

## **Growth and yield response of two safflower (*Carthamus tinctorius* L.) cultivars to four concentrations of humic acid and three planting dates**

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### **Abstract**

The field experiment was carried out during the autumn season of 2024-2025 at AL-Asheq locations in Nineveh Governorate located on the line (42°39'50"W36°26'47"N), with the aim of studying the effect of four concentrations of humic acid (0, 5, 10 and 15 g/L) and three planting dates (1/11, 15/11 and 30/11) and two cultivars of safflower (Gila and Rabie 500) on the resulting growth traits. The three-factor factorial experiment was conducted using a randomized complete block design (RCBD) with a split-plot system. The results showed significant differences between humic acid concentrations for most of the studied traits. The 15 g/L level resulted in the highest average plant height, days to 50% flowering, head diameter, number of heads, seed yield, oil percentage, and oil yield at both study locations. The planting date of November 1st showed a significant advantage in all studied traits. The Gila cultivar exhibited the highest average for all studied traits. The interaction between humic acid concentrations and planting dates was also significant, with the 15 g/L level and the November 1st planting date significantly excelled on the Gila cultivar in terms of plant height, days to 50% flowering, head diameter, number of heads per plant, seed yield, oil percentage, and oil yield. Finally, the interaction between humic acid concentrations and cultivars was also significant, with the 15 g/L level performing better with the Gila cultivar. The study found that the plant exhibited the highest average number of days to 50% flowering, seed yield ( $\text{g.m}^{-2}$ ), oil percentage (%), and oil yield ( $\text{g.m}^{-2}$ ). However, the plant height, head diameter, and number of heads did not reach statistical significance. Regarding the interaction between planting dates and cultivars, the planting date of November 1st with the Gila cultivar resulted in the highest average plant height, number of days to 50% flowering, head diameter, seed yield, and oil yield. No differences were found in the number of heads or oil percentage. The three-way interaction between humic acid concentrations, planting dates, and cultivars resulted in the significantly higher average number of days to 50% flowering, head diameter, and number of heads per plant compared to the 15 g/L humic acid level, the planting date of November 1st, and the Gila cultivar. The remaining traits did not reach statistical significance at the study location.

Keywords: Safflower, *Carthamus tinctorius* L., Humic acid, Planting dates, Cultivars

### **Introduction**

Safflower its scientific name is *Carthamus tinctorius* L. It belongs to the Asteraceae family, one of the most widespread flowering plant families [1]. This family comprises 32,913 species in 13 families and 1,911 genera [8]. The scarcity of oils has led to a growing shortage, necessitating increased production of oilseed

crops. In 2020, oil production reached 610.1 million tons, representing a 3.8% increase compared to 2019 [9]. The use of organic materials is not a replacement for chemical fertilizers but rather a complement to them, meeting the plant's nutritional needs to complete its life cycle and achieve high productivity. One such organic material is humic acid, a bio-

stimulant that enhances plant growth and photosynthesis by improving water absorption and utilization efficiency, as well as nutrient uptake [16]. Humic acid helps It stimulates many vital reactions in the plant and leads to increased cell membrane permeability, which in turn leads to increased vegetative growth, such as plant height and stem diameter [3]. Determining the appropriate planting date for oilseed crops is extremely important and must be based on the region's climate. A suitable planting date for oilseed crops is determined when all environmental factors are present, including light, appropriate temperatures, nutrients, and water, which lead to germination, plant establishment, and improved growth. Each stage of plant growth requires specific conditions and should not encounter undesirable environmental situations [6]. Furthermore, cultivars are an important and direct factor influencing production and quality due to their varying ability to adapt to environmental conditions and respond to different growth conditions [15]. This study aims to determine the effect of humic acid and planting dates on the growth traits and yield of safflower [12] conducted a study on safflower. Using several concentrations (0, 6, 12, and 18 kg ha<sup>-1</sup>), the results showed that the 12 kg ha<sup>-1</sup> concentration was excelled, giving the highest plant height, number of days to 50% flowering, number of heads, seed yield (% for oil), and oil yield, reaching (180.43 cm), (106.75 days), (83.37 heads/plant), (4.331 t ha<sup>-1</sup>), (35.00%), and (1439 t ha<sup>-1</sup>), respectively. [2] in his study on sunflower plants using several concentrations of humic acid (0, 3, 6, and 9 ml L<sup>-1</sup>) applied as a foliar spray, stated that the 9 ml L<sup>-1</sup> concentration was significantly excelled, giving the highest average plant height and head diameter, reaching (161.3 cm) and (16.21 cm). In a study conducted by [11] on safflower with four planting dates (November 1, November 15, December 1, and December 15), the results showed that the November 1 date was excelled, gave the highest average number of days to 50% flowering, plant height, head diameter, number of heads per year (%) for oil, and oil yield (164.7 days, 155.00 cm, 17.60 branches per

