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THE EFFECTS OF SOWING DATE ON GROWTH, SEED YIELD AND OIL CONTENT OF SUNFLOWER (*HELIANTHUS ANNUUS* L.) CULTIVARS UNDER RAINFED CONDITIONS

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ABSTRACT

This study was conducted at Research Farm of Ahi Evran University in Kırşehir Province of Turkey in 2012 and 2013 to determine effects of sowing date on yield and agronomic characteristics of sunflower hybrid cultivars in rainfed conditions. Five sowing dates 10 days apart set on 10th April, 20th April, 1st May, 10th May and 20th May and 6 hybrid sunflower cultivars (LG-5580, SanayMr, SanbroMr, Sirena, Tarsan and Transol) were used. The study was taken place in both rainy (2012) and dry (2013) warm conditions due to different weather. In this way, the effects of both sowing dates and extreme climatic conditions were tested. Sunflower yield and yield components were higher in 2012 than 2013, except dehulled/ hulled seed weight and oil content. When sowing date was delayed, seed and oil yields declined. The highest plant height (151.18 cm), 1000-seed weight (51.72g), crude oil content (46.18%), seed yield (2.55 t ha^{-1}) and oil yield (1.18 t ha^{-1}) were obtained on the second sowing date (20th of April) while the highest ratio of dehulled/hulled seed weight (70.04%) and head diameter (20.49 cm) were obtained on the first sowing date (10th of April) in 2012. However, the first sowing date in early April resulted in higher yield and agronomic characteristics than delayed sowing due to a decrease in rainfall during the growing period of both research years. SanbroMr cultivar in the first year and Transol cultivar in the second year reached the higher yields with best yield components. In conclusion, by considering the spring last frost date, the sowing date of 20th April provided significant improvements in yield and yield parameters due to the longer growing season with suitable soil moisture, allowing sufficient time for vegetative growth and head and achenes filling.

KEYWORDS:
Oil content, rainfed, sowing date, sunflower, yield.

INTRODUCTION

Sunflower is an essential edible oil seed plant, which has been ranked at 3rd after soybean and rapeseed in the world. World sunflower production was 47.3 million tons from 26.2 M ha areas in 2016 [1]. Sunflower is a temperate zone crop, which can easily adapt and perform well under a variety of climate and soil condition [2-4]. Sunflower is an important oilseed crop also to meet the vegetable oil demands of Turkey due to the high drought tolerance and sufficient yield in non-irrigated areas [5-7]. Although sunflower has high yield with great adaptation capacity, the main factors affecting sunflower production in rainfed conditions are irregular and inadequate amount of precipitation during the growing season [8]. Additionally, higher temperatures (and consequently higher evapotranspiration rates), relatively shallow soils and uncertain water storage during winter and growing season restrict plant growth and sunflower yield [9]. With delayed sowing, the generative development is hastened and early harvesting time is observed due to the crops are exposed to higher temperature with dry conditions [10]. As usually known, it is a kind of reproduction instinct of plant to continue its generations. Shortening of growing cycle decreases the amount of radiation intercepted during the growing season and thus total dry matter at harvest [11-13]. When the sowing time is delayed sunflower yield decreases in rainfed conditions [13, 14]. The water availability of soil is usually low during flowering and seed maturation, which are crucial periods in terms of seed filling. Water deficiency during these periods reduces the supplementation of nutrients from the soil for reproductive growth and, consequently, reduces seed yield [15, 16]. The number and weight of seeds per unit of area, which are main yield components of sunflower, are closely related to air temperature and soil water content during critical seed set period [11, 17, 18]. Andrade [11] reported that a delay in sowing date reduced grain yield in sunflower due to decreases in the number of seeds and their weight per square meter. The sowing date had significant effects on the both seed yield and its oil content in sunflower cultivars under different climate conditions [19].

