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# Assessing of Heritability and Variance Components of Yield and Some Agronomic Traits of Different Safflower (*Carthamus tinctorius* L.) Cultivars

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**Abstract:** This study was carried out to determine broad-sense heritability and variance components of seed yield and some components of safflower cultivars. The experiments were arranged in randomized blocks experiment designs with three replications in the 2000-2001 growing season in the East of Turkey. The twelve safflower cultivars were sown in the experimental area of Field Crops Department of Agricultural Faculty in Van ecological conditions. The broad-sense heritability values were determined for yield and yield components. According to the average results of the both experiment years, the maximum plant height (73.67 cm) and head diameter (32.12 mm) was obtained from cv. GW-9003, while the maximum heads/plant in (30.80 ) and seed yield (1737.50 kg $ha^{-1}$) was obtained from cv. GW-9023. The primary branches/plant ranged from 5.75-7.30, seeds/head from 24.57 to 33.43 and 100-seed weight from 37.67 to 44.40 g in the safflower cultivars. The broad-sense heritability values of plant height, primary branchs/plant, heads/plant, head diameter, seeds/head, 100-seed weights and seed yield were calculated as 89, 76, 78, 81, 91, 91 and 92%, respectively.

**Key words:** Safflower, yield, agronomic traits, heritability, variance components, genotypic variance

## INTRODUCTION

Safflower is the only species of *Carthamus* that is domesticated (Knowles, 1958). Safflower has long been widely cultivated for different aims in India, the Near East, the Middle East and China. Safflower is known as an important alternative plant in order to enlarge the oil sources. Safflower is grown as a rainfed crop in Turkey. Therefore the farmers produce it on the marginal land areas, usually ignore irrigation for supplementary water and refuse to use plant nutrients and pesticides in safflower fields. In 2005, total production of safflower seed was 717,778 mt in the world. The highest amount of production was in Mexico with 212,765 mt; 210,000 mt in India; 87,340 mt in the USA, 75,000 mt in Kazakhistan and 51,000 mt in Argentina. Also, the production of safflower seed was 150 mt in Turkey (Anonymous, 2005).

Expression of various traits is often changed as the changing breeding material and environment. Therefore, the information of character associations between the traits themselves and with the traits themselves and with the yield is important for the breeding material subjected to selection for high yielding genotypes (Iqbal *et al*., 2006). Plant height, branchs/plant, heads/plant, seeds/head, head diameter and 1000-seed weight are the most important characters in safflower improvement for increasing seed yield (Omidi Tabrizi, 2005) because of direct and indirect effects on seed yield (Singh *et al*., 2004; Çamaş and Esendal, 2006). Some of these characters are more affected from environmental and genotypic differences (Çamaş and Esendal, 2006). Each breeder is faced with an array of environments in which his or her breeding program is to achieve result (Welsh, 1981). Thus, an estimate of heritability should be determined for optimum breeding program (Çamaş and Esendal, 2006).

The aim of this study was to determine heritability through variance components for plant height, branches/plant, heads/plant, seeds/head, head diameter, 1000-seed weight and seed yield on safflower genotypes.

## MATERIALS AND METHODS

The study was conducted under irrigation conditions between 2000 and 2001 years on the experimental area of the Department of Field Crops, Agriculture Faculty, Yuzuncu Yil University in Van, Turkey. Field experiments were established in the midst of May in the both years. The twelve safflower cultivars (Centennial, GW-9003, GW-9005, GW-9022, GW90-23, GW-9025, Montola 2000, Montola 2001, Yenice, Dinçer, Remzibey and C9305) were used. The total rainfall was 234.60 and 355.2 mm in the experimental years, compared with the long-term (1965-1995) mean of 412.5 mm. The monthly average temperature (first year 10.3°C and second year 10.9°C) and relative humidity (first year 59.4% and second year 60.1%) means were similar to the long-term average (8.3°C;

65.1%). The soil of the experimental area was clay-loam, pH was 7.7, low in organic matter (1.0%), poor in available nitrogen (0.080 mg $L^{-1}$) and phosphorus content (27.5 kg $ha^{-1}$), rich in potassium and lime contents (524.0 kg $ha^{-1}$ and 12%, respectively) and at least in salt content (0.080%). The experimental design was a randomized complete block design with three replications. Seeding rates were 20 kg $ha^{-1}$. Individual plot size 2.25×5 m = 11.25 $m^{-2}$. Row spacing was 45 cm. All plots were harvested for seed yield in the second week of October during both the years. The followed data were measured; plant height, branches/plant, heads/plant, seeds/head, head diameter, 1000-seed weight and seed yield. The collected data was analyzed through computer TARIST statistical package. The heritability values ($h^2$) and variance components were calculated according to the equations reported by Comstock and Moll (1963).