plant, 2.5 cm, and 37.60 heads per plant), respectively. This was in contrast to the last planting date, December 15, which gave the lowest average for these traits (141.0 days, 75.06 cm, 2.1 cm, 17.00 heads per plant) (34.8%), and (1.2 tons ha<sup>-1</sup>). [3] noted a significant effect. For the planting dates of (1/10, 4/11, and 2/12) on safflower crops, the results showed that the 4/11 date was excelled, giving the highest average seed yield of (1.64 ton. ha<sup>-1</sup>). [11] in their study on six safflower cultivars (8311, 3307, 0210, S-351, and 323-S), indicated that cultivars 0260 and S-351 were significantly excelled, giving the highest average plant height of (105 and 100 cm), respectively. [10], in their study of four safflower cultivars (Padideh, Parnian, Goldasht, and Golmehr), indicated differences in the studied yield traits. The Goldasht cultivar significantly excelled others, producing the highest average number of heads per plant and the highest head diameter (22.74 heads/plant) and (29.68 mm), respectively. In a study conducted by [19] on five safflower cultivars (Gila, Sina, Pi 537, 636, Pi 527, 710, and Kiama), significant differences were found between the cultivars in the number of days to flowering. The Gila cultivar exhibited the lowest average number of days (107.7 and 85.3 days) both seasons, respectively. Similarly, [14] in a study of several safflower cultivars (CTI, CTI 5, CTI 6, CTI 9, CTI 10, CTI 11, CTI 13, CTI 15, CTI 17, and Montola 2000), found that CTI 17 was excelled in terms of the number of heads per plant (averaging 15 heads/plant), seed yield (1.40 tons/ha), and overall yield. Oil content (0.58 tons ha<sup>-1</sup>), while the CTI 9 cultivar had the highest percentage of oil in the seeds (41.6%).

## **Materials and Methods**

A field experiment was conducted during the autumn season of 2024-2025 in the village of Al-Ashiq, west of Nineveh province (more than 60 km from the city of Mosul) to study the effect of humic acid concentrations, planting dates, and cultivars on growth traits, yield, and quality. It was implemented as a three-factor factorial experiment using a randomized

complete block design (RCBD) with a split-plot system. The three factors were: four humic acid concentrations (0, 5, 10, and 15 g/L), three planting dates (November 1, 15, and 30), and the two cultivars (Gila and Rabi' 500). With three replicates, the initial number of experimental units was  $4 * 3 * 2 = 24$ , resulting in 72 units. Each experimental unit consisted of four rows, each 2 meters long, with a spacing of 25 cm between rows and 20 cm between plants. Treatments were randomly distributed within each replicate, with a spacing of 1 meter between units and 1.5 meters between replicates. The field was plowed perpendicularly with a moldboard plow, then leveled and divided. Planting took place on the specified dates, and 15 days after emergence, the plants were thinned to one per hill. The readings were taken from the midlines.