TABLE 1
Physical and chemical properties of soils in trial areas

Texture	pH	EC (mmhos/cm)	Salinity (%)	Available P_2O_5 (kg ha^{-1})	$CaCO_3$ %	Available K_2O (kg ha^{-1})	OM (%)
Clayed-Loamy	7.59	0.52	0.02	21.4	27.90	666.2	1.81

TABLE 2
Meteorological data in Kırşehir Province during the period of 1970-2013

Month	Relative Humidity (%)			Precipitation (mm)			Temperature (°C)		
	1970-2013	2012	2013	1970-2013	2012	2013	1970-2013	2012	2013
January	83.7	78	83.7	43.6	97.1	29.1	-0.2	-2.2	1.3
February	79.8	74.5	74.4	34.6	30.9	39.4	1.1	-2.7	4.7
March	68.4	67.6	63	35.9	36.2	14.2	5.4	2.4	7.1
April	50.3	63.8	63.2	45.6	20.1	46.2	10.6	13.3	11.9
May	66.5	61	50.7	43.9	109.5	15.1	15.3	15.4	18
June	47.7	54.3	41.1	34.5	11.9	1	19.6	21.6	20.4
July	38.8	48.4	41.2	6.7	1.4	6.6	23.1	25.3	22.7
August	42	48.7	39.7	5	0	0.2	22.8	23	23.1
September	39.4	53.2	50	11.8	1.2	32	18.2	20.6	16.8
October	63	63.7	52.9	29.2	59.3	20.5	12.4	14.7	10.5
November	82.5	73	67.1	37.9	41.7	40	6.2	7.4	7.6
December	84.6	78.6	75.7	48.6	90.1	10.4	2	3.3	-2.31
Total				377.3	499.4	254.7			
Mean	62.23	63.73	58.56				11.38	11.84	11.82

Under arid and semi-arid conditions, the water is the most limiting factor for sunflower production. That is why the early sowing date has a great importance for maintaining reasonable production values in these climate conditions [9]. The productivity in sunflower farming depends on the environmental factors such as temperature, precipitation and rainfall distribution and also sowing date [20-23].

The previous studies [21, 24-27] underlined the importance effects of the genetic materials and sowing date on sunflower seed yield and its oil content. Therefore, it is crucial to identify effects of sowing date on seed yield and yield components of hybrid sunflower cultivars under rainfed conditions to meet of vegetable oil demand and improve the cultivation of sunflower in arid conditions. The purpose of this research is to examine the changes in seed yield, oil content and yield components, in response to without irrigation, in six hybrid cultivars of sunflower at five different sowing dates (spring), in rainfed conditions.

MATERIALS AND METHODS

The field study was conducted in springs of 2012-2013 growing season at the Research Farm of Ahi Evran University in Kırşehir Province. This experimental field is located at 39.15° Northern latitude and 34.11° Eastern longitude at 1014 meters above sea level.

The experimental design was randomized complete block design with split plot arrangement having 3 replicates. Five planting dates (on 10th April, 20th April, 1st May, 10th May and 20th May) were main plots and six varieties (LG-5580, SanayMr, SanbroMr, Sirena, Tarsan and Transol) were subplots. The plot size was 4.2 m x 6.0 m. Seeds were planted in five rows at 70 x 30 cm intervals with hand mounted seed drill placing 3 seeds per hill. According to the soil analysis, 50 % of nitrogen requirements (50 kg N ha^{-1}) and all P needs (60 kg P2O5 ha^{-1}) were applied to trial areas before the seeding time. Rest 50 % of nitrogen (50 kg N ha^{-1}) was applied 20-25 days after sowing (DAS). Ten randomly tagged plants from each plot were evaluated for plant height, 1000-seed weight, the ratio of dehull/hulled seed weight, head diameter, crude oil content. Dehull/hulled seed weight was determined following the procedure reported by Urie, et al. [28]. Seed yield were obtained from an area 2.8 m wide and 5.0 m long of the center four 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 extraction technique. Oil yield was calculated as a function of seed yield and oil content. Collected data were statistically analysed by Mstat-C and means were adjudged by LSD test [29].

