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Seed Yield, Oil Content and Yield Components of Confection and Oilseed Sunflower (*Helianthus annuus* L.) Cultivars Planted in Different Dates

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ABSTRACT

Study was conducted to determine the response of oilseed (P-6480) and confection (Inegol) sunflower cultivars to different planting dates during 2001. The crop was sown on 26 March; 6, 16 and 26 April; 5 May, 16 and 26 May and 6 June. Days to maturity, plant height, head diameter, total number of seeds head^{-1}, seed setting efficiency, 1000-seeds weight, seed yield, hull ratio and seed oil content of oilseed and confection sunflower cultivars were significantly affected by different planting dates. Crop sown on the 26 March resulted in the highest plant height, head diameter, total number of seeds head^{-1}, seed setting efficiency, 1000-seed weight and seed yield; while the 16 April planting resulted in the highest oil content. Oilseed sunflower cultivar had higher head diameter, total number of seeds head^{-1}, seed setting efficiency, seed yield and oil content than confection sunflower.

Key Words: Sunflower; Planting dates; Seed yield; Oil content; Yield components

INTRODUCTION

Turkey has been facing a recurring shortage of vegetable oils for many years due to fluctuations in the production of oil seeds. The major edible oilseeds are grown as irrigated and rainfed crops. To stabilize the production of vegetable oils, there is urgent need to increase potential oilseed sowing areas. Sunflower is a potential oilseed crop for irrigated areas of East Mediterranean region of Turkey. The oil extracted from this crop is used for either human consumption or industrial purposes. Several studies have demonstrated that seed and oil yield in sunflower is strongly reduced when normal planting dates are delayed (Robinson, 1970; Johnson & Jellum, 1972; Bhattacharya *et al.,* 1975; Unger, 1980; Beard & Geng, 1982; Killi & Gencer, 1992; Bange *et al.,* 1997). Miller *et al.* (1984) found that as planting was delayed, head diameter, seed yield and oil content declined. Dedio (1985) reported that as planting was delayed, seed yield and oil content decreased. Weight per seed and seed oil concentration in sunflower are determined during the seed filling period from end of flowering to physiological maturity (Aguirrezabal *et al.,* 2003). Seed oil concentration begins to increase rapidly a few days after flowering and continues to increase until a few days before physiological maturity, when it stabilizes (Goffner *et al.,* 1988). Changes in environmental conditions during the seed filling period potentially effects sunflower yield components (Aguirrezabal *et al.,* 2003). The objective of this study was to determine the optimum planting date for seed yield, yield components and oil content of oilseed and confection sunflower cultivars for Kahramanmaras province or East Mediterranean climate.

MATERIALS AND METHODS

Two sunflower were selected based on their adaptation to the sunflower production areas in the East Mediterranean Region of Turkey. P-6480 and Inegöl sunflower cultivars have been successfully grown under rain-fed and irrigated conditions of this region. P-6480 was selected because of having relatively small seeds, a hybrid cultivars and oilseed cultivars. Inegöl was selected because of having relatively large seeds, composite and confection. These two sunflower varieties were shown at eight different planting dates (26 March; 6, 16 & 26 April; 5, 16 & 26 May; & 6 June) in 2001 at the Agricultural Research Institute of Kahramanmaras province, Turkey. Kahramanmaras province is located in the East-Mediterranean region of Turkey between 37° 36' north parallel and 46° 56' east meridians. The studies were established on alluvial clay loam with the following mean properties; pH = 7.5, organic matter = 1.7%, N = 0.05%, $CaCO_3$ = 19.8%, available P = 51.5 kg ha^{-1}, and available K = 73 kg ha^{-1}. Based on soil test conducted in test year, nitrogen, phosphorus and potassium at the rate of 60 kg N, P_2O_5 and K_20 ha^{-1} were applied, respectively, and remaining nitrogen (60 kg N ha^{-1}) was top dressed at the R_1 stage (Schneiter & Miller, 1981). Cultural practices, control of insects and weeds and furrow irrigation were given as needed during the growth season according to the local recommendations. All other receded production

practices were followed.