## RESULTS AND DISCUSSION

The morphological characters were significantly differences between cultivars ($p<0.01$) (Table 1). The heritability values, phenotypic variance, genotype×year variance, genotypic variance and phenotypic and genotypic variance coefficients for cultivars are given in Table 2.

The plant height, numbers of primary branches per plant, number of heads per plant, head diameter, number of seeds per head, 100-seed weight are important traits that are used to determine seed yield. The highest plant height (76.67 cm) and head diameter (32.12 mm) were measured from the GW-9003 safflower cultivar. The GW-9022 safflower cultivar produced less primary branches/plant than the other cultivars. The seeds/head ranged from 24.57 to 33.43 and highest number of seeds per head counted was 33.43 in cv. Dinçer. The results reported by Nie *et al.* (1987) indicate that the height of branching is positively correlated with flower yield per plant. Nie *et al.* (1997) showed that the most important direct effects on seed yield are plant height, branching height and number of seeds per head. These authors also reported that the high yielding safflower varieties always have taller individual lower branches, more effective heads, fewer ineffective heads and a longer flowering period. Çamaş and Esendal (2006) found similar results; but, maximum plant height was determined 124.0 cm by Kolsarici and Eda (2002). The Montala 2001 showed lower value than the other cultivars for 100-seed weight (37.67 g). However; the highest 100-seed weight (44.40 g) was determined for cv. C-9305, which is in agreement with the figure 19.0-48.0 g reported by Kolsarici and Eda (2002) and Çamaş and Esendal (2006). The cv. GW-9023 had higher

Table 1: Statistical analysis of yield and agronomic traits in some safflower cultivars* (TARIST statistical program was used)

| Traits/Cultivars | PH | PBN | HN | HD | SN | SW | SY |
|---|---|---|---|---|---|---|---|
| Centennial | 58.28e-g | 7.30bc | 28.52ab | 29.42a-d | 31.37ab | 37.93ef | 1640.20ab |
| GW-9003 | 73.67a | 7.13b-d | 26.67a-d | 32.12a | 30.87b | 40.63cd | 1586.50a-c |
| GW-90050 | 51.65h | 8.78a | 23.78c-e | 25.38e-g | 26.38c | 41.12b-d | 1103.00fg |
| GW-9022 | 63.30c-e | 5.75d | 22.92de | 27.98c-f | 25.90c | 42.85ab | 1216.70e |
| GW-9023 | 59.87d-f | 6.03cd | 30.80a | 28.48bc-f | 30.30b | 39.67c-f | 1737.50a |
| GW-9025 | 60.20d-f | 6.08cd | 24.33b-e | 24.52g | 29.78b | 39.53d-f | 1251.50d-f |
| Montola-2000 | 67.53bc | 7.82ab | 26.13a-d | 28.67b-e | 30.07b | 38.10ef | 1707.00a |
| Montola-2001 | 57.88e-g | 6.15cd | 28.27a-c | 26.73d-g | 31.77ab | 37.67f | 1710.30a |
| C-9305 | 53.80gh | 7.32bc | 20.63e | 25.28fg | 24.57c | 44.40a | 955.70g |
| Dinçer | 64.43cd | 6.17cd | 22.10de | 30.57a-c | 33.43a | 38.10ef | 1045.70fg |
| Yenice | 71.53ab | 6.71b-d | 24.93b-e | 31.57ab | 30.60b | 39.90cde | 1404.20c-e |
| Remzibey | 54.82f-h | 6.28cd | 27.92a-c | 28.50b-f | 29.70b | 41.80bc | 1471.00b-d |
| LSD | 5.71** | 1.40** | 4.68** | 3.37** | 2.48** | 2.16** | 22.98** |

*Means within a column with different letters are different at $p<0.01$ using the LSD, **: Significant at alpha level 1%, PH: Plant Height (cm), PBN: Primary Branches per plant, HN: Head No. per plant, HD: Head diameter (mm), SN: Seed No. per plant, SW: 1000-Seed Weight (g), SY: Seed yield (kg $ha^{-1}$)

