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# Determination of Yield and Quality Characteristics of Sunflower Genotypes Newly Developed

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**HIGHLIGHTS**

- Sunflower is the most important oil plant for Türkiye.
- Improving sunflowers is an agricultural study and development process to enhance the genetic characteristics of the sunflower plant and to develop new varieties with desired characteristics.

**Abstract**

This research was conducted to determine the yield and quality characteristics of oil sunflower genotypes as candidates for registration under Konya and Karaman conditions, in four replications according to the "Random Blocks Trial Design". The differences between the cultivars used in both locations of the study in terms of the number of days to bloom, the number of days to physiological maturity, plant height, the diameter of the head, the thousand seed weight, seed moisture, seed yield, oil rate, and oil yield were found to be statistically significant. The number of flowering days of the genotypes was found to be 65.6-60.6 days (H194; P63MM54), the number of days to physiological maturity was 116.9-109.0 days (Tunca; P63MM54), plant height 172.0-143.3 cm (Tunca; H249), head diameter 18.8-15.9 cm (H250; P63MM64), thousand-seed weight 43.4-54.2 g (H250; Gibraltar), hectoliter weight 32.3-30.3 kg (P63MM54; H194), seed moisture 7.1-8.4 % (H250; P63MM54, Gibraltar), seed yield 4.37-3.82 t ha$^{-1}$ (H194; H249), oil rate 47.8-42.9 % (H250; H55), and oil yield 2.04-1.64 t ha$^{-1}$ (H250; H249). According to the averages of the locations, it can be argued that the H194, H250, H55, and H5 hybrids that have high seed and oil yield can be successfully grown in regional conditions.

**Keywords:** Sunflower breeding; yield; hybrid

## 1. Introduction

Sunflower (*Helianthus annuus*) is a plant species of the daisy family (*Asteraceae*) that originates from America. Sunflower is commonly known for its oilseeds and large yellow flowers and is an important agricultural crop on a global scale. Sunflower seeds are grown for various purposes, such as producing sunflower oil, consuming it as a snack, and using bird feed.

There has been a recent increase in vegetable oil consumption in our country. However, when the climate and soil characteristics of our country are evaluated, it is seen that although we have great potential for the production of oil plants, we cannot produce enough to meet our oil needs. We cover our vegetable oil deficit from imports. However, except for coconut and palm oil plants, other important oil plants such as sunflower,

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soybean, cottonseed, peanut, poppy, safflower, rapeseed, sesame, flax, and hemp can be grown easily in our country. Sunflower meets approximately 70% of our country's vegetable oil consumption among the oil crops and ranks first in this ratio (Top and Ilkay 2012).

Approximately 80-90% of the oil production need of the world is covered by plant-based sources (Arıoğlu 2007). The production of oil plants is cotton, sunflower, and soybean in our country. Sunflower alone covers 49% of our vegetable oil production (Durmaz 2012). As well as being the raw material of the vegetable oil sector, oil plants are also the raw material of many different sectors. Oilseed meal is used in animal nutrition because it has high protein content (Ilkdogan 2008). Vegetable-derived oils are also used extensively in the energy, chemistry, and food sectors (Top and Ilkay 2012).

Improving sunflowers is an agricultural study and development process to enhance the genetic characteristics of the sunflower plant and to develop new varieties with desired characteristics. Such studies are generally conducted by selecting plant populations with superior characteristics, crossing them, using the plants obtained as a result of the cross, and identifying plants with the desired characteristics.

Studies conducted to improve sunflowers are also conducted to enhance the sunflower plants' genetic structure and develop the desired characteristics. Sunflower cultivation is important because it has many economic and agricultural benefits. Among the objectives of sunflower cultivation, is the development of high-yielding, high oil content, and better-quality sunflower varieties that are more resistant to diseases and pests. Newly developed cultivar candidates must be tested for environmental compatibility, quality, and safety. The present study determined the yield and some agricultural characteristics of the candidate oil sunflower cultivars in different locations.