## **Results and Discussion**

### **1- Plant Height (cm)**

Table (1) shows significant differences in plant height between humic acid concentrations. The (15 g/L) level resulted in the highest average height of (125.70 cm), while the control treatment (Spray water only) resulted in the lowest average height of (113.83 cm) This may be because Humic acid consists of phenolic cyclic compounds and has an effect similar to plant hormones [17]. This leads to increased cell division and elongation in the apical and lateral meristematic regions, thus stimulating growth and increasing its rates. It also increases the size of the vegetative mass, including plant height. This is consistent with the findings of [2]. Table (2) shows significant differences between planting dates. The first planting date (November 1st) resulted in the highest average height of (125.70 cm) compared to the last (30/11) gave the lowest average planting date. height (116.62 cm. This is due to the fact that the effect was more pronounced in the first date, where the plants were more advanced in growth than in the other dates, thus affecting plant height compared to the other dates. These results are consistent with those of [11]. As for the cultivars, the results in Table (3) showed a

significant advantage for the Gila cultivar, gave the highest average height (122.55 cm) compared to the Gila cultivar, which gave the lowest average height (119.61 cm) for the two study locations. This may be due to the fact that cultivars differ in their response to growth factors, as auxins present in the growing tips play a key role in regulating many developmental processes in plants, including controlling plant height. These auxins are present with varying activity and effectiveness among different cultivars, leading to variations in plant responses to the same environmental factors. This is supported by the results of Maziero (19, 20). Regarding the interaction between humic acid concentrations and planting dates, the results in Table (4) show a significant advantage of the 15 g/L level with the first planting date (November 1st) gave the highest average depth (132.16 cm) compared to the 0 g/L level with the planting date (November 30th), which gave the lowest average depth (111.33 cm). As can be seen from Table (6), the results of the interaction between planting dates and cultivars show that the first planting date (November 1st) and the Gila cultivar significantly excelled them, gave the highest average depth (127.75 cm) compared to the November 30th planting date with the Rabi' 500 cultivar, which gave the lowest average depth (115.41 cm) at the study location. As for the interaction between concentrations, planting dates and cultivars, the results in Table (7) showed that the level (15 g/L), planting date (1/11) and cultivar Gila

### **2- Number of days to 50% flowering:**

Table (1) shows differences in humic acid concentrations regarding the number of days to 50% flowering. The (15 g/L) level significantly excelled gave the highest average number of days (157.88 days), while the control treatment (0 g/L) resulted in the lowest average for this trait (155.05 days). This can be due to the active role of humic acid in increasing cell activity and division, acting similarly to plant hormones, particularly auxins, cytokinins, and gibberellins [18]. This aligns with the findings of [12]. From the same two tables, we observe significant

differences between planting dates. The first date (November 1st) gave the highest average number of days, reaching (160.37 days) respectively, compared to the first date (November 30th), which gave the lowest average for this characteristic, reaching (151.87 days). This may be due to the fact that the plants of the first date had a longer growth period than the plants of the third date, as the plants, from emergence to flowering, received sufficient thermal accumulation and photoperiod. This is consistent with the findings of [11]. As for the cultivars, the results showed a significant advantage for the Gila cultivar, which flowered earlier with the lowest average number of days (155.27 days) compared to the Rabie 500 cultivar, which gave the highest average (157.19 days) at the study location. This may be due to the differences in the cultivars' utilization of temperature and photoperiod, given the importance of these two factors in accelerating vital processes that lead to faster flowering[4]. This result is consistent with the findings of [19]. Regarding the interaction between humic acid concentrations and planting dates, the results in Tables 4 showed significant differences. The 15 g/L level with the planting date of November 1st resulted in the highest average number of days (163.00 days) compared to the 0 g/L level with the planting date of November 30th, which resulted in the highest average number of days (150.33 days). As for the interaction between humic acid concentrations and cultivars, the same tables showed that the 15 g/L level was excelled with the Gila cultivar, resulting in the lowest average number of days (158.33 days) compared to the 0 g/L level with the Rabie 500 cultivar, which resulted in the highest average for this trait (153.66 days). From Tables 6 we observe that the interaction between planting dates and cultivars shows that the planting date of November 30th and the Gila cultivar significantly excelled the others, gave the lowest average of 150.75 days. This contrasts with the November 1st planting date and the Rabie cultivar, which exhibited the highest average of 161.16 days for this trait at the study location. Regarding the interaction between humic acid

concentrations, planting dates, and cultivars, the results in the same two tables also show significant differences. The humic acid level of 15 g/L, the planting date of November 1st, and the Rabie 500 cultivar resulted in the highest average of humic acid days (164.00 days), compared to the humic acid level of 0 g/L, the planting date of November 30th, and the Gila cultivar, which gave the highest average of 148.33 days for this trait.