According to soil analysis, the experimental soil was salt-free, clayed-loamy textured, low in organic matter and slightly alkaline reaction. It was classified as the poor soil in terms of available phosphorus, but rich in potassium (Table 1).

According to the climatic data (Table 2), the relative humidity between April and September (the period the study was conducted) was slightly below

the long-term annual average in 2013. Annual precipitation was 499.40 mm in 2012, which was above the long-term average precipitation values. On the other hand, annual precipitation was 254.70 mm in 2013, which was considerably below the long-term average precipitation values. Total monthly precipitation was observed as irregular during the months of sunflower cultivation. Precipitation was 109.5 mm in April, 2012. Although this level of precipitation might appear to have a positive impact on the total level of annual precipitation, irregular precipitation in the other months and less rain in July having a potential to affect yield adversely Temperature values during the cultivation period were above the long-term average for the region.

RESULTS AND DISCUSSION

According to the present results, the differences in sunflower yield parameters among sowing dates and cultivars are shown in Tables 3 and 4. Sowing dates and cultivars affected all investigated parameters significantly. The effects of sowing date on plant height, 1000 seed weight, head diameter and ratio of dehulled/hulled seed weight (only at 0.05 significance level in 2013), oil content, seed yield and oil yield were statistically important (at 0.01 significance level) in 2012 and 2013 growing season. On the other hand, cultivar had significant effects on yield and agronomic traits (at 0.01 significance level), except plant height, the ratio of dehulled/hulled seed weight (at 0.05 significance level in 2012), 1000-seed weight and crude oil content (at 0.05 significance level in 2013). However, the interaction of cultivar x sowing date was not significant, except for 1000- seed weight, seed yield and oil yield (Tables 3 and 4).

Plant Height. Significant differences were detected in plant height between two years. The average plant height in 2012 was 12.65 cm higher than that of 2013 due to the changed weather conditions, considerably below the long-term average precipitation values in 2013. When comparing the two years with respect to plant height, the highest plant height was observed in the first year on 2ndsowing date, 20th April (151.18cm), since the highest amount of rainfall was recorded during this growing season (Table 3). This was evidently associated with warmer and rainy weather conditions prevailing during the early growth stage and flowering, particularly at the first three sowing dates. In contrast, in the second year of study, the lower precipitation and warm weather conditions affected all sowing dates and resulted in stable decrease in plant height. In the second year, the highest plant height (142.37 cm) was observed for the 1st sowing date on 10 April. Depending on the ability of varieties to adapt to environmental conditions, the plant heights were significantly different between cultivars for both years (Tables 3 and 4). In the first year when rainfall was high, SanayMr (145.18 cm) produced significantly higher plants than others. In the second year when rainfall was low, SanbroMr was the

TABLE 3
Effects of sowing date and cultivars on yield and yield characters of oilseed sunflower grown in 2012.