## 2. Materials and Methods

The present study was conducted in two separate trials in Konya-Altinekin and Karaman in 2022. Commercial hybrid sunflower varieties (P63MM54, Gibraltar and Tunca), and the H194, H249, H250, H253,H5 and H55 hybrids developed by Assoc. Prof. Rahim ADA in Selcuk University Faculty of Agriculture was used in the study. The study was conducted in four replications according to the "Randomized Blocks Trial Design" at each location (Düzgüneş et al. 1987).

The trial fields, where the front crop was wheat, were ploughed deeply with a socket in the autumn following the preliminary crop harvest and left for the winter. The disc harrow and the field were raked several times and made ready for planting before planting in the spring.

The study plots were 2.8 mx 7.5 m = 21.0 $m^2$ and each plot was arranged in a way that there were 70 cm in 4 rows in the row spacing and 120 kg $ha^{-1}$ and 80 kg $ha^{-1}$ $P_2O_5$ were applied to all trial plots, all together with sowing.

## 3. Results and Discussion

### 3.1. *Number of 50% Flowering Days*

The difference between the locations where the study was conducted and the varieties was found to be statistically significant at the level of 1% in terms of 50% flowering days of sunflower cultivars and the location x variety interaction was found to be statistically insignificant (Table 1).

Average values for 50% flowering days of sunflower varieties are given in Table 2. As seen in Table 2, 50% flowering days of the cultivars varied between 60.6 and 65.6 days according to the averages of the two locations. The 50% flowering days of the longest cultivars were determined in H194 and the 50% flowering days of the shortest cultivars were determined in P63MM54. When the locations of the varieties were compared in terms of 50% flowering day durations, it was seen that there were different results, which shows that although 50% of flowering days was a cultivar characteristic, it was also associated with environmental changes because of differences in climate and soil conditions among years.

*3.2. Physiological Maturity Days*

Regarding physiological maturity days, the difference between the cultivars in which the study was conducted was found to be statistically significant at the 1% level and the locations and location x cultivar interaction were found to be statistically insignificant (Table 1).

As seen in Table 2, the physiological maturity durations of the cultivars varied between 109.0 and 116.9 days, according to the averages of the two locations. The physiological maturity days of the longest cultivars were determined in Tunca, and the physiological maturity days of the shortest cultivars were determined in the P63MM54 cultivar. It was also found that the cultivars did not produce different results when compared in terms of physiological maturity durations in locations, which shows that physiological maturity durations have a variety of characteristics.

*3.3. Plant Height*

As understood in Table 1, the difference between the locations where the study was conducted in terms of plant height values, the difference between the varieties, and the location x variety interaction were found to be statistically significant at the 1% level.

According to Table 2, the average plant height was found to be a maximum of 156.7 cm in Karaman and it was found to be 145.9 cm in Altınekin. The plant heights of the genotypes used in the study differed according to the locations. The highest average plant height was found in the Tunca variety with 173.0 cm in Karaman, and the lowest in H194 genotype in Altınekin with 120.0 cm (Table 2). These results show that plant height is also associated with environmental changes because of different climate and soil conditions over the years (Önder et al. 2001).

As the average of the locations, the highest plant height was measured in the Tunca variety with 172.6 cm, which was followed by plant heights of H253 (160.6 cm), H55 (151.3 cm), Gibraltar (148.9 cm), H250 (147.6 cm), H5 (146.5 cm), P63MM54 (145.0 cm) and H194 (145.9) genotypes, respectively. The lowest plant height at 143.3 cm in the H249 genotype (Table 2). Genetic structure is among the most defining factors in plant height (Önder et al. 2001; Akkaya 2006; Ceyhan et al. 2008; Öztürk et al. 2008; Day 2011; Tan 2014). It was reported in many previous studies that the grading status of sunflower varieties was different (Önder et al. 2001; Ceyhan et al. 2008; Gholinezhad et al. 2009; Tan 2014; Yılmaz and Kınay 2015). Önder et al. (2001) reported that plant heights varied between 96.8 cm and 110.5 cm in sunflower varieties in their study conducted on plant heights. Day (2011) reported that plant height was between 144.2 cm and 145.6 cm in sunflowers. On the other hand, Katar et al. (2012) reported in their study that plant heights varied between 101.77 cm and 127.53 cm. Yılmaz and Kınay (2015) reported that the plant height varied between 123 cm and 153 cm in sunflowers.