### 3- Head Diameter (cm):

Table (1) shows significant differences in head diameter between humic acid concentrations. The (15 g/L) level resulted in the highest average diameter (2.56 cm), while the control treatment (0 g/L) resulted in the lowest average diameter (2.16 cm) at the study location. This is due to the importance of humic acid in increasing enzymatic activity and vital processes, which lead to increased cell division and elongation, thus increasing head diameter. This aligns with the findings of [2]. Table (2) shows significant differences in planting dates. The first planting date (November 1st) resulted in the highest average diameter (2.46 cm), compared to the last planting date (November 30th), which resulted in the lowest average diameter (2.29 cm). This may be due to the longer growth period, during which the plant received its full humic acid requirement. The growth period improved plant development, leading to increased dry matter production and its transfer to the fruiting parts during the flowering period. This, in turn, increased the average head diameter. These results are consistent with those of [11]. Table 3 shows significant differences between the cultivars. The Gila cultivar significantly excelled others, gave the highest average diameter (2.42 cm) compared to the Rabie 500 cultivar, which gave the lowest average diameter (2.33 cm) for the study location. This difference in head diameters between the cultivars is due to genetic factors specific to each cultivar. These results are consistent with those of [10] who stated that the two cultivars studied differed significantly in yield traits, including head diameter. Regarding the interaction between humic acid

concentrations and planting dates, the results in Table (4) showed a significant advantage for the (15 g/L) level with the first planting date (November 1st gave the highest average (2.65 cm) compared to the (0 g/L) level with the planting date (November 30th), which gave the lowest average (2.08 cm). As for the interaction between humic acid concentrations and cultivars, as shown in Table (5), no significant differences were found between them. As for the interaction between planting dates and cultivars, Table (6) shows that the (1/11) planting date with the Gila cultivar was excelled, as it gave the highest average head diameter of (2.58 cm), compared to the (0 g/L) level and the Rabie 500 cultivar, which gave the lowest average of (2.26 cm). As for the interaction between concentrations, planting dates, and cultivars, Table (7) shows that the (15 g/L) level, the (1/11) planting date, and the Gila cultivar were significantly excelled, giving the highest average of (2.75 cm), compared to the (0 g/L) level, the (30/11) planting date, and the Rabie 500 cultivar, which gave the lowest average of (2.05cm) for the study location.

#### 4- Number of heads/plants:

From Tables(1) The (15 g/L) level significantly excelled, giving the highest average of (32.74 heads/plants), while the control treatment (0 g/L) gave the lowest average for this trait, reaching (23.57 heads/plants) for the study location. This result is consistent with the findings of several researchers, including [12]. The same tables revealed significant differences between planting dates. The first date (November 1st) was significantly excelled, gave the highest average (31.19 heads/plants) compared to the last date (November 30th), which produced the lowest average (26.69 heads/plants) This may be due to the fact that early planting extends the growing season due to exposure to lower temperatures and a high percentage of sunlight. This positively impacts plant growth, resulting from the activation of various physiological activities and increased nutrient accumulation. Consequently, the number of main and secondary branches increases, which is directly proportional to the

number of heads per plant. This aligns with the findings of [11]. As for the cultivars, the Gila cultivar significantly excelled others, gave the highest average of 31.23 heads per plant (heads per plant) compared to the Rabie 500 cultivar, which gave the lowest average of 27.39 heads per plant. This may be due to differences in the genetic traits of the cultivars in completing the flowering process, as each cultivar exhibits a unique interaction with surrounding environmental factors, leading to variations in agricultural traits such as the number of heads per plant [13]. This aligns with the findings of [5] and Ghobadi (2022). Regarding the interaction between humic acid concentrations and planting dates, the results showed that the 15 g/L level with the first planting date (November 1st) gave the highest average of 35.68 heads per plant (heads per plant), compared to the 0 g/L level with the planting date (November 30th), which gave the lowest average. The average plant height was 21.52 heads per plant (heads per plant) respectively. Regarding the interaction between humic acid concentrations and cultivars, the results showed no significant differences. Regarding the interaction between planting dates and cultivars, the results showed no significant differences at the study location. However, regarding the interaction between humic acid concentrations, planting dates, and cultivars, the results showed that the 15 g/L level, planting date (November 1st), and the Gila cultivar gave the highest average (38.67 heads per plant), compared to the 0 g/L level, planting date (November 30th), and the Rabie 500 cultivar, which gave the lowest average (19.66 heads per plant).