Analysis of Variance	*Df*	*Plant Height (cm)*	*Head diameter (cm)*	*1000 Seed Weight (g)*	*The ratio of de-hulled/ hulled seed weight*	*Oil content (%)*	*Seed yield (t ha^{-1})*	*Oil yield (t ha^{-1})*
Replication	*2*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	***ns***
Sowing Dates	*4*	**	**	**	**	**	**	**
Error1	*8*							
Cultivars	*5*	*	**	**	*	**	**	**
SDxC	*20*	*ns*	*ns*	*	*ns*	*ns*	**	**
Error	*50*							
CV(%)		***4,44***	***7,17***	***6,43***	***3,25***	***2,82***	***6,56***	***6,5***
				Sowing date				
April 10		150.71a	20.49a	50.04a	70.04a	46.18a	2.06c	0.95b
April 20		151.18a	19.39b	51.72a	69.79a	46.05a	2.55a	1.18a
April 30		141.82b	16.85c	47.22b	68.07a	44.10b	2.18b	0.96b
May 10		137.94b	15.38d	42.82c	64.67b	42.89b	1.84d	0.79c
May 20		126.48c	14.52d	39.31d	62.90b	42.85b	1.54e	0.66d
LSD		***4.51***	***1.07***	***2.54***	***2.28***	***1.58***	***0.97***	***0.53***
				Cultivars				
Lg5580		140.51b	16.38cd	38.95d	67.56a	43.51b	1.94c	0.85de
SanayMr		145.18a	16.69c	47.75b	67.08a	43.22b	1.93c	0.84e
SanbroMr		141.01ab	18.47ab	48.44ab	67.25a	43.86b	2.33a	1.02a
Sirena		141.84ab	18.79a	45.07c	65.31b	45.44a	1.93c	0.88cd
Tarsan		141.83ab	17.84b	50.13a	67.03a	45.04a	2.04b	0.92bc
Transol		139.37b	15.78d	47.00bc	68.33a	45.40a	2.04b	0.93b
LSD		***4.61***	***0.875***	***2.18***	***1.07***	***0.919***	***0.98***	***0.43***
MEAN		***141.62***	***17.33***	***46.22***	***67.09***	***44.41***	***2.03***	***0.91***

*, ** significant at the 0.05 and 0.01 level, respectively. For each main effect, values within columns followed by the same letter are not significant. ns, nonsignificant.

highest (132.38 cm). On the other hand, Transol (139.37 and 126.88 cm) had the lowest plant height in all seasons. When the cultivars were compared in two different wet and dry seasons, significant differences were obtained in plant lengths of the cultivars. In wet season SanayMr (14.95 cm high) and Sirena (14.67 cm high) had higher plant height than dry condition whereas SanbroMr (8.63 cm high) was affected by the seasons in a lesser extent. Semi-arid, arid and rainfed condition rainfall is very important climate parameter for vegetative growth and in this research the lack of rainfall caused significant reductions in plant height. These observations were also supported by, Baghdadi, et al. [30], Ahmed, et al. [25] and Ozturk, et al. [27] who emphasized that the plant heights of sunflower increased with the early sowings dates but decreased with delayed sowing dates.

Head Diameter. The mean head diameters of the sunflower cultivars in 2012 and 2013 were 17.33 and 15.04 cm, respectively. Both high precipitation in 2012 and low precipitation in 2013 affected the size of the head diameter compared to long term rainfall. The highest head diameter was obtained from the first sowing date and delaying sowing date reduced head diameter in both years. Similar finding was reported by Miller, et al. [31] and Ozturk et al. (2017) and they emphasized that when sowing date was delayed, head diameter, seed yield and crude oil content declined. Comparing the two year head diameter results of cultivars, cultivar Sirena (18.79 cm) in 2012 and cultivar LG5580 (15.91 cm) in 2013 had highest head diameter and cultivars Transol (15.78 cm) in 2012 and cultivar Tarsan (14.01cm) and Sirena (14.39 cm) had smallest head diameter in 2013. Depending on the genetic characteristics of the cultivars, significant changes were observed in head diameter in rainy and dry periods. The significant difference in the head diameter could be attributed to the availability of adequate moisture, which helps roots to absorb sufficient amount of nutrients for plant growth and development [21].