*3.4. Head diameter*

As understood in Table 1, the difference between the locations where the study was conducted in terms of tray diameter values was found to be statistically insignificant. In contrast, the difference between the cultivars and the cultivar x year interaction was statistically significant. Önder et al. (2001) and Ceyhan et al. (2008) reported that the diameter of the tray in sunflowers showed differences between cultivars.

In terms of the average of the varieties, the diameter of the tray was determined to be 17.3 cm in Altınekin and 17.8 cm in Karaman. The diameters of the trays in sunflowers generally vary in wide ranges such as 6 - 75 cm, and the size of the tray is affected by environmental factors, especially plant density, soil moisture, and productivity (Önder et al. 2001). The diameter of the head of the plant shows significant changes in sunflower according to the genetic structure of the variety, ecological conditions, cultivation techniques, soil characteristics, and irrigation or not (Gürbüz et al. 2003; Arıoğlu 2007; Yılmaz and Kınay 2015).

In terms of the averages of the locations, the tray diameters of the cultivars varied between 15.9 (P63MM54) and 18.8 cm (H250). The H250 variety had the largest head diameter. The results of the studies conducted by Kıllı and Özdemir (2001), Önder et al. (2001), Mahar et al. (2007), Ceyhan et al. (2008), Day (2011), Ali et al. (2012) Tan (2014) and Yılmaz and Kınay (2015) regarding the head diameters agree with our study results.

*3.5. Thousand Seed Weight*

As seen in Table 1, the effects of locations and location x variety interaction on thousand-seed weight were statistically insignificant, and the difference between genotypes was statistically significant. In many studies, researchers reported that there were significant differences between varieties in terms of the thousand-seed weight of sunflower (Ceyhan et al. 2008; Öztürk et al. 2008; Ali et al. 2012; Tan 2014; Yılmaz and Kınay 2015).

Regarding the average of the cultivars used in the study, the highest thousand-seed weight was found to be 50.4 g in Karaman in 2017 (Table 2). It is already known that the thousand-seed weight, which is one of the most important agricultural characteristics that affect the seed yield in sunflowers, varies depending on the variety and growing conditions (Ilbaş et al. 1996).

Regarding the average of the two locations, the highest thousand-seed weight was obtained in the H250 genotype with 54.2 g, followed by Tunca (52.5 g) and H249 (52.3 g) genotypes, respectively. The lowest thousand-seed weight was found in the Gibraltar variety with 43.4 g (Table 2). The thousand-seed weights of sunflower varieties that are oily vary between 35-120 g, and those with thousand-seed weights that are higher than 120 g are known as snack foods (Atakış 1991; Turan and Göksoy 1998; Önder et al. 2001). The thousand-seed weight values obtained in this study were similar to the results reported in the studies conducted by Önder et al. (2001), Mahar et al. (2007), Ceyhan et al. (2008), Gholinezhad et al. (2009), Ali et al. (2012) on the same subject. On the other hand, the values obtained in the present study in thousand-seed weights were lower than the values reported by Öztürk et al. (2008), Katar et al. (2012), Tan (2014), Yılmaz and Kınay (2015), Çetin and Öztürk (2018), which may be because of the different materials used and environmental conditions.

*3.6. Hectoliter*

In terms of hectoliter values of sunflower cultivars, the locations where the study was conducted, the difference between cultivars and the location x cultivar interaction was found to be statistically insignificant (Table 1).

As seen in Table 2, hectoliters varied between 30.3 and 32.3 kg/hl according to the averages of the two locations. Although the highest hectoliter weight was determined in the H194 genotype, 50% of flowering days of the shortest genotypes were determined in P63MM54. When the locations of the cultivars were compared in terms of hectoliter weights, it was found that the values were close to each other in both locations.

*3.7. Seed Moisture*

In terms of seed moisture values of the sunflower cultivars, the locations where the study was conducted, the difference between cultivars and location x cultivar interaction was found to be statistically insignificant (Table 1).

