

Effect of Planting Dates on Yield Traits and Components in Sunflower Genotypes

Mushtaq K. Sraih ^{1*} and Abdullah F. Sarheed ²

¹ Mushtaq K. Sraih, Al-Furat Al-Awsat Technical University, Al-Mussaib Technical College, Babylon, Iraq.

E-mail: mush86mks@gmail.com

² Abdullah F. Sarheed, Al-Furat Al-Awsat Technical University, Al-Mussaib Technical College, Babylon, Iraq.

E-mail: com.abdf@atu.edu.iq

*Corresponding Author E-mail: mush86mks@gmail.com

Received 25/06/2026, Received in revised form 08/07/2026

Accepted 15/07/2026, Available online 10/10/2026

FJIAS 2026, 2(S1): 205-213

Special Issue: Selected Papers from the 3rd International Conference on Sustainable Development and Climate Change (ICSDCC 2026). Organized by Al-Mussaib Technical College / Al-Furat Al-Awsat Technical University, Iraq, in cooperation with Delta University for Science and Technology, Egypt. Held at Delta University for Science and Technology, Mansoura, Egypt, on 18 July 2026.

ABSTRACT

*A field experiment was conducted during the spring and autumn seasons of 2025 to cultivate sunflower (*Helianthus annuus* L.) at the experimental fields of Al-Musayyib Technical College, Babil Governorate, within Al-Musayyib Project District, located about 40 km north of the governorate (longitude 44.50° E, latitude 32.50° N). The experiment aimed to study the effect of planting dates on yield traits and their components for several sunflower genotypes. The study included a factorial field experiment with two factors. The first factor consisted of six sunflower genotypes, while the second factor included three planting dates. The experiment was arranged in a Randomized Complete Block Design (RCBD) according to a factorial experiment system. The results of the statistical analysis showed significant differences among genotypes. The genotype Zahrat Al-Iraq recorded the highest mean number of seeds per head (1125.57), whereas Argensun recorded the lowest mean (932.33). Planting dates also showed a significant effect, as the first planting date (20 June) produced the highest mean (1097.60), while the third planting date (10 July) produced the lowest mean (971.43). The interaction treatment (Zahrat Al-Iraq × first planting date) recorded the highest value (1271.70), whereas (Argensun × third planting date) recorded the lowest value (817.70). Seed weight differed significantly among genotypes. Zahrat Al-Iraq recorded the highest mean seed weight (6.96 g), whereas Shumoos recorded the lowest mean (3.81 g). The first planting date resulted in the highest seed weight (5.69 g), while the third planting date produced the lowest value (4.52 g). The interaction (Zahrat Al-Iraq × first planting date) recorded the highest value (7.47 g), whereas (Shumoos × third planting date) recorded the*

lowest (3.17 g). Significant differences were also observed in plant yield, biological yield, and harvest index. Zahrat Al-Iraq recorded the highest plant yield (76.75 g plant⁻¹) and biological yield (260.57 g plant⁻¹), whereas Shumoos recorded the lowest values (37.90 and 161.90 g plant⁻¹). The first planting date produced the highest values for plant yield (63.40 g plant⁻¹), biological yield (233.40 g plant⁻¹), and harvest index (27.20%). The interaction (Zahrat Al-Iraq × first planting date) recorded the highest harvest index (35.65%), whereas (Argensun × third planting date) recorded the lowest (21.65%).

Keywords: Planting Dates; Genotypes; Sunflower ; Effect Yield Traits.

1. Introduction

sunflower (*Helianthus annuus* L.) belongs to the family Compositae and is considered one of the most important oilseed crops worldwide. It is cultivated for seed production, which contains up to 50% oil in some improved varieties, in addition to other desirable quality traits [1]. Sunflower oil is widely used for food purposes due to its high nutritional value and its content of essential vitamins such as E, D, and A, which play an important role in preventing oil oxidation, making it one of the most consumed edible oils globally [2]. Sunflower is also used in the pharmaceutical, soap, and paint industries. The by-product (oil cake) contains 30–35% protein and is used in poultry and livestock feeding. However, sunflower productivity in Iraq remains below the desired level due to the lack of proper scientific practices and inadequate crop and soil management. Crop growth is determined by genetic makeup, environmental factors, their interaction, and planting date, highlighting the importance of identifying the optimum planting date that ensures high yield. Selection is one of the oldest and most widely used breeding methods for improving degraded varieties, as it increases the frequency of favorable genes controlling selected traits. Tolerance to environmental stress is a physiological trait associated with genetic improvement of yield. Yield is a complex trait influenced by environmental factors; therefore, selection for traits with high heritability is essential in breeding programs [3]. Plant height of approximately 150 cm is considered an important selection criterion that enhances sunflower yield and stress tolerance. Head diameter is closely associated with seed yield and is considered a reliable indicator for increasing productivity [4]. Yield is controlled by multiple genes rather than a single gene. Heritability and genetic advance are key parameters used to evaluate selection efficiency and predict expected genetic gain [5]. Therefore, this study aimed to:

1. Improve some field traits related to yield through evaluating selection efficiency.
2. Determine the optimum planting date that achieves maximum efficiency and high yield.
3. Estimate broad- and narrow-sense heritability and some genetic parameters.
4. Identify selection indices for seed yield of the studied sunflower genotypes by analyzing genetic and phenotypic correlations.

2. Material and methods

A field experiment was conducted during the spring and autumn seasons of 2025 at the Technical College / Musayyib. In the first season, seeds of three sunflower genotypes (*Helianthus annuus* L.)—namely, Zahra Al-Iraq, Argensun, and Shumus—were sown on March 15. The planting was done in rows with a spacing of 75 cm between rows and 25 cm between plants. At physiological maturity, five plants from each genotype were selected based

on head diameter as selection criteria. The seeds of each genotype were then mixed to form the first selection generation (S1), resulting in three selected lines along with their three parental genotypes, giving a total of six genotypes used for sowing in the autumn season. The autumn experiment was conducted using three planting dates: June 20, June 30, and July 10, 2025, with three replications, resulting in 54 experimental units. The seeds of the eight genotypes were sown using a Randomized Complete Block Design (RCBD) in a factorial arrangement with two factors: the first factor being genotypes and the second factor being planting dates. Each experimental unit consisted of five rows, each 3 m long, and studies were carried out on the middle three rows. Fertilization for both seasons was applied using DAP fertilizer (18% N, 46% P_2O_5) at a rate of 150 kg ha⁻¹ before sowing [6]. Sowing was performed manually by placing three seeds per hole, then thinning to one plant per hole at the four-leaf stage. Urea fertilizer (46% N) was applied at a rate of 100 kg ha⁻¹ in two splits: the first 2–3 weeks after emergence and the second at the beginning of floral bud formation [6]. Manual weeding, pest control, and irrigation were performed as needed. After flowering was completed, ten plants were randomly taken from the middle three rows, and their heads were covered with mesh bags (potato bags) to protect them from bird attacks. From these plants, five were randomly selected for the study of the following.

Yield and Its Components

The heads of the five plants selected for the field trait study were harvested at full maturity (when the back of the heads turned yellow and the outer bracts began to brown) [7]. The seeds were manually threshed and yield component analyses, as well as other studies, were conducted after adjusting seed moisture content to 8%. The yield components included:

2.1. Number of seeds per head

Determined by manually counting all seeds in the head, including both filled and empty seeds.

2.2. Seed weight (g)

Calculated by weighing 1,000 filled seeds and determining the average weight per seed.

2.3. Single-plant seed yield (g)

Calculated as the average seed yield per plant from the five sampled plants, based on 8% moisture content.

2.4. Biological yield

Calculated by adding the dry weight of the entire plant (air-dried) to the seed yield.

2.5. Harvest index (%)

Calculated as the economic yield divided by the biological yield, multiplied by 100.

Results

The statistical analysis indicated a significant effect on the number of seeds per head. The results in Table (1) show significant differences among genotypes, planting dates, and their interaction for this trait. The genotype V1S1 recorded the highest number of seeds per head, reaching 1125.57, whereas genotype V2 had the lowest mean value of 932.33. Regarding planting dates, the first date (June 20) produced the highest seed number per head (1097.60),

while the third date (July 10) produced the lowest (971.43). The interaction between genotypes and planting dates revealed that the combination V1S1 $\times$ first planting date resulted in the highest seed number (1271.70), whereas V2 $\times$ third planting date recorded the lowest (817.70). These results are consistent with those reported by [8]. The observed variation is attributed primarily to genetic differences among genotypes, in addition to environmental factors. Each sunflower genotype has a unique genetic composition that determines head size, the number of disc flowers, and the fruiting rate, which ultimately affects the final number of seeds. Genetically improved cultivars usually have larger heads and more disc flowers, resulting in higher seed numbers. Additionally, [9] reported that some cultivars achieve high fruiting rates due to effective pollinator attraction or fertilization efficiency, thereby increasing the seed number per head. Regarding 100-seed weight (g), the results in Table (2) show significant differences among genotypes, planting dates, and their interaction for this trait. Genotype V1 recorded the highest 100-seed weight (6.96 g), while genotype V3 had the lowest (3.81 g). For planting dates, the first date (June 20) produced the highest 100-seed weight (5.69 g), whereas the third date (July 10) gave the lowest (4.52 g). The interaction between genotypes and planting dates indicated that V1 $\times$ first planting date had the highest 100-seed weight (7.47 g), while V3 $\times$ third planting date had the lowest (3.17 g). These results agree with [10], as this trait is influenced by year, environmental conditions, and their interactions. High temperatures generally reduce seed weight in most genotypes, and differences in stress tolerance among genotypes become evident [11].