#### 5- Seed yield (g.m<sup>2</sup>):

From Table (1), we observe significant differences between humic acid concentrations in plant height. The 15 g/L level resulted in the highest average. The average yield was 340.50 g m<sup>-2</sup>, while the control treatment (0 g/L) gave the lowest average for this trait at 291.79 g m<sup>-2</sup>. Spraying the plants with humic acid leads to an increase in the total seed yield by increasing head weight, seed weight per head, number of heads per plant, number of seeds per head, and

the 1000-seed weight. This is supported by the findings of [12]. From Table (2), we observe significant differences between planting dates. The first date (November 1st) was significantly excelled, giving the highest average yield of  $332.36 \text{ g m}^{-2}$ , compared to the last date (November 30th), which gave the lowest average yield of  $305.69 \text{ g m}^{-2}$ . This may be due to the fact that early planting extends the growing season for plants due to exposure to lower temperatures and a high percentage of sunlight, which has a significant impact. This positively impacts plant growth performance, resulting from the activation of various physiological activities and increased nutrient accumulation. This aligns with the findings of Ghodare (2024) and [3]. Regarding the cultivars, the results in Table (3) show that the Gila cultivar significantly excelled others, gave the highest average ( $331.81 \text{ g m}^{-2}$ ) compared to the rabe500 cultivar, which gave the lowest average ( $304.29 \text{ g m}^{-2}$ ). This is due to the Gila cultivar's ability to maximize its utilization of environmental conditions [14]. Regarding the interaction between humic acid concentrations and planting dates, as shown in Table (4), the (15 g/L) level was significantly excelled with the first planting date (November 1st), gave the highest average yield of ( $360.06 \text{ g/m}^2$ ) compared to the (0 g/L) level with the planting date (November 30th), which gave the lowest average yield of ( $282.63 \text{ g/m}^2$ ). As for the interaction between humic acid concentrations and cultivars, the results in Table (5) show that the (15 g/L) level was excelled with the Gila cultivar, giving the highest average seed yield of ( $355.78 \text{ g/m}^2$ ), compared to the (0 g/L) level and the Rabie cultivar, which gave the lowest average yield of ( $283.88 \text{ g/m}^2$ ). As can be seen from Table (6), the interaction between planting dates and cultivars is significant. The results show that the first planting date (1/11) and the Gila cultivar gave the highest average yield ( $350.68 \text{ g/m}^2$ ), compared to the planting date (30/11) and the Rabie 500 cultivar, which gave the lowest average yield ( $294.44 \text{ g/m}^2$ ). However, the three-way interaction between planting concentrations, planting dates, and

cultivars, as shown in Table (7), did not reveal any significant difference at the study location.

#### 6- Oil content (%):

The results in Table (1) show significant differences between humic acid concentrations in the percentage of oil. The (15 g/L) level gave the highest average (30.53%), while the control treatment (0 g/L) gave the lowest average for this trait (26.28%) for both study locations, respectively. This is supported by the findings of [12]. Table (2) shows significant differences between planting dates. The first date (November 1st) was significantly excelled, gave the highest average yield of 30.19%, compared to the last date (November 30th), which gave the lowest average yield of 26.81%. This may be due to the fact that delayed planting is associated with higher temperatures, which affect the oil content of the seeds. Oil content decreased with increasing temperatures [7]. These results are consistent with those of [10] who found that varying planting dates led to a significant increase in the oil content of safflower seeds. As for the cultivars, the results in Table (3) showed the significant excelled of the Gila cultivar, which gave the highest average (29.15%) compared to the Rabie 500 cultivar, which gave the lowest average (27.68%), respectively, for the study location. The reason for the difference in the oil percentage in the seeds of the cultivars can be due to the influence of environmental conditions that affected the excelled composition of the cultivar over the other, and to the genetic variation among the cultivars themselves in the oil content of their seeds. This result is consistent with what was indicated regarding the significant difference among safflower cultivars in the trait of oil percentage in their seeds, a result that matches the findings of [14]. Regarding the interaction between humic acid concentrations and planting dates, Table (4) shows a significant advantage of the (15 g/L) level with the first planting date (November 1st) gave the highest (32.30%) compared to the (0 g/L) level with the planting date (November 30th), which gave the lowest average height (24.25%) at the study location. As for the