As seen in Table 2, it was found that the seed moisture values of the two locations varied between 7.3 and 8.1% according to the averages. The highest seed moisture was detected in H250 and H253 genotypes, and the lowest seed moisture was found in Gibraltar and P63MM54 cultivars. When the locations of the varieties were compared in terms of seed moisture, it was found that the values were close to each other in both locations.

**Table 1.** Results of variance analysis in the experiment conducted in Konya-Altinekin and Karaman Locations

| Source of Variation | df | Means square | | | | |
|---|---|---|---|---|---|---|
| | | Number of days to bloom | Number of days to physiological maturity | Plant height (cm) | Head diameter (cm) | Thousand-seed weight (g) |
| Location | 1 | 84,50** | 2,00 | 2080,13** | 5,01 | 12,67 |
| Replication [L] | 6 | 5,84 | 1,78 | 19,72 | 1,72 | 9,07 |
| Genotypes | 8 | 22,15** | 49,44** | 718,06** | 8,05** | 94,02** |
| L x G | 8 | 1,66 | 3,13 | 614,56** | 6,73* | 31,25 |
| Error | 48 | 1,76 | 2,60 | 15,32 | 2,38 | 24,93 |
| **Source of Variation** | **df** | **Hectoliter weight** | **Seed moisture (%)** | **Seed yield (t ha$^{-1}$)** | **Oil rate (%)** | **Oil yield (t ha$^{-1}$)** |
| Location | 1 | 1,18 | 2,26 | 780,13 | 0,03 | 1.15,27 |
| Replication [L] | 6 | 4,43 | 1,11 | 3596,59 | 5,28 | 1195,58 |
| Genotypes | 8 | 2,75 | 0,81 | 2581,41* | 20,92** | 1168,17** |
| L x G | 8 | 3,47 | 0,62 | 168,25 | 2,68 | 93,75 |
| Error | 48 | 1,83 | 1,36 | 1178,56 | 2,96 | 302,35 |

[1] Tables may have a footer.

**Table 2.** Means of two locations for Number of days to bloom (day), Physiological maturity days (day), Plant height (cm), Head diameter (cm), Thousand seed weight (g), Hectoliter weight (kg) of 9 sunflower genotypes evaluated in Konya and Karaman Locations