Table 1. Effect of planting dates on the growth and yield of sunflower genotypes and their interaction on the number of seeds per head

Genotype mean	Planting dates			Genotypes
	D3	D2	D1	
1098.87	1030.30	1065.00	1201.30	V1
1125.57	1026.00	1079.00	1271.70	V1S1
932.33	817.70	978.00	1001.30	V2
1030.77	964.30	1021.00	1107.00	V2S2
993.77	989.00	992.30	1000.00	V3
1003.10	1001.30	1003.70	1004.30	V3S3
52.08**	90.20**			Lsd5%
	971.43	1023.17	1097.60	Mean of planting dates
	36.82**			Lsd5%

Table 2. Effect of planting dates on the growth and yield of sunflower genotypes and their interaction on 100-seed weight (g)

Genotype mean	Planting dates			Genotypes
	D3	D2	D1	
6.96	6.27	7.13	7.47	V1
5.88	5.27	5.87	6.50	V1S1
5.28	4.70	5.37	5.77	V2
5.01	4.27	5.27	5.50	V2S2
3.81	3.17	3.67	4.60	V3
4.04	3.43	4.37	4.33	V3S3
0.12**	0.20**			Lsd5%

Genotype mean	Planting dates			Genotypes
	4.52	5.28	5.69	Mean of planting dates
	0.08**			Lsd5%

Regarding single-plant seed yield (g), the results presented in Table (3) show significant differences among genotypes, planting dates, and their interaction. Genotype V1 recorded the highest single-plant yield (76.75 g), whereas genotype V3 had the lowest (37.90 g). Concerning planting dates, the first date (June 20) produced the highest single-plant yield (63.42 g), while the third date (July 10) produced the lowest (44.00 g). The interaction between genotypes and planting dates indicated that the combination V1 × first planting date resulted in the highest yield (89.70 g), whereas V3 × third planting date had the lowest (31.32 g). These results are consistent with those reported by [12, 13], highlighting the importance of selecting an appropriate cultivar and optimal planting date to achieve maximum productivity. Hybrid cultivars generally produce higher yields compared to conventional varieties due to genetic dominance that enhances productivity. Regarding biological yield (g plant⁻¹), the results in Table (4) show significant differences among genotypes, planting dates, and their interaction. Genotype V1S1 recorded the highest biological yield (260.57 g plant⁻¹), whereas genotype V3 had the lowest (161.90 g plant⁻¹). For planting dates, the first date (June 20) produced the highest biological yield (233.40 g plant⁻¹), while the third date (July 10) produced the lowest (181.85 g plant⁻¹). The interaction between genotypes and planting dates revealed that V1S1 × first planting date achieved the highest biological yield (275.00 g plant⁻¹), whereas V3 × third planting date had the lowest (140.00 g plant⁻¹). These results agree with [14, 15], indicating that genetic differences among sunflower cultivars have a clear impact on dry matter accumulation and biological yield due to variations in photosynthetic efficiency and the distribution of dry matter among plant organs. Moreover, variation among cultivars affects the relative growth rate and biomass accumulation throughout different growth stages.

Table 3. Effect of planting dates on the growth and yield of sunflower genotypes and their interaction on plant yield (g)

Genotype mean	Planting dates			Genotypes
	D3	D2	D1	
76.75	64.57	75.97	89.70	V1
66.67	54.04	63.30	82.66	V1S1
49.60	38.56	52.49	57.74	V2
51.93	41.14	53.77	60.89	V2S2
37.90	31.32	36.39	46.00	V3
40.58	34.38	43.83	43.52	V3S3
2.73**	4.72**			Lsd5%
	44.00	54.29	63.42	Mean of planting dates
	1.93**			Lsd5%

Table 4. Effect of planting dates on the growth and yield of sunflower genotypes and their interaction on biological yield (g plant⁻¹)

