Iraqi Journal of Agricultural Sciences –2026:57(8):2269-2279
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/khnz4t18

Effect of Cultivars and Planting Date on the Growth and Yield of Sunflower

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ABSTRACT

This study aimed to improve the germination and growth of the pollen tube, increase fertility rates, and enhance seed yield and its components for the sunflower crop. A field fall experiment was conducted during the 2023 and spring 2024 seasons using split-plot arrangements witm Randomized Complete Block Design (RCBD) and four replicates. The main factor were planting dates (June 1, 10, 20, 30, and July 10 for fan, and February 18, March 1, 10, 20, and 30 for spring), while the secondary factor were three oilseed sunflower Cultivars (Aqmar, Flamme, and Sakha). The results showed that the February 18 planting date achieved the highest fertility percentage (97.04%) and seed yield (4.892 Mg ha^{-1}), July 10 recorded the highest 1000-seed weight (85.72 g), and June 1 achieved the highest biological yield (38.655 Mg ha^{-1}). Flamme outperformed in most traits, while Sakha recorded the highest harvest index (12.36%). The results indicate that genetic and environmental variability improved Cultivars productivity, recommending Flamme for planting on June 1 and February 18.

Keywords: biological yield, Fertility %, Harvest index, Seeds per head, seed yield, ,

Received: 4/9/2024, Accepted: 18/12/2024, Published: 31/8/2026

INTRODUCTION

The environmental conditions for cultivating sunflower (*Helianthus annuus* L.) in Iraq are favorable, indicating potential for expansion in its cultivation. However, addressing the causes of reduced seed yield and quality is essential, which may be attributed to poor crop management practices, Key factors include determining the optimal planting date and selecting a cultivar suited to the prevailing environmental conditions. Such measures are critical to enhancing flowering, pollen tube germination and growth, improving fertility rates, and ultimately achieving higher yield and better-quality produce. Sunflower (*Helianthus annuus* L.) is cultivated in Iraq during two seasons: spring and autumn. The planting date significantly influences growth stages; seed yield due to its relationship with variations in temperature, and day length caused by early or delayed planting (Hamd & Hamza, 2024). Elevated temperatures above the optimal range reduce the growth duration, leading to lower accumulation of dry matter. Most studies have indicated that high temperatures and low relative humidity shorten the crop's life cycle, accelerate senescence, and consequently decrease dry matter accumulation (Sadras & Villalobos, 1993). The cultivar Flamme outperformed Euroflor in seed yield and the 100-seed weight (42.645 g and 4.988 g per plant, respectively) when planted on March 10 compared to other planting dates (February 20 and March 20) (Al-Salem et al., 2014). The planting date significantly affected growth and production indicators in sunflower, particularly seed yield and the number of seeds per head. This was attributed to insufficient water availability during seed filling and the shortened seed-filling period (Debata, 2024). Numerous studies have indicated that genetic patterns generally differ from one another due to the dominance of genetic factors that influence plant growth stages and its response to environmental conditions, leading to variability in growth and yield among genotypes (Elawi & Zeboon, 2020). Significant differences have also been observed in the number of seeds per head and

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the 1000-seeds weight among cultivars. For instance, the cultivar Isaaki achieved the highest averages (1826.24 seeds and 94.93 g, respectively), whereas the cultivar Leilwa recorded the lowest averages (1119.40 seeds and 81.2 g, respectively). On the other hand, the cultivar Flamme achieved the highest fertility rate (96.63%), while Isaaki recorded the lowest fertility rate (88.70%). These differences were attributed to genetic variations among the cultivars and their adaptability to environmental conditions (Al-Saadi, 2023). Another study revealed significant differences in the number of seeds per head among cultivars. The cultivar Leilwa recorded the lowest average (735.14 seeds), followed by Flamme (738.93 seeds), and Isaaki achieved the highest average (757.78 seeds). This was attributed to genetic differences among the cultivars and their interaction with environmental conditions (Al-Zaidy & Al-Hilfy, 2023).The study aims to enhance the germination and growth of the pollen tube, increase fertility rates, and improve seed yield and its components.

MATERIALS AND METHODA

A field experiment was conducted in two growing seasons: autumn 2023 and spring 2024, at Station A, one of the research Stations of the College of Agricultural Engineering Sciences, University of Baghdad, Jadriyah. The study conducied two factors using a Randomized Complete Block design (RCBD) arranged in a split-plot with four replicates. The planting date treatments were assigned to the main plots. These included:

Fall season: June 1, June 10, June 20, June 30, and July 10.

Spring season: February 18, March 1, March 10, March 20, and March 30.