The trials were conducted using a randomized complete block design with split-plot arrangement keeping with planting dates as main plots and cultivars as subplots. Each subplot consisted of four rows 7 m in length with 70 cm between rows and 35 cm hill spacing. Individual plots were spaced 2.8 m apart. Each treatment was replicated three times. The sunflower seeds were sown by putting three seeds to hills by hand. Plants were thinned to one plant per hill 15 days after sowing. Ten randomly tagged plants from each plot were evaluated for plant height, head diameter, total number of seeds head^{-1}, seed setting efficiency, seed yield head^{-1} and 1000-seeds weight. Achenes were separated into nonempty and empty. Nonempty achenes were counted, oven dried (with air circulating at 60°C) to constant weight, and weighed. Seed setting efficiency were calculated from nonempty and empty achenes as *(nonempty achenes / nonempty + empty achenes) X 100*. Seed yield were obtained from an area 1.4 m wide and 5 m long of the center two rows of each plot. Seed samples were collected from each plots and ground with an electric coffee mill. A small portion of ground seeds (5 g) was transferred to a disposable filter column and seed oil content was determined by the Soxhlet apparatus. Hull ratio was determined following the procedure reported by Urie *et al.* (1968). In the experiment, confection and oilseed sunflower cultivars at the eight different planting dates were harvested 15th August, 23rd August, 3rd September, 13th September, 17th September, 21st September, 25th September and 3rd October by hands, respectively. All data were analyzed using the MSTAT-C statistical package programme. When the *F*-test indicated statistical significance at the *P*=0.05 level, the protected least significant difference (Protected LSD) was used to separate the means.

RESULTS AND DISCUSSION

All weather data were collected at an official weather station located about 5 km from the experimental site. The monthly precipitation, temperatures (mean, maximum and minimum) and relative humidity data for 2001 are presented in Fig. I. Air temperatures during the growing season were changed from 9.1°C (March) to 36.9°C (August). There was considerable variability in rainfall amounts and distribution from month to month. The March rainfall was the highest. There was an extended dry and hot period during June, July and August when only 1.7 mm of precipitation occurred. September continued warm with 9.6 mm of rainfall. The means of the relative humidity during the growing season were similar (Fig. 1).

Differences in sunflower parameters among planting dates and cultivars are presented in Table I. The main effects associated with date of planting and cultivars were significant for all of the investigated characteristics. However, the interaction term (cultivar X planting date) was not significant except for plant height and seed yield. The number of days from planting to maturity of cultivars was 128-136 days. P-6480 (oilseed sunflower) reached maturity 8 days earlier than Inegol (confection sunflower). As the planting date was delayed, the number of days to maturity was reduced. Planting on 26 March resulted in 147 days to maturity while the number of days to maturity in the 6 June planting was 120 days. An increased number of days to maturity induced by early sowing could be explained by the fact that delayed planting reduces the period required from sowing to flowering. On average, late-sown sunflower (6 June) reached maturity 27 days earlier than the early-sown sunflower (26 March). This result indicated that the number of days to maturity varied with temperature conditions during the growing season and planting date. Johnson and Jellum (1972) reported that as planting was delayed, the number of days from planting to flowering and days to

Fig. 1. Monthly mean, maximum and minimum temperatures (°C), precipitation (mm) and humidity (%) at Kahramanmaras province, Turkey in 2001