| | **Number of days to bloom (day)** | | | **Number of days to physiological maturity (day)** | | | **Plant height (cm)** | | |
|---|---|---|---|---|---|---|---|---|---|
| **Genotypes** | **Altinekin** | **Karaman** | **Mean** | **Altinekin** | **Karaman** | **Mean** | **Altinekin** | **Karaman** | **Mean** |
| H194 | 65,0 | 66,3 | 65,6 A | 117,0 | 114,8 | 115,9 A | 120,0 I | 171,8 A | 145,9 DE |
| H249 | 62,3 | 63,8 | 63,0 BC | 113,3 | 113,8 | 113,5 BC | 145,0 FG | 141,5 GH | 143,3 E |
| H250 | 62,3 | 63,0 | 62,6 BC | 113,3 | 113,8 | 113,5 BC | 142,5 G | 152,8 C-E | 147,6 C-E |
| H253 | 63,0 | 65,0 | 64,0 AB | 115,0 | 115,8 | 115,4 AB | 160,3 B | 161,0 B | 160,6 B |
| H5 | 62,5 | 64,8 | 63,6 B | 116,3 | 115,3 | 115,8 A | 148,5 D-G | 144,5 FG | 146,5 C-E |
| H55 | 60,3 | 63,0 | 61,6 CD | 110,5 | 112,3 | 111,4 C | 144,3 FG | 158,3 BC | 151,3 C |
| P63MM54 | 59,0 | 62,3 | 60,6 D | 108,3 | 109,8 | 109,0 D | 134,3 H | 155,8 B-D | 145,0 DE |
| Tunca | 63,8 | 67,3 | 65,5 A | 116,8 | 117,0 | 116,9 A | 172,3 A | 173,0 A | 172,6 A |
| Gibraltar | 61,3 | 63,5 | 62,4 BC | 112,8 | 113,8 | 113,3 BC | 146,3 E-G | 151,5 C-F | 148,9 CD |
| Mean | 62,1 B | 64,3 A | 63,2 | 113,7 | 114,0 | 113,8 | 145,9 B | 156,7 A | 151,3 |
| | | Lsd $_{genotype\ (0.01)}$ = 1,78 | | | Lsd $_{genotype\ (0.01)}$ = 2,16 | | | Lsd $_{genotype\ (0.01)}$ = 5,25 | |
| | | | | | | | | Lsd $_{locationx\ genotype\ (0.01)}$ = 7,42 | |
| **Genotypes** | | **Head diameter (cm)** | | | **Thousand-seed weight (g)** | | | **Hectoliter weight (kg)** | |
| H194 | 15,8 EF | 19,8 A | 17,8 A-C | 46,8 | 50,8 | 48,8 A-C | 30,3 | 30,2 | 30,3 |
| H249 | 16,5 D-F | 16,8 C-F | 16,6 BC | 51,5 | 53,1 | 52,3 AB | 32,0 | 29,3 | 30,6 |
| H250 | 19,0 AB | 18,5 A-D | 18,8 A | 56,9 | 51,6 | 54,2 A | 30,5 | 31,5 | 31,0 |
| H253 | 17,8 A-E | 18,8 A-C | 18,3 AB | 50,8 | 53,6 | 52,2 AB | 31,1 | 31,0 | 31,0 |
| H5 | 19,0 AB | 17,3 B-E | 18,1 AB | 51,1 | 49,9 | 50,5 AB | 31,6 | 30,6 | 31,1 |
| H55 | 19,0 AB | 17,0 B-F | 18,0 AB | 45,5 | 47,0 | 46,3 BC | 29,9 | 31,9 | 30,9 |
| P63MM54 | 15,0 F | 16,8 C-F | 15,9 C | 46,1 | 54,1 | 50,1 AB | 32,7 | 31,9 | 32,3 |
| Tunca | 17,5 B-E | 18,5 A-D | 18,0 AB | 52,9 | 52,1 | 52,5 AB | 31,5 | 31,6 | 31,6 |
| Gibraltar | 15,8 EF | 16,8 C-F | 16,3 BC | 44,9 | 41,8 | 43,4 C | 30,8 | 30,4 | 30,6 |
| Mean | 17,3 | 17,8 | 17,5 | 49,6 | 50,4 | 50,0 | 31,2 | 30,9 | 31,0 |
| | | Lsd $_{genotype\ (0.01)}$ = 2,07 | | | Lsd $_{genotype\ (0.01)}$ = 6,70 | | | | |
| | | Lsd $_{locationx\ genotype\ (0.05)}$ = 2,19 | | | | | | | |

**Table 3.** Means of two locations Seed moisture (%), Seed yield (t ha$^{-1}$), Oil content (%), Oil yield (t ha$^{-1}$) of 9 sunflower genotypes evaluated in Konya and Karaman Locations

| | **Seed moisture (%)** | | | **Seed yield (t ha$^{-1}$)** | | |
|---|---|---|---|---|---|---|
| **Genotypes** | **Altinekin** | **Karaman** | **Mean** | **Altinekin** | **Karaman** | **Mean** |
| H194 | 8,4 | 7,4 | 7,9 | 4,40 | 4,34 | 4,37 A |
| H249 | 7,9 | 8,1 | 8,0 | 3,85 | 3,78 | 3,82 B |
| H250 | 7,8 | 8,4 | 8,1 | 4,33 | 4,22 | 4,27 AB |
| H253 | 8,7 | 7,6 | 8,1 | 3,93 | 3,87 | 3,90B |
| H5 | 7,9 | 7,6 | 7,7 | 4,18 | 4,13 | 4,16AB |
| H55 | 7,8 | 7,5 | 7,7 | 4,25 | 4,15 | 4,20AB |
| P63MM54 | 7,5 | 7,1 | 7,3 | 4,10 | 4,24 | 4,17 AB |
| Tunca | 8,3 | 7,7 | 8,0 | 4,01 | 3,94 | 3,98AB |
| Gibraltar | 7,5 | 7,1 | 7,3 | 4,26 | 4,04 | 4,15AB |
| Mean | 8,0 | 7,6 | 7,8 | 415,0 | 4,08 | 4.11 |
| | | | | | Lsd $_{genotype\ (0.05)}$ = 4.6 | |