The treatments for sunflower oilseed cultivars (Aqmar, Flamme, and Sakha) were assigned to the sub-plots. The experimental field was plowed twice using a moldboard plow, with the second plowing conducted perpendicular to the first. The soil was leveled and refined using disc harrows. The field was divided into furrows. Each experimental unit measured 3 m × 2 m and consisted of four furrows spaced 75 cm apart, with a 20 cm spacing between hills. Seeds were sown at a depth of 3 cm, with three seeds per hill, and were thinned to one plant per hill after seedlings reached a height of 20 cm.Phosphorus fertilizer was applied at a rate of 88 kg P ha^{-1} in a single dose two weeks after planting, placed in furrows 5 cm away from the plants and at a depth of 5 cm. Nitrogen fertilizer was applied at a rate of 120 kg N ha^{-1}, and potassium fertilizer was applied at a rate of 77 kg K ha^{-1} in two equal splits: the first two weeks after planting and the second at the initiation of floral bud formation (Ministry of Agriculture, 2017).The field was irrigated and weeds were removed as needed. To protect the sunflower heads from bird damage, perforated calico bags were used to cover the heads after pollination. Plants were harvested when signs of full maturity were observed, including the yellowing of the back of the heads and the browning of the outer bracts (Martin & Leonard, 1959).The seeds were obtained from the Field Crops Department, College of Agriculture, University of Anbar. Soil samples were collected from the field at a depth of 0–30 cm from multiple locations within the field and mixed to create a composite sample representative of the field soil. Climatic data, including temperature, day length, solar radiation intensity, thermal accumulation (calculated), and rainfall, were obtained from the Iraqi Meteorological Authority. The following traits were studied:

1. **Fertility Percentage (%):** Fertility percentage was calculated as the ratio of the number of filled seeds to the total number of seeds, multiplied by 100

$$\text{Fertility Percentage} = \frac{\text{Number of filled seeds}}{\text{Total number of seeds}} \times 100 \qquad \text{(Masoud, 2013)}$$

2. **Number of seeds per head (seeds):** Seeds from ten heads were threshed, and the number of filled and unfilled seeds was counted. The average seed number per head was calculated at harvest.

3. **Weight of 1000 Seeds (g):** A random sample of 1000 filled seeds was selected after mixing the seeds from the ten threshed heads. The seeds were weighed using a sensitive

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balance for each experimental unit, based on a standard moisture content of 8%.

4. **Total seeds yield (Mg ha⁻¹):** Total seed yield was calculated by multiplying the mean seed yield per plant by the plant density per hectare and converting it into megagrams per hectare at a standard moisture content of 8%:

Total Seed Yield=mean yield per plant × Plant density per hectare

5. **Biological Yield (Mg ha⁻¹):** The biological yield was determined by weighing all above-ground plant parts (heads with seeds, leaves, and stems) at harvest.

6. **Harvest Index (%):** The harvest index was calculated using the equation by (Baldini & Vannozzi, 1999):

$$\text{Harvest Index } (\%) = \frac{\text{Seed Yield per plant}}{\text{Biological Yield}} \times 100$$

RESULTS AND DISCUSSION

Fertility Percentage (%): The results in Table 1 show a significant effect of planting dates and cultivars on fertility percentage, as well as a significant interaction effects, except for the interaction during the spring season, which did not significant. The planting dates of June 1 (fall season) and February 18 (spring season) showed a significant superiority, achieving the highest averages of 96.25% and 97.04%, respectively. In contrast, the planting date of March 30 recorded the lowest mean fertility percentage of 92.24% for spring seasons. The superiority of the planting dates of June 1 (fall season) and February 18 (spring season) in fertility percentage can likely be attributed to the favorable environmental conditions (temperature and humidity) during the flowering and pollination period. Variations in temperature, whether elevated or reduced, can significantly impact flowering and pollination processes. This finding aligns with the results reported by Al-Saadi (2023), who noted that deviations in temperature from optimal levels significantly influenced the differences in fertility percentage across planting dates. Such conditions directly affected fertilization, seed formation, and seed count. Similar conclusions were drawn by (Shamran et al., 2022). The cultivar Flamme achieved the highest fertility percentage (95.81% and 96.10%) in both fall and spring seasons, respectively, with a significant difference compared to the other cultivars. In contrast, the cultivar Aqmar recorded the lowest percentage (93.63%) in the fall season, while the cultivar Sakha had the lowest value (93.08%) in the spring season (Table 1). This variation may be attributed to the genetic could differences among the cultivars. These findings are consistent with the results of (Hassan, 2019; Al-Saadi, 2023), who all highlighted the influence of genetic variation among sunflower cultivars on fertility percentage. The results in Table (1) indicate a significant interaction effect between planting dates and cultivars during the autumn season. The cultivar Flamme, planted on June 1, exhibited the highest fertility percentage (97.98%), showing a significant difference compared to other treatments except for June 10 with the same cultivar. In contrast, the lowest fertility percentage (91.54%) was recorded for the cultivar Aqmar on June 30, which differed significantly from the other treatments. This variation is likely due to the availability of favorable environmental conditions and the genetic interaction of the cultivars with environmental factors such as temperature and humidity, which influenced fertility percentage through their interaction with growth factors. These findings are consistent with those of (Al-Zaidy & Al-Hilfy, 2023), who reported that environmental conditions interact with cultivars, exerting a direct effect on fertility percentage.