interaction between humic acid concentrations and cultivars, Table (5) indicates that the (15 g/L) level was excelled with the Gila cultivar, giving the highest average plant height (31.25%), compared to the (0 g/L) level with the Rabie cultivar, which gave the lowest average height (25.65%).Table (6) also shows no significant differences in the interaction between planting dates and cultivars. Regarding the interaction between concentrations, planting dates, and cultivars, Table (7) shows no significant difference at the study location.

**7- Oil yield (g.m<sup>-2</sup>):**

Table (1) shows significant differences between humic acid concentrations in oil yield The (15 g/L) level resulted in the highest average (104.25 g.m<sup>-2</sup>), while the control treatment (0 g/L) gave the lowest average for this trait (76.82 g.m<sup>-2</sup>). Spraying the plants with humic acid led to an increase in seed yield and an increase in oil percentage, thus leading to an increase in oil yield. This is consistent with the findings of [12]. Table (2) shows significant differences between planting dates. The first date (November 1st) was significantly excelled gave the highest average 100.83 g/m<sup>2</sup>), compared to the last date (November 30th), which gave the lowest average (82.32 g/m<sup>2</sup>). This may be due to the excelled of earlier planting dates in seed yield (Table1), which is directly proportional to oil yield. This aligns with the results of [11]. Table (3) reveals significant differences between the cultivars. The Gila cultivar significantly excelled others, gave the highest average (97.24 g/m<sup>2</sup>) compared to the Rabie 500

cultivar, which gave the lowest average (84.92 g/m<sup>2</sup>). The excelled of the Gila cultivar is due to its excelled in both seed yield and oil percentage in the seeds, resulting in a higher oil yield. This finding aligns with the earlier report indicating that the Gila cultivar significantly excelled others in seed yield, oil percentage in the seeds, and oil yield. It also agrees with the findings of [14] who noted significant differences between cultivars in yield and quality traits in their research. Regarding the interaction between humic acid concentrations and planting dates, Table (4) shows that the 15 g/L level with the first planting date (November 1st) was significantly excelled gave the highest average oil yield of 116.50 g/m<sup>2</sup>, compared to the 0 g/L level with the planting date (November 30th), which gave the lowest average oil yield of 65.58 g/m<sup>2</sup>. As for the interaction between humic acid concentrations and cultivars, Table (5) shows that the 15 g/L level was excelled with the Gila cultivar, gave the highest average oil yield of 111.38 g/m<sup>2</sup>, compared to the 0 g/L level with the Rabea cultivar, which gave the lowest average oil yield of 72.86 g/m<sup>2</sup>.Regarding the interaction between planting dates and cultivars, the results in Table (6) show that the first planting date (1/11) and the Gila cultivar significantly excelled others, gave the highest average (108.95 g/m<sup>2</sup>), compared to the planting date (30/11) and the Rabie 500 cultivar, which gave the lowest average (77.42 g/m<sup>2</sup>) at the study location. As for the interaction between humic acid concentrations, planting dates, and cultivars, the results in Table (7) indicate no significant differences at the study location.

**Table (1): Effect of Humic Acid Concentrations on Some Safflower Traits.**

<b>Oil yield (g/m<sup>-2</sup>)</b>	<b>Oil content (%)</b>	<b>Seed yield (g/m<sup>-2</sup>)</b>	<b>No. of heads/plant</b>	<b>Head diameter(cm)</b>	<b>Day to %50 flowering</b>	<b>Plant height (cm)</b>	<b>Humic acid concentrations (g/L)</b>
76.82 d	26.28 d	291.79 d	23.57c	2.16 c	155.05d	113.83 d	<b>0</b>
86.19c	27.79 c	308.98 c	30.05b	2.33 b	155.61c	121.27c	<b>5</b>
96.46 b	29.07 b	330.93 b	30.90b	2.45 b	156.38 b	123.44 b	<b>10</b>
104.25 a	30.53 a	340.50a	32.74a	2.56 a	157.88 a	125.77 a	<b>15</b>

Table (2): The effect of planting date concentrations on some safflower traits.