| **Genotypes** | | **Oil rate (%)** | | | **Oil yield (t ha$^{-1}$)** | |
|---|---|---|---|---|---|---|
| H194 | 44,4 | 45,8 | 45,1 BC | 1,95 | 1,99 | 1,97 AB |
| H249 | 41,9 | 44,0 | 43,0 C | 1,61 | 1,67 | 1,64 D |
| H250 | 47,8 | 47,9 | 47,8 A | 2,07 | 2,02 | 2,04 A |
| H253 | 46,1 | 45,3 | 45,7 AB | 1,81 | 1,75 | 1,78 B-D |
| H5 | 44,9 | 45,4 | 45,2 BC | 1,88 | 1,88 | 1,88 A-C |
| H55 | 43,2 | 42,5 | 42,9 C | 1,83 | 1,76 | 1,79 B-D |
| P63MM54 | 43,5 | 43,0 | 43,2 C | 1,78 | 1,82 | 1,80 B-D |
| Tunca | 43,8 | 43,6 | 43,7 BC | 1,75 | 1,72 | 1,73 CD |
| Gibraltar | 44,7 | 43,1 | 43,9 BC | 1,90 | 1,74 | 1,82 A-D |
| Mean | 44,5 | 44,5 | 44,5 | 184,6 | 1,82 | 1,83 |
| | | Lsd $_{genotype\ (0.01)}$ = 2,31 | | | Lsd $_{genotype\ (0.01)}$ = 2,3 | |

[1] Tables may have a footer.

*3.8. Seed Yield*

Although locations and location x genotype interaction were statistically insignificant regarding seed yield in sunflower cultivars, the differences between cultivars were statistically significant at the 5% level (Table 1). Similar to our study results, Önder et al. (2001), Ceyhan et al. (2008), Öztürk et al. (2008), Katar et al. (2012), Tan (2014), Yilmaz and Kinay (2015) and Çetin and Öztürk (2018) reported that there were significant differences between sunflower varieties in terms of seed yield.

The average values for the seed yield per decare of the genotypes employed in the study and the resulting groups are given in Table 3. It can be seen in Table 3 that there were no significant differences between the seed yields of the cultivars at each location. As the average of all varieties, it was found that the seed yield, which was 4.08 kg /da in Karaman, increased to 4.15 kg/da in Altınekin. Seed yields per decare of the cultivars in Altınekin varied between 3.85 (H249) – 4.40 kg (H194), and in Karaman 3.78 (H249) – 4.37 kg (H194). Although the highest seed yield was obtained in H194 genotype in both locations, the lowest seed yield was obtained in the H249 genotype. In the study, the highest seed yield per decare was determined in the H194 variety planted in Altınekin with 4.40 kg, and the lowest value was determined in the H249 variety planted in Karaman with 3.78 kg. Many characteristics create seed yield in sunflowers, as in all other plants, and many factors (e.g., ecological conditions, morphological, physiological, and agricultural characteristics) besides the genetic structure of the plant affect the yield (Bange et al. 1997; Çetin and Öztürk 2018). In other words, yield in sunflowers may differ depending on genetic structure, environment, and cultivation techniques as in other plants.