Thousand Seed Weight. Thousand seed weight was significantly affected by sowing date. Planting on 20th April produced heavier seeds while sowing on 20th May produced lighter seed weight in 2012, in which more rain than long-term was observed. In the 2nd year, early sowing date on 10th April, the heaviest seed weights were obtained than other sowing dates. In both two years delaying sowing date decreased 1000-seed weight. The reduction in 1000-seed weights for the late sown sunflower can be explained by increased temperature [32] in rainfed conditions. Overall, 1000-seed weight was between 38.95 to 50.13 g in 2012, and 37.53 and 40.76 g in 2013. Cultivar Tarsan had the heaviest 1000- seed weight (50.13 g) in the first year and LG5580 had the heaviest 1000-seed weight (38.95 g) in rainy weather conditions. In the second year, cultivar SanbroMr had the heaviest 1000- seed weight (40.76g), while SanayMr had the lightest 1000-seed weight (37.53 g). The 1000-seed weights of cultivars were different between the years 2012 and 2013. This is due to the decrease in

TABLE 4
Effects of sowing date and cultivars on yield and yield traits of oilseed sunflower grown in 2013.

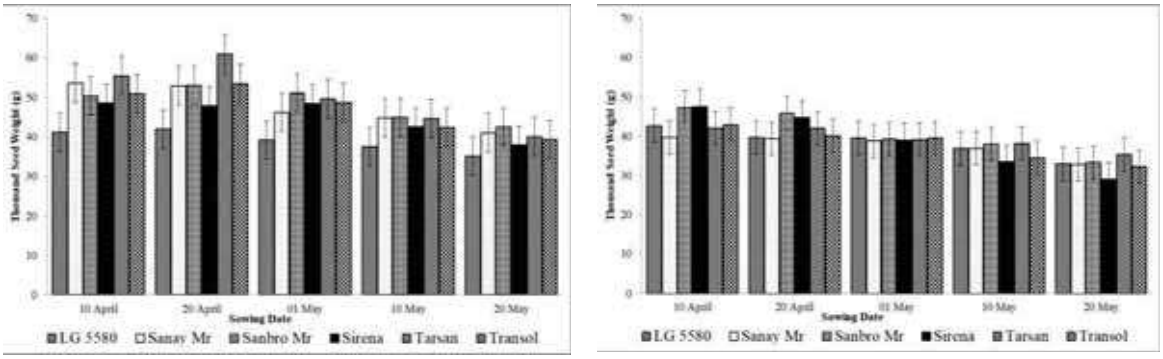
Analysis of Variance	*Df*	*Plant Height (cm)*	*Head diameter (cm)*	*1000 Seed Weight (g)*	*The ratio of dehulled/ hulled seed weight*	*Oil content (%)*	*Seed yield (t ha^{-1})*	*Oil yield (t ha^{-1})*
Replication	*2*	*ns*	*ns*	*ns*	*ns*	*Ns*	*ns*	***ns***
Sowing Dates	*4*	**	**	**	*	**	**	**
Error1	*8*							
Cultivars	*5*	**	**	*	**	*	**	**
SDxC	*20*	*ns*	*ns*	*	*ns*	*Ns*	**	**
Error	*50*							
CV(%)		***3,09***	***7,74***	***6,69***	***3,09***	***4,2***	***6,44***	***7,67***
Sowing date								
April 10		142.37a	17.49a	43.74a	72.23a	48.93a	1.49a	0.73a
April 20		136.55b	15.37b	42.02a	71.33a	49.16a	1.53a	0.75a
Apirl 30		126.96c	14.50c	39.23b	71.25a	48.20a	1.40b	0.68b
May.10		122.22d	14.41c	36.34c	70.24ab	46.67b	1.26c	0.59c
May.20		116.78e	13.40d	32.62d	68.73b	44.54c	1.20c	0.54d
LSD		3.56	0.69	2.54	2.19	1.36	0.62	0.43
Cultivars								
Lg5580		129.50abc	15.91a	38.39b	68.94d	48.08ab	1.343.27c	0.65bc
SanayMr		130.23ab	14.89bc	37.53b	72.42a	48.45a	1.331.29c	0.65bc
SanbroMr		132.38a	15.34ab	40.76a	70.30cd	47.48ab	1.417.85b	0.68b
Sirena		127.17c	14.39c	38.79b	70.05cd	46.76b	1.224.73d	0.58d
Tarsan		127.69bc	14.01c	39.40ab	70.75bc	47.16ab	1.316.53c	0.62c
Transol		126.88c	15.67ab	37.89b	72.08ab	47.06ab	1.623.22a	0.77a
LSD		2.92	0,89	1.90	1.60	1,46	0.65	0.37
MEAN		***128.97***	***15.04***	***38.79***	***70.76***	***47.5***	***1.38***	***0.66***