Oil yield (g/m <sup>-2</sup> )	Oil content (%)	Seed yield (g/m <sup>-2</sup> )	No. of heads/plant	Head diameter(cm)	Day to %50 flowering	Plant height (cm)	Planting dates
100.83 a	30.19 a	332.36 a	31.19a	2.46 a	160.37 a	a 125.70	11/1
89.64 b	28.25 b	316.11 b	30.06b	2.38 b	156.25 b	b 120.91	11/15
82.32 c	26.81 c	305.69 c	26.69c	2.29 c	152.08 c	c116.62	11/30

Table (3)The effect of cultivars on some traits of safflower.

Oil yield (g/m <sup>-2</sup> )	Oil content (%)	Seed yield (g/m <sup>-2</sup> )	No. of heads/plant	Head diameter(cm)	Day to %50 flowering	Plant height (cm)	cultivars
97.24 a	29.15 a	331.81 a	31.23 a	2.42 a	155.27b	122.5 a	Gila
84.62 b	27.68 b	304.29 b	27.39 b	2.33 a	157.19a	119.61 b	Rabie 500

Table (4): Effect of humic acid concentrations and Planting dates on some traits of safflower.

Oil yield (g/m <sup>-2</sup> )	Oil content (%)	Seed yield (g/m <sup>-2</sup> )	No. of heads/plant	Head diameter(cm)	Day to %50 flowering	Plant height (cm)	cultivars	Humic acid concentrations
83.98f	28.41cd	295.19g	25.51g	2.24bc	159.16c	115.83h	11/1	0
77.89g	26.16e	297.54g	23.67h	2.17de	155.66e	114.33g	11/15	
68.60h	24.25f	282.63h	21.52i	2.08e	150.33i	111.33h	11/30	
94.96d	29.46c	321.76de	30.20d	2.49b	159.00 c	126.83b	11/1	5
85.33f	27.56d	308.93f	31.12cd	2.31c	156.33de	121.00d	11/15	
78.29g	26.37e	296.25g	28.83e	2.20d	151.50h	116.00f	11/30	
107.91b	30.59b	352.41c	33.37b	2.47b	160.33b	128.00b	11/1	10
92.62d	28.47cd	324.98d	31.80c	2.47b	156.16de	124.00c	11/15	

88.86e	28.15d	315.41e f	27.54f	2.42b	152.66g	118.33 e	11/30	15
116.50 a	32.30a	360.06a	35.68a	2.65a	163.00a	132.16 a	11/1	
102.73 c	30.81b	332.99c	33.67b	2.59a	156.83d	124.33 c	11/15	
93.53d	28.49c d	328.46c d	28.88e	2.45b	153.83f	120.83 d	11/30	

**Table (5): Effect of humic acid concentrations and cultivar on some safflower traits**

Oil yield (g/m <sup>2</sup> )	Oil content (%)	Seed yield (g/m <sup>2</sup> )	No. of heads / plant	Head diameter(cm)	Day to %50 flowering	Plant height (cm)	cultivars	Humic acid concentrations
80.78e	26.90d	399.70 e	25.46 a	2.21a	153.66f	115.55 a	Gila	0
72.86f	25.65e	283.88 g	21.68 a	2.12a	156.44c	112.11 a	Rabie 500	
94.41c	29.01b c	325.05 c	31.79 a	2.40a	154.66e	122.33 a	Gila	5
77.98e	26.58d	292.91 f	28.31 a	2.27a	156.55c	120.22 a	Rabie 500	
102.41 b	29.46b c	346.73 b	32.50 a	2.49a	155.33d	125.00 a	Gila	10
90.51d	28.68c	315.13 d	29.31 a	2.42a	157.44b	121.88 a	Rabie 500	
111.38 a	31.25a	355.78 a	35.20 a	2.61a	157.44b	127.33 a	Gila	15
97.12c	29.82b	325.23 c	30.28 a	2.51a	158.33a	124.22 a	Rabie 500	