Genotype mean	Planting dates			Genotypes
	D3	D2	D1	
245.80	207.70	251.70	278.00	V1
260.57	221.70	275.00	285.00	V1S1
223.80	185.00	253.70	232.70	V2

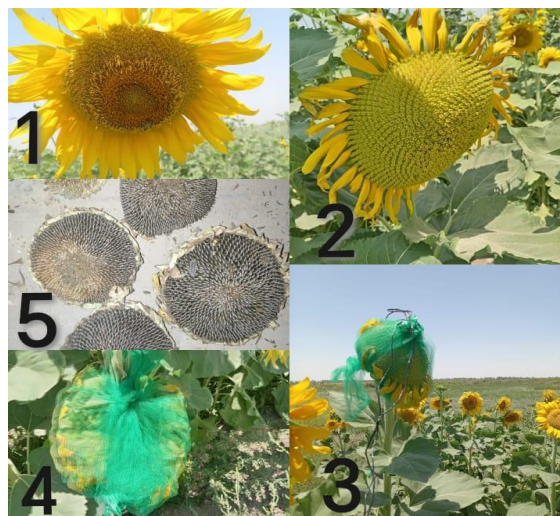
Genotype mean	Planting dates			Genotypes
228.67	190.00	256.00	240.00	V2S2
161.90	140.00	172.00	173.70	V3
176.33	146.70	191.30	191.00	V3S3
19.20**	Ns			Lsd5%
	181.85	233.28	233.40	Mean of planting dates
	13.58**			Lsd5%

The statistical analysis indicated a significant effect on the harvest index (%). The results presented in Table (5) show significant differences among genotypes, planting dates, and their interaction for this trait. Genotype V1S1 recorded the highest harvest index (25.56%), while genotype V2 had the lowest (22.07%). Regarding planting dates, the first date (June 20) produced the highest harvest index (27.20%), [16] whereas the second date (June 30) produced the lowest (23.07%). The interaction between genotypes and planting dates revealed that the combination V1 $\times$ first planting date achieved the highest harvest index (35.65%), [17] while V2S2 $\times$ third planting date had the lowest (21.65%). These results are consistent with [17], which reported that differences in harvest index are associated with the efficiency of water and nutrient use, as well as the balance between vegetative and reproductive growth [18]. Cultivars with higher harvest indices are better able to utilize environmental resources and convert a larger proportion of carbohydrates into seed production. Furthermore, [19] noted that environmental conditions, such as high temperatures during seed filling, reduce the dry matter available to seeds, thereby lowering the harvest index. [20,21].

Table 5. Effect of planting dates on the growth and yield of sunflower genotypes and their interaction on harvest index (%)

Genotype mean	Planting dates			Genotypes
	D3	D2	D1	
31.36	31.09	27.33	35.65	V1
25.56	24.40	22.21	30.06	V1S1
22.07	20.89	22.56	22.77	V2
22.61	21.65	22.41	23.78	V2S2
23.85	22.79	20.96	27.81	V3
23.18	23.45	22.95	23.14	V3S3
1.94**	3.36**			Lsd5%
	24.05	23.07	27.20	Mean of planting dates
	1.37**			Lsd5%

Figures



1. The beginning of flowering and head formation.
2. Seeds become more clearly formed on the head.
3. Covering the heads with mesh bags to protect them from bird attacks.
4. Continuation of the covering process and drooping of the heads due to their heavy weight and advancement toward maturity.
5. Cutting the heads after drying and complete seed formation to expose them to sunlight and measure all traits.

References

- [1] Hosni, T., Abbes, Z., Abaza, L., Medimagh, S., Ben Salah, H., & Kharrat, M. (2022). Biochemical characterization of seed oil of Tunisian sunflower (*Helianthus annuus* L.) accessions with special reference to its fatty acid composition and oil content. *Journal of Food Quality*, 2022, Article ID 2875072, 1–12.
- [2] Nakonechna, K., Ilko, V., Berčíková, M., Vietoris, V., Panovská, Z., & Doležal, M. (2024). Nutritional, utility, and sensory quality and safety of sunflower oil on the Central European market. *Agriculture*, 14(4), 536.
- [3] Pourmohammad, A., Toorchi, M., Alavikia, S. S., & Shakiba, M. R. (2016). Estimation of genetic parameters for yield and yield components in sunflower under normal and water deficit stress. *Bulgarian Journal of Agricultural Science*, 22(3), 426–430.
- [4] Memon, S., Baloch, M. J., Baloch, G. M., & Keerio, M. I. (2014). Heritability and correlation studies for phenological, seed yield, and oil traits in sunflower (*Helianthus annuus* L.). *Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Sciences*, 30(2), 159–171.
- [5] Al-Barki, F. R. A. (2020). *Plant Breeding and Improvement*. Al-Muthanna University, Iraq.
- [6] Al-Rawi, W. M. (1998a). *Cytoplasmic Male Sterility and the Production of Synthetic and Hybrid Sunflower Varieties*. PhD Thesis, College of Agriculture, University of Baghdad, Iraq.