*, ** significant at the 0.05 and 0.01 level, respectively. For each main effect, values within columns followed by the same letter are not significant. ns, nonsignificant.

precipitation and soil moisture which cause negative effect on seed growth period. With respect to 1000-seed weight, Tarsan cultivar was better in the rainy season, whereas SanbroMr cultivar was better in arid conditions. This is due to the genetic capabilities and different reflex of the cultivars for changing environmental conditions. The significant sowing date x cultivar interaction was observed for 1000-seed weight. The interaction indicated that the heaviest 1000-seed weight (60.82 g) was observed for 20th April sowing date in Tarsan cultivar in 2012 while this was 47.60 g for 10th April sowing date in SanbroMr cultivar in 2013 (Figure 1a-b).

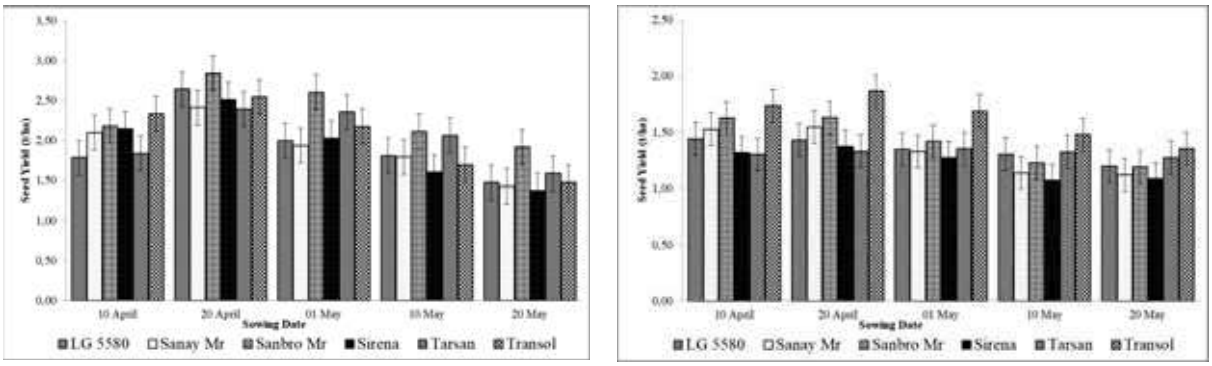
The Ratio of Dehulled/Hulled Seed Weight. The ratio of dehulled/ hulled seed weight which directly affected crude oil ratio in sunflower is an important quality criterion. The results presented in Table 3 and 4 of the ratio of dehulled/hulled seed weight, indicate both genetic and climatic effects. Comparing two years, the sunflower cultivars were tended to produce a higher ratio of dehulled/hulled seed weight in 2013 (70.76%) than that of 2012 (67.09%). These differences related to the weather condition. The climatic effects revealed by the significant differences for the cultivars in the ratio of dehulled/hulled seed weight highest in 2013 and lowest in 2012. Precipitation was much higher in 2012 than in 2013, throughout the growing cycle, especially after flowering. This can be related to the seed hull more grower than the seed kernel when precipitation is sufficient. This would also explain the difference in the seed yield of cultivars, which was much higher in 2012 than in 2013 (2.03 vs.1.38 t/ha). Similar findings were reported by Killi and Altunbay [33], Ahmad [34] and Dauguet, et al. [35]. The higher ratios of dehulled/hulled seed weight (70.04%, in 2012) and 72.23%, in 2013) were obtained from the first sowing dates, and at the later sowing dates resulted decreases in both years. Killi and Altunbay [33] reported that sunflower crops did not have sufficient time to fill achenes due to late sowing and, consequently, had higher hull ratio.

