in reverse relation with plant height was also reported by Kluza and Musnicki[15] and Göksoy[16]. In addition the genotype, environmental conditions also had an influence on this yield component. Previous studies indicated that the head diameter ranged from 12 to 24 cm and results are in agreement with these studies[13,17].

The number of seeds per head is positively associated with seed yield in sunflower. There was more number of seeds per head in 2001, ranging from 758 (64A52) to 1435 (NSH-01), than in 2002 when it ranged between 665.2 (NSH-712) and 1126.4 (NSH-43) (Table 1). The reduction in mean number of seeds observed for the study is mostly explained by the reduction observed in

Table 1: Variation in yield and some agronomic characters of six oilseed sunflower hybrids grown at Van in 2001 and 2002

	Plant height (cm)			Stem diameter (mm)			Head diameter (cm)			Number of seeds per head		
Cultivars	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
NSH-01	185.36a	190.23d	187.69b	24.64b	18.32b	21.48b	21.88ab	14.03b	17.96b	1435.0a	762.9b	1098.9a
NSH-712	171.66b	207.01b	189.33b	23.11bc	20.15ab	21.63b	21.04bc	14.43b	17.95b	1143.5c	665.2b	904.3cd
NSH-43	188.90a	218.84a	203.87a	26.90a	22.85a	24.87a	20.91bc	20.69a	20.75a	1001.0d	1126.4a	1063.7ab
NSH-111	171.10b	203.10bc	187.10b	23.39bc	21.78a	22.58b	23.64a	18.09a	20.86a	953.5d	980.0a	966.7bcd
64A52	155.92c	183.74d	169.83c	19.33d	20.17ab	19.75c	16.31d	16.04ab	16.17c	758.0e	1018.6a	888.3d
TR-6149	186.26a	193.58cd	189.91b	22.50c	20.33ab	21.41b	19.51c	17.60a	18.56b	1300.0b	699.5b	999.7abc
Mean	176.53b	199.38a		23.31a	21.41b		20.55a	16.81b		1098.5a	875.4b	
CV (%)	0.84	1.93	1.60	2.37	5.92	4.13	3.86	4.93	4.58	2.98	8.44	5.99
Year (Y)			**			**			**			**
Cultivar ©	**	**	**	**	**	**	**	**	**	**	**	**
Y×C			**			**			**			**

	1000 seed weight (g)			Seed yield (t ha^{-1})			Oil content (%)			Oil yield (t ha^{-1})		
Cultivars	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
NSH-01	38.06f	33.00d	35.53d	2.90b	1.34c	2.12c	40.20d	41.21e	40.70d	1.14b	0.53d	0.83d
NSH-712	40.20e	30.50e	35.35d	2.43d	1.06d	1.74d	38.13e	40.13f	39.13e	0.91c	0.41d	0.66e
NSH-43	52.16c	41.75b	46.95b	2.77c	2.46a	2.61b	44.70b	47.03b	45.86b	1.21b	1.15b	1.18b
NSH-111	55.56b	35.58c	45.58b	2.79c	1.82b	2.30c	41.76c	42.56d	42.16c	1.17b	0.75c	0.96c
64A52	44.70d	36.50c	40.60c	1.77e	1.95b	1.86d	39.10de	44.20c	41.65c	0.70d	0.87c	0.78d
TR-6149	60.33a	64.00a	62.16a	3.96a	2.38a	3.17a	49.83a	50.20a	50.01a	1.96a	1.20a	1.58a
Mean	48.50a	40.22b		2.77a	1.83b		42.28b	44.25a		1.18a	0.81b	
CV (%)	1.22	1.39	1.40	7.49	3.92	5.71	1.01	0.36	0.77	6.70	3.62	5.12
Year (Y)			**			*			**			**
Cultivar ©	**	**	**	**	**	**	**	**	**	**	**	**
Y×C			**			*			**			**

*,**: Significant at the 0.05 and 0.01 level, respectively; CV: Coefficient of Variation

the head diameter component. Besides, the number of seeds per head varied according to variety heritage, head diameter, seed-setting ratio, number of fertile floret and anthesis, as reported by Kluza and Musnicki[15] and Göksoy *et al.*[17]. In addition to genotype, environmental conditions also had an influence on this yield component. The number of seeds/head varied significantly with cultivar and it was ranked very different according to the year. Maximum the number of seeds per head was obtained from NSH-01 and minimum it from 64A52. Results are in close agreement with those of, Arslan *et al.*[10], Akkaya *et al.*[13] and Göksoy *et al.*[17].

Thousand seed weight is commonly a major determinant of sunflower yield. This yield component was less in 2002, ranging from 30.50 (NSH-712) to 64 g (TR-6149), than in 2001 when it ranged between 38.06 (NSH-01) and 60.33 g (TR-6149) (Table 1). 1000 seed weight was related to cultivar and environmental conditions, as reported by Monotti *et al.*[3] and Lauretti *et al.*[12]. The cultivars had greater head diameters and more 1000 seed weight in 2001. Previous studies indicated that the 1000 seed weight ranged from 30 to 68 g and results are in agreement with these studies[10,13,18,19].

Seed yield: The cultivars differed significantly in both years. In 2001 yields were higher than those in 2002 (Table 1). In 2001, seed yield ranged from 1.77 (64A52) to 3.96 t ha^{-1} (TR-6149), whereas it ranged between 1.34 (NSH-01) and 2.46 t ha^{-1} (NSH-43) in 2002 (Table 1). The differences between years probably reflect influence of environmental conditions. While 2001 year had the high temperature during flowering phase and grain filling period, the 2002 had the lower values of temperature during these crop stages. Seed yield varied significantly with cultivar. Maximum seed yield was obtained from the TR-6149 cultivar and minimum seed yields from the NSH-712 and 64A52 cultivars. Among cultivars this difference could be partially associated with the genotypic characters, especially the head diameter, number of seeds per head and 1000 seed weight. Previous studies indicated that the seed yield ranged from 1.10 to 3.98 t ha^{-1} and results are in agreement with these studies[4,7,12,14,16].

Seed oil content and oil yield: Seed oil content, an important quality component in sunflower, varied significantly with year and cultivar (Table 1). This yield component was less in 2001, ranging from 38.13 (NSH-712) to 49.83% (TR-6149), than in 2002 when it ranged between 40.13 (NSH-712) and 50.20% (TR-6149) (Table 1). Since oil content is determined by several environmental factors (especially temperature) as well as genotypic structure, it is likely that these differences are mainly due to environmental conditions. On the other hand, results for

the oil content are also expected, as reported by Lopez *et al.*[19] and Gonzales and Oliva[20], negative correlations were found between oil content and 1000 seed weight. Seed oil content varied significantly with cultivar. Maximum oil content was obtained from the TR-6149 cultivar and minimum oil content from the NSH-712 in both years. Previous studies indicated that the oil content ranged from 35 to 50% and results are in agreement with these studies[3,5,10,12,16,18].

The oil yield was altered by year and cultivar. In 2001, oil yield ranged from 0.70 (64A52) to 1.96 t ha^{-1} (TR-6149), whereas it ranged from 0.41 (NSH-712) to 1.20 t ha^{-1} (TR-6149) in 2002 (Table 1). These differences were related to variations in yield components, especially seed yield. Results are in close agreement with those of Mancuso[7], Lauretti *et al.*[12], Tkachenko[14] and Önder *et al.*[18].

It is concluded that TR-6149, NSH-111 and NSH-43 cultivars can be grown for their high seed and oil yield under irrigated conditions in Van, Turkey.

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