- [7] Martin, J. H., & Leonard, W. H. (1959). *Principles of Field Crop Production*. The MacMillan Company, New York, pp. 1176.
- [8] Schneiter, A. A. (Ed.). (1997). *Sunflower Technology and Production*. Agronomy Monograph 35. Madison, Wisconsin, USA: ASA, CSSA, and SSSA.
- [9] Jiyad, S. H. (2014). The relationship between some qualitative traits of sunflower seeds, head diameter, and seed position on the head. *Al-Anbar Journal of Agricultural Sciences*, Proceedings of the 4th Scientific Conference, 12 (Special Issue).
- [10] Radić, V., Mrđa, J., Jocković, M., Čanak, P., Dimitrijević, A., & Jocić, S. (2013). Sunflower 1000-seed weight as affected by year and genotype. *Ratarstvo i Povrtarstvo*, 50(1), 1–7.
- [11] Mu, J., et al. (2025). Optimizing sunflower cultivar selection under climate variability: Evidence from coupled meteorological-growth modeling in arid northwest China. *Agronomy*, 15(7), 1724.
- [12] Gordeyeva, Y., Shelia, V., Shestakova, N., Amantayev, B., Kipshakbayeva, G., Shvidchenko, V., Aitkhozhin, S., Kurishbayev, A., & Hoogenboom, G. (2024). Sunflower (*Helianthus annuus* L.) yield and yield components for various agricultural practices (sowing date, seeding rate, fertilization) for steppe and dry steppe growing conditions. *Agronomy*, 14(1), 36.
- [13] Ibrahim, B. A., Eldey, E. M., Ishag, A. A., & El Naim, A. M. (2023). Response of sunflower (*Helianthus annuus* L.) to plant spacing. *Innovation in Science and Technology*, 2(2), 32–37.
- [14] Rondanini, D. P., Savin, R., & Hall, A. J. (2007). Estimation of physiological maturity in sunflower as a function of fruit water concentration. *European Journal of Agronomy*, 26(3), 295–309.
- [15] Sadras, V. O., & Hall, A. J. (1988). Quantification of temperature, photoperiod, and population effects on plant leaf area in sunflower crops. *Field Crops Research*, 18(2–3), 185–196.
- [16] Keipp, K., Hütsch, B. W., & Schubert, S. (2019). How does the harvest index affect water-use efficiency and nutrient-utilization efficiency of sunflowers (*Helianthus annuus* L.) *Journal of Agronomy and Crop Science*, 205, 519–532.
- [17] Weiss, E. A. (2000). *Oilseed Crops* (2nd ed.). Wiley-Blackwell.
- [18] ABDHUSSIAN, H.M. A.F. SARHEED, and A.J. MUSA .2023. GENETIC PARAMETERS OF RICE (*ORYZA SATIVA* L.) HYBRIDS FOR YIELD RELATED TRAITS USING FACTORIAL HYBRIDIZATION METHOD . SABRAO Journal of Breeding and Genetics 56(01): February Issue – 2024”.
- [19] Abdullah F.S.,M. A. Hamza and F. R. Abdulhussein.2022.EFFECT OF ADDING DIFFERENT CONCENTRATIONS OF POTASSIUM AND SPRAYING

MICROELEMENTS ON THE YIELD AND COMPONENTS OF CORN AND ESTIMATING THE PATH COEFFICIENT . *Int. J. Agricult. Stat. Sci.* Vol. 18, Supplement 1, pp. 1745-1750, 2022.

[20] ABDULLAH, FADHIL, SARHEED.2023. EVALUATION OF FOUR BARLEY GENOTYPES FOR YIELD CHARACTERISTICS AND ITS COMPONENTS AND ESTIMATION OF SOME GENETIC PARAMETERS”. *SABRAO Journal of Breeding and Genetics* 55(6): December Issue – 2023”.

[21] Mahdi A. Hamza, Jassim J. Jader and Abdullah Fadhil Sarheed .2020. GENETIC PARAMETERS OF GENOTYPE OF WHEAT (*TRITICUM AESTIVUM* L.) . *Plant Archives* Vol. 20 Supplement 1, pp. 1819-1822.