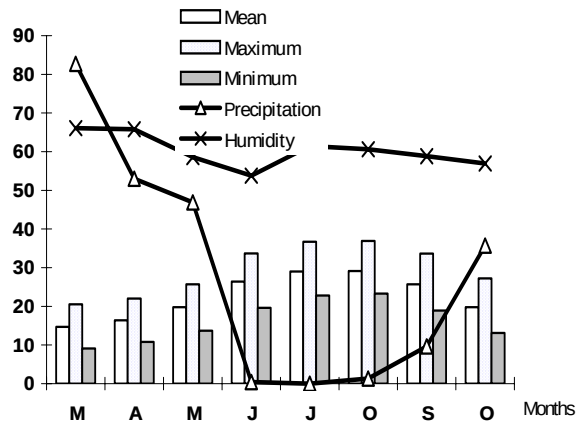


Fig. 2. Plant height of sunflower cultivars planted in different dates

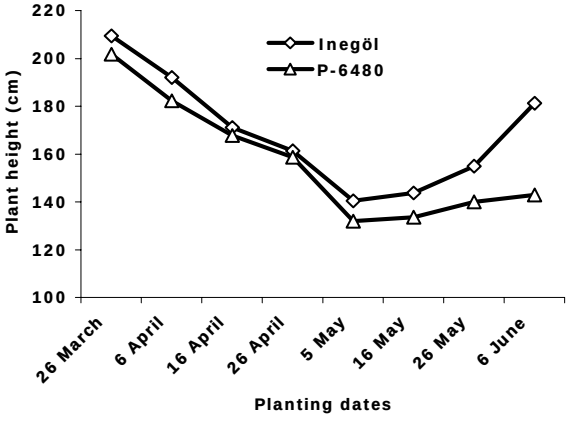
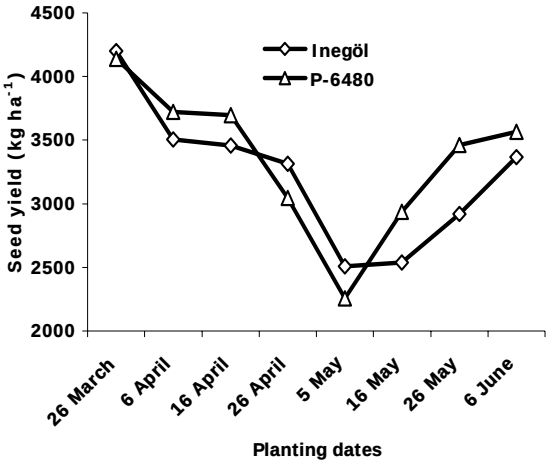


Fig. 3. Seed yield of sunflower cultivars planted in different dates



maturity decreased. Premsekar *et al.* (1977) found that the maturity was completed after 94 and 78 days for early (March) and late (June) planting, respectively.

Although the oilseed sunflower cultivar (P-6480) produced higher head diameter, number of total seeds head^{-1}, seed setting efficiency, seed yield (kg ha^{-1}) and seed oil content than those of confection sunflower cultivar (Inegol), Inegol produced higher plant height, 1000-seed weight and hull ratio than those of P-6480. All of the investigated characteristics were significantly affected by planting dates. The 26 March planting gave the highest plant height, head diameter, number of total seeds head^{-1}, seed setting efficiency, 1000-seed weight and seed yield (kg ha^{-1}) while the 5 May planting gave the lowest. Plant height, head diameter, number of total seeds head^{-1}, seed setting efficiency, 1000-seed weight and seed yield (kg ha^{-1}) decreased gradually when planting date was delayed from 26 March to 5 May, but after the 5 May planting date they were increased gradually. 26 March planting date gave the lowest hull ratio while 26 April planting date gave the highest. After the 16 April planted sunflower crops did not have sufficient time to fill achenes and consequently had higher hull ratio. All of the planting dates except first and last planting gave the similar oil content which was changed from 29.8 to 33.3%. The lowest oil content (25.8%) was obtained from 6 June planting. Results from this study agree with those of Miller *et al.* (1984) and Dedio (1985).

Cultivar X planting date interaction for plant height and seed yield were significant (Table I). Delaying planting until 5 May resulted in a significant reduction in plant height of two sunflower cultivars (Fig. 2). Plant height of sunflower cultivars increased gradually after 5 May planting date. When planting was delayed from 5 May to 6 June, the plant height was increased by 30 and 10% for Inegöl and P-6480, respectively. The plant height of Inegöl at late planting date (6 June) was 26% higher than P-6480.