**Table (6): Effect of Planting dates and cultivars on some traits of safflower**

Oil yield (g/m <sup>2</sup> )	Oil content (%)	Seed yield (g/m <sup>2</sup> )	No. of heads/ plant	Head diameter(cm)	Day to %50 flowering	Plant height (cm)	cultivars	Planting dates
108.95a	30.97a	350.68a	33.01a	2.58a	159.58b	127.75a	Gila	11/1
92.72c	29.41a	314.04c	29.37a	2.38bc	161.16a	123.66a	Rabie 500	
95.57b	29.06a	327.83b	31.89a	2.42b	155.50d	122.08c	Gila	11/15
83.71d	27.44a	304.39d	28.23a	2.35bc	157.00c	119.75d	Rabie 500	

87.22d	27.44a	316.94c	28.80a	2.31cd	150.75f	117.83e	Gila	11/30
77.42f	26.19a	294.44e	24.58a	2.26d	153.41 e	115.41 f	Rabie 500	

**Table (7): Effect of humic acid concentrations, planting dates, and cultivars on some safflower traits**

Oil yield (g/m <sup>2</sup> )	Oil content (%)	Seed yield (g/m <sup>2</sup> )	No. of heads/plant	Head diameter(cm)	Day to %50 flowering	Plant height (cm)	cultivars	Planting dates	Humic concentrations
90.22a	29.27a	308.41a	27.42hij	2.29f-i	158.00fg	119.33a	Gila	11/1	0
77.74a	27.56a	281.98a	23.61klm	2.20h-k	160.33cd	112.33a	Rabie 500		
80.50a	26.76a	300.75a	25.57jkl	2.22hij	154.66ij	115.00a	Gila	11/15	
75.27a	25.57a	294.33a	21.72mn	2.13ijk	156.66h	113.66a	Rabie 500		
71.61a	24.69a	289.92a	23.38lm	2.11jk	148.33p	112.33a	Gila	11/30	
65.58a	23.83a	275.35a	19.66n	2.05k	152.33m	110.33a	Rabie 500		
103.63a	30.34a	341.61a	31.58def	2.57bc	158.66ef	127.66a	Gila	11/1	5
86.28a	28.57a	301.92a	28.83ghi	2.41ceg	159.33m	126.00a	Rabie 500		
93.37a	28.65a	325.89a	32.29c-f	2.36e-h	155.33i	122.33a	Gila	11/15	
77.30a	26.47a	291.98a	29.94fgh	2.25g-j	157.33gh	119.66a	Rabie 500		
86.24a	28.04a	307.65a	31.52d-g	2.26g-j	150.00o	117.00a	Gila	11/30	
70.35a	24.70a	284.85a	26.15jk	2.14ijk	153.00lm	115.00a	Rabie 500		
116.02a	31.00a	374.15a	34.39bc	2.59cde	159.66de	130.00a	Gila	11/1	10
99.79a	30.18a	330.67a	32.35c-f	2.35gh	161.00c	126.00a	Rabie 500		
98.03a	28.92a	338.80a	33.27cd	2.49b-e	155.00ij	125.00a	Gila	11/15	
87.21a	28.02a	311.15a	30.32efg	2.45b-f	157.33gh	123.00a	Rabie 500		
93.17a	28.46a	327.24a	29.84fgh	2.39d-g	151.33n	120.00a	Gila	11/30	
84.55a	27.84a	303.58a	25.25jkl	2.46b-e	154.00jkl	116.66a	Rabie 500		
125.91a	33.27a	378.55a	38.67a	2.75a	162.00b	134.00a	Gila	11/1	15
107.08a	31.34a	341.61a	32.68cde	2.55bcd	164.00a	130.33a	Rabie 500		
110.38a	31.91a	345.88a	36.43ab	2.60b	157.00gh	126.00a	Gila	11/15	
95.09a	29.70a	320.11a	30.90d-g	2.58b	156.66h	122.66a	Rabie 500		
97.85a	28.57a	342.93a	30.49efg	2.49b-e	153.33klm	122.00a	Gila	11/30	
89.20a	28.41a	313.99a	27.27ij	2.41c-g	154.33ijk	119.66a	Rabie 500		

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