Table 2: Statistical analysis of variance components and heritability of yield and agronomic traits in some safflower cultivars*(TARIST statistical program was used)

| Vance components | PH | PBN | HN | HD | SN | SW | SY |
|---|---|---|---|---|---|---|---|
| Borders of variation (Min-Max) | 40.4-76.2 | 4.4-9.5 | 17.0-35.5 | 21.5-35.8 | 20.8-35.5 | 34.4-46.2 | 828-1950 |
| Means±SE | 61.4±0.96 | 6.8±0.14 | 25.6±0.54 | 28.2±0.36 | 29.6±0.36 | 40.1±0.31 | 1402±36.2 |
| CV (%) | 13.24 | 17.28 | 17.75 | 10.79 | 10.36 | 6.45 | 21.88 |
| MS | 13.50** | 0.81** | 9.06** | 4.70** | 2.55** | 1.94** | 218.56** |
| GV | 42.89 | 0.78 | 8.16 | 5.78 | 6.51 | 4.11 | 724.02 |
| GYV | 5.28 | 0.21 | 1.36 | 1.08 | 0.20 | 0.13 | 58.68 |
| PV | 1.02 | 1.02 | 10.35 | 7.11 | 7.14 | 4.49 | 789.79 |
| GCV | 0.11 | 0.11 | 0.32 | 0.20 | 0.22 | 0.10 | 5.16 |
| PCV | 0.15 | 0.15 | 0.40 | 0.25 | 0.24 | 0.11 | 5.63 |
| $h^2$ | 0.89 | 0.76 | 0.78 | 0.81 | 0.91 | 0.91 | 0.92 |

**$p<0.01$, CV: Coefficient of Variation, MS: Mean Squares, GV: Genotypic Variance, GYV: Genotype×Year interaction Variance, PV: Phenotypic Variance, GCV: Genotypic Coefficient of Variation, PCV: Phenotypic Coefficient of Variation, $h^2$: heritability, PH: Plant Height (cm), PBN: Primary Branches per Plant, HN: Head No. per Plant, HD: Head Diameter (mm), SN: Seed No. per Plant, SW: 1000-Seed Weight (g), SY: Seed Yield (kg $ha^{-1}$)

values than the rest for the head diameter (32.12 mm) and seed yield (127.50 kg $ha^{-1}$). Omidi Tabrizi (2002) investigated that the floret removal effects on grain and oil yield and their components in spring safflower. He also reported agronomic values for seed yield, heads/plant and seeds/head to be 350-1600 kg $ha^{-1}$, 9.8-13.4 and 34-42 respectively. Uslu *et al*. (2002) determined 55.3 cm plant height, 22.0 mm head diameter and 546 kg $ha^{-1}$ seed yield in safflower.

The expression of quantitative inheritance is also influenced by the environment. The breeders aim to quantify the impact of genetics and environment. To help breeders distinguish between genotype and environmental effects, a heritability value can be determined using the ratio of genotypic and phenotypic variation (Tekeli and Ateş, 2002a, b; Ateş and Tekeli, 2004). Heritability was low for number of primary branches per plant (76 %) and number of heads per plant (78%). These traits may be affected by the environment. These results indicated that these traits were controlled by genetic factors. Present findings are similar to those of Kavani *et al*. (2001), Çamaş and Esendal (2006). They reported that heritability values for plant height, number of branches, head diameter, seeds/head and 1000-seeds weight as 93, 45, 21, 69 and 81%, respectively. Nie *et al*. (1987) reported that number of branch had high heritability. According to Arshad *et al*. (2002), low heritability percentage coupled with low and moderate genetic advancement has been observed for primary and secondary branches, respectively. Additionally, they indicated that these characters were greatly affected by environment. Manju and Sreelathakumary (2002) found that heritability values for plant height, primary branches per plant, 1000-seed weight and yield per harvest as 87, 39, 93 and 98%, respectively. The plant height was less influenced by environment (Yücel *et al*., 2006). Abel and Driscoll (1976) reported that 1000-seed weight was generally less affected by different environments, but seeds/head were more influenced.

The plant height showed a relatively large difference in phenotypic and genotypic variance coefficients, whereas there was little difference in the phenotypic and genotypic variance coefficients for other traits.

The phenotypic variance coefficient was found to range from 0.11-5.63; the highest phenotypic variance coefficients being for seed yield (5.63), followed by heads/plant (0.40). The highest genotypic variance coefficient was 5.16 for seed yield, followed by 0.32 for heads/plant, as was the case for genotypic variance coefficients. Traits that showed a comparatively high genotypic variance coefficient may respond favorably to selection (Debnath, 1987).

From the results of this investigation, it is concluded that environmental fluctuations have a greater effect on number of primary branches per plant and number of heads per plant than on other characters. So these factors may be considered as practical selection criteria for improving safflower cultivars.

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