The cultivar X planting date interaction for seed yield detected in this study was due to the decrease in seed yield of P-6480 at the 26 April and 5 May planting dates (Fig. 3). Delaying planting until 5 May resulted in a significant reduce in seed yield of confection and oil seed sunflower cultivars. When planting was delayed from 5 May to 6 June, seed yields of cultivars were increased. Oil seed sunflower (P-6480) had higher seed yield than confection sunflower (Inegöl) at late planting dates (16 May, 26 May & 6 June). The seed yield of cultivars was the highest in 26 March planting date while it was the lowest in 5 May planting date. Seed yield in sunflower is strongly reduced when normal planting dates are delayed (Robinson, 1970; Johnson &

Table 1. Seed yield, oil content and yield components of confection and oil seed sunflower cultivars planted in different dates

	Days to maturity (d)	Plant height (cm)	Head diameter (cm)	Total seed (no. head $^{-1}$)	Seed setting efficiency (%)	1000-Seed weight (g)	Seed yield (kg ha^{-1})	Hull ratio (%)	Oil content (%)
Cultivar (C)									
Inegöl	136 a	169.2 a	16.2 b	1045 b	80.7 b	96.5 a	3226.5 b	42.4 a	27.0 b
P-6480	128 b	157.4 b	17.5 a	1672 a	93.3 a	55.1 b	3352.8 a	36.8 b	34.2 a
$LSD_{0.05}$	5.8	8.9	0.7	244.9	4.0	10.5	64.9	3.4	3.2
Planting date (D)									
26 March	147 a	205.5 a	19.2 a	1773 a	90.3 a	85.3 a	4170.1 a	34.7 d	29.5 bc
6 April	143 a	187.2 b	17.3 bc	1431 b	86.7 bc	74.6 bc	3613.6 b	37.8 cd	31.5 ab
16 April	140 ab	169.3 c	17.7 ab	1427 b	85.7 bc	73.9 bc	3576.3 b	41.7 ab	33.3 a
26 April	131 bc	160.0 c	16.0 c	1393 bc	85.5 bc	71.8 bc	3179.6 d	43.5 a	33.0 ab
5 May	129 bc	136.2 d	13.8 d	1094 e	84.3 c	68.3 c	2382.0 f	40.1 abc	31.5 ab
16 May	124 c	138.6 d	16.3 bc	1227 cde	86.3 bc	70.8 bc	2738.3 e	41.3 abc	29.8 ab
26 May	122 c	147.5 d	17.3 bc	1324 bcd	88.6 ab	77.5 ab	3189.3 d	39.8 abc	30.3 ab
6 June	120 c	162.2 c	17.2 bc	1199 de	88.7 ab	84.4 a	3468.0 c	38.1 bcd	25.8 c
$LSD_{0.05}$	11.0	12.2	1.6	187.6	3.5	8.8	75.1	3.9	3.7
C x D	ns	*	ns	ns	ns	ns	**	ns	ns

*, ** Significant at the 0.05 and 0.01 level, respectively. For each main effect, values within columns followed by the same letter are not significantly at *P*= 0.05. ns, Non-significant.

Jellum, 1972; Bhattacharya *et al.,* 1975; Unger, 1980; Beard & Geng, 1982; Killi & Gencer, 1992; Bange *et al.,* 1997). The seed yield reductions in oil seed and confection sunflowers in 5 May planting date can be explained by lower head diameter, number of total seeds head^{-1}, seed setting efficiency and 1000-seed weight. The greater yield with early planting can probably be explained by the fact that the early planted sunflower took advantage of early spring rains and maximum yields, allowing the last achenes to develop. By planting sunflower earlier, plants are able to get the full benefit of soil moisture and nutrients during the extended growing season, allowing more total seeds head^{-1} to form and the achenes to mature because of sufficient time to fill. Changes in environmental conditions during the seed filling period potentially effects sunflower yield components (Aguirrezabal *et al.,* 2003).

On the basis of this study, it can be concluded that confection (Inegöl) and oilseed (P-6480) sunflower should be sown at the end of the March (26 March) or at the beginning of the April (6 April) to obtain maximum yield and yield components.

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