According to the average values of the locations, the highest seed yield was detected in the H250 genotype with 427.9 kg/da and the lowest in the H249 genotype with 382.3 kg/da (Table 3). Seed yields of other genotypes were followed by H250 (4.27 kg/da), H55 (4.20 kg/da), H5 (4.16 kg/da), P63MM54 (4.17 kg/da), Gibraltar (4.15 kg/da), Tunca (3.98 kg/da) and H253 (3.90 kg/da) seed yields, respectively (Table 2). Different seed yields were obtained in the studies conducted by many researchers in different varieties and regions with different ecologies. Seed yield values (3.30 – 4.25 kg/da) that were detected in the varieties included in this study were in line with those reported by Ceyhan et al. (2008), Ali et al. (2012), Yilmaz and Kinay (2015) and Çetin and Öztürk (2018). On the other hand, the seed yields that were obtained in this trial were higher than the seed yields obtained by Gözütok and Gül (1986), Önder et al. (2001), Jahangir et al. (2006), Beg et al. (2007), Mahar et al. (2007), Öztürk et al. (2008), Day (2011), Katar et al. (2012) and Pekcan and Ensendal (2015). The genetic structure of the cultivars, environment, and cultivation techniques can explain these differences in seed yield.

*3.9. Oil ratio*

Although locations and location x genotype interaction were statistically insignificant in terms of oil ratios in sunflower cultivars that were used in the trial, the differences between cultivars were statistically significant at the level of 1% (Table 1). Önder et al. (2001), Ceyhan et al. (2008), Öztürk et al. (2008), Yilmaz and Kinay (2015) and Çetin and Öztürk (2018), who investigated the same subject, reported that there were differences between cultivars in terms of oil contents.

The average oil content of the cultivars was 44.5% in both locations. The highest fat ratio was determined in the H250 genotype in Karaman of the trial at 47.9%, and the lowest oil rate was determined in the H249 genotype in Altınekin at 41.9%. As an average of the locations where the study was conducted, the highest fat ratio was obtained from the H250 genotype with 47.8%, followed by the H253 (45.7%), H5 (45.2%), H194 (45.1%), Gibraltar (45.9%), Tunca (43.7%), P6MM54 (53.2%), and H249 (43.0%) genotypes. The lowest value was detected in the H55 genotype with 42.9%. The high oil content occurs primarily because of the variety in sunflowers, but it can also vary with the effect of cultivation technique and ecological factors. Our study results are similar to the results reported by Önder et al. (2001), Ceyhan et al. (2008), Öztürk et al. (2008), Katar et al. (2012), Tan (2014), Yilmaz and Kinay (2015) and Çetin and Öztürk (2018).

*3.10. Oil Yield*

As seen in Table 1, although the locations where the study was conducted and the location x genotype interaction were statistically insignificant in terms of oil yield, the differences between the genotypes were statistically significant.

Although the average oil yield of the cultivars used in the study was found to be 1.82 kg/da in Karaman, this was found to be 1.84 kg/da in Altınekin. The H250 genotype that was planted in Altınekin had the highest oil yield with 2.07 kg/da, and the H249 variety that was planted in Altınekin had the lowest oil yield with 1.61 kg/da. As the average of the locations where the study was conducted, the highest oil yield was obtained in the H250 genotype with 2.04 kg/da, and the lowest value was detected in the H249 genotype with 1.64 kg/da. The oil yields of other genotypes were among these values (Table 5). The most economically important yield criterion in all oil crops is oil yield. According to Ilisulu (1970), oil yields of varieties should be calculated in studies because the seed yield of a variety with low oil content in its seeds can be high and as a result, more oil can be obtained per unit area. The high oil yield in H250, H194, and H5 cultivars, depending on the oil content and seed yield, respectively, occurred because of the high oil content of the cultivars (Table 3). The oil yield of the sunflower plant varies according to the oil content of the variety and the seed yield. The varieties with high oil contents and seed yields in sunflowers must be included in the production (Tan 2014). Many researchers who previously conducted studies on this subject reported that they found results similar to ours in their studies (Ceyhan et al. 2008; Öztürk et al. 2008; Tan 2014; Yılmaz and Kınay 2015; Çetin and Öztürk, 2018).

## 4. Conclusions

As a result of the present study, it was determined that the H194, H250, H55, and H5 genotypes, which are in the first place among the genotypes considered candidates for registration in this study, had the highest seed yield and some agricultural characteristics. According to the test results, it was concluded that applying for registration of H194, H250, H55, and H5 genotypes is appropriate.

**Author Contributions:** The authors have read and agreed to the published version of the manuscript.

**Conflicts of Interest:** The author declares no conflict of interest.

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