Crude oil content (%). In general, the crude oil content of sunflower cultivars seed was significantly changed by year and sowing dates (Tables 3 and 4). For example, the crude oil content of seed in 2012 (44.41%) was significantly lower than that of 2013 (47.50%). These differences related to the



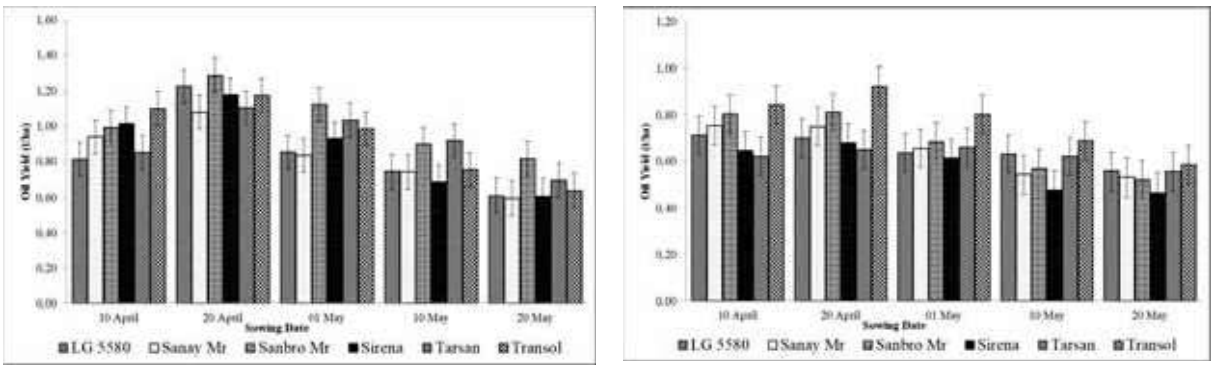
a b

FIGURE 1
The interaction of sowing date and cultivars on thousand seed weight (g) graphics in 2012 (a) and 2013 (b)



a b

FIGURE 2
The interaction of sowing date and cultivars on seed yield (t/ha^{-1}) graphics in 2012 (a) and 2013 (b)



a b

FIGURE 3
The effects of the interaction between sowing date and cultivars on oil yield (t/ha^{-1}) graphics in 2012 (a) and 2013 (b)

climate conditions effects on of the ratio of de-hulled/hulled seed weight. A high ratio of de-hulled/hulled seed weight was resulted in high oil content. In both years, however, the highest crude oil content of seeds was obtained from the 1st and 2nd sowing dates and the crude oil content was substantially decreasing in delayed sowing date. It is clear that the late sowed seeds contained less oil compared to the other sowing dates, especially from plants sown on May 20th, when the lowest value was obtained in both years. The highest oil rate was obtained from Sirena, Transol and Tunca cultivars (45.44, 45.40 and 44.04% respectively) in 2012 and SanayMr (48.45%) in 2013. These results might be attributed to the interaction effect of genotypes and environmental conditions such as temperature, precipitation and humidity which significantly affected crude oil content in sunflower seed under rainfed conditions. The oil content results showed that sunflower seed oil concentration depends on genotype (hybrid), but it may be changed differentially under environmental conditions especially growing period climate. Previous research results showed that seed oil content could vary widely with plant variety and growing conditions [36].

Seed Yield. The results showed that the higher annual mean seed yield (2.03 t ha^{-1}) was obtained in rainy and warmer season (in 2012) compared to dry and warm season in 2013(1.38t ha^{-1}). In general, when sowing dates of two years (2012 and 2013) were compared, 20th April produced maximum seed yield, and lowest seed yield was recorded on 20th May (last sowing date). According to the seed yield data, sunflower cultivars showed the significant differences in both years. SanbroMr (2012) and Transol (2013) were tended to have higher seed yield (2.33 and 1.62 t ha^{-1}, respectively) than other cultivars. Cultivar Sirena gave the lowest seed yield (1.93 and 1.22 t ha^{-1}) in both years. Related studies (Ali et al., 2012; Nasim et al., 2012; Hussain et al., 2015) reported that the cultivars showed wide differences in their agronomic characteristics and seed yield, depending on their genotypes and environmental conditions. Different responses occurred between sowing date and cultivars in both years. The higher seed yields (2.84 and 1.87 t ha^{-1}) were obtained from SanbroMr (2012) and Transol (2013) sunflower cultivars planted on 20th April sowing date. The lowest yields (1.37 and 1.07 t ha^{-1}) were obtained from Sirena cultivar on 20th May (2012) and 10thMay (2013) sowing dates (Figure 2a-b). The productivity of sunflower is mainly determined by the prevailing weather conditions throughout its life cycle and the imposed cultural practices [20]. Seed yield generally decreased with delayed sowing, and this might be attributed to the decrease in yield components [37]. This behavior might be ascribable to the best soil water content in the early stages of plant development [38]

Oil Yield. The oil yield is calculated by multiplying the seed yield by crude oil content. Therefore, oil yield mainly depends on seed yield. The oil yield obtained in this study was significantly changed by sowing date and cultivars in both years. In both years, oil yield generally decreased when sowing was delayed. The highest oil yield (1.29 and 0.92 t ha^{-1}) was obtained from sunflower plants sowed at the end of April (in second sowing date) compared to the early and late sowed plants for both two years. According to the oil yield results, sunflower cultivars were completely different (Tables 2 and 3) between each other. Similar to seed yield and oil content, the oil yield of SanbroMr (1.02 t ha^{-1}) and Transol (0.77 t ha^{-1}) was higher than those of other cultivars in 2012 and 2013. The interaction between sowing dates and cultivars had also a significant influence on oil yield. The highest oil yield was obtained from the SanbroMr (1.29 t ha^{-1}) in 2012 and from Transol (0.92 t ha^{-1}) in 2013 when sown at 20th April (Figure 3a-b). In addition to this, SanbroMr cultivar in rainy and warm season

and Transol cultivars in dry and warm season for had superior oil yields than others due to the height seed yield and crude oil content. Differences among hybrids for seed oil content and seed yield may be attributed to their genetic potential as well as interactive effects of environmental variables during achene development and crop physiological maturity [39].

CONCLUSIONS

Hybrid sunflower commercial varieties produced higher seed yield having higher oil content in sunflower seed production trials. The changes in yield and yield parameters are dependent upon the environmental conditions in which the varieties are cultivated. When we take into account the negative effects of climate change, the choosing of cultivars and the sowing date in arid regions are very important factors affecting the yield and yield parameters. There is a need to conduct further studies on sowing date and cultivars due to the changes in global climate conditions and new hybrid cultivars by advanced breeding studies for different ecological conditions. It is necessary to efficient sunflower production to meet demand of world vegetable oil and this necessity increased the importance of this kind of studies as determining sowing date and cultivars. For this reason, five different sowing dates (spring) and six hybrid sunflower cultivars were compared in order to determine which of them maximized their yield and quality parameters in the present study.

The results of the study showed that the yield and yield components in rainfed conditions generally tend to be decreased in both two years (2012 and 2013) with delayed sowing. Sunflower cultivars showed yield performance in terms of sowing date. This was a distinctive factor for both years in the present study. Also, the changes in production traits might be related to the annual weather differences. The research also showed how the cultivars and sowing dates effect yield and yield parameter of sunflower in both dry and wet conditions. To conclude, the early planting (on 20th April) of sunflower cultivars provided significant advantage in yield and yield parameters due to the long growing season with convenient soil moisture and sufficient time to fill head and achenes.

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