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Table 1. Effect of cultivars and planting dates on the fertility percentage (%) in sunflower

Fall Season 2023					Spring Season 2024				
Planting date	Cultivars			Mean	Planting date	Cultivars			Mean
	Aqmar	Flamme	Sakha			Aqmar	Flamme	Sakha	
1-Jun	95.54	97.98	95.24	96.25	18-Feb	96.93	98.95	95.26	97.04
10-Jun	93.83	96.51	94.22	94.85	1-Mar	96.37	97.58	94.59	96.18
20-Jun	92.95	95.26	93.20	93.80	10-Mar	94.03	96.26	93.19	94.49
30-Jun	91.54	95.20	94.22	93.65	20-Mar	92.81	94.21	91.59	92.87
10-Jul	94.32	94.11	93.13	93.85	30-Mar	92.45	93.50	90.78	92.24
LSD 0.05		1.66		1.38	LSD 0.05		N.S		2.53
Mean	93.63	95.81	94.00		Mean	94.51	96.10	93.08	
LSD 0.05		0.74			LSD 0.05		0.65		

Number of seeds head^{-1}

Results in Table (2) show a significant effect of planting dates and cultivars on the number of seeds per head in both seasons, while the interaction effect was significant only in the fall season. The planting dates of June 1 (fall season) and February 18 (spring season) recorded the highest means (863.67 and 935.63 seed head^{-1}, respectively), significantly outperforming other planting dates. In contrast, the planting dates of July 10 (fall season) and March 30 (spring season) recorded the lowest averages (779.00 and 739.76 seed. head^{-1}, respectively). This result could be attributed to favorable environmental conditions and higher fertility rates during these planting dates (Table 1). These factors enhanced seed filling, reduced seed abortion, and promoted efficient photosynthesis and the absorption of water and nutrients, leading to an increased number of seeds per head. Conversely, suboptimal conditions during other planting dates, such as temperatures deviating from the optimal range, caused variations in the average number of seeds per head by affecting fertility rates. These findings align with the results of (Shakir, 2008; Al-Salem et al., 2014; Shamran et al., 2022), who reported that environmental conditions (temperature and humidity) have a direct impact on the number of seeds per head. This influence could be occur through effects on fertility during flowering or through the suitability of conditions for photosynthesis and nutrient transport to seeds. The cultivar Flamme achieved the highest means number of seeds per head (876.80 and 916.44 seed head^{-1}) in the fall and spring seasons, respectively, with a significant differences compared to the other cultivars. In contrast, the cultivar Aqmar recorded the lowest means (754.00 seeds seed head^{-1}) in the autumn season, while the cultivar Sakha recorded the lowest average (771.18 seed head^{-1}) in the spring season (Table 2). The superiority of the cultivar Flamme in this trait can be attributed to genetic variation among cultivars and the genes responsible for this trait in each cultivar, as well as their responsiveness to prevailing environmental conditions. These results are consistent with those of (Hassan, 2019; Basheer et al., 2016), who reported significant differences among genetic compositions in the number of seeds per head in sunflower. The results revealed significant interaction between planting dates and cultivars for the number of seeds per head during the autumn season. The cultivar Flamme recorded the highest number of seeds (954.00 seed. head^{-1}) when planted on June 1, with a significant difference compared to other planting dates. This superiority be could attributed to the higher fertility percentage observed for this treatment (Table 1), which positively influenced the number of seeds per head. These findings align with those of (Mohamed et al., 1992; Al-Salem et al., 2014; Al-Zaidy & Al-Hilfy, 2023), concluded that cultivars they differ in their ability to produce seeds per head due to genetic and environmental interactions.

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Table 2. Effect of cultivars and planting dates on number of seeds per headin sunflower

fall Season 2023					Spring Season 2024				
Planting date	Cultivars			Mean	Planting date	Cultivars			Mean
	Aqmar	Flamme	Sakha			Aqmar	Flamme	Sakha	
1-Jun	811.00	954.00	826.00	863.67	18-Feb	927.30	1019.30	860.30	935.63
10-Jun	743.00	836.00	980.00	853.00	1-Mar	905.30	962.30	836.30	901.30
20-Jun	717.00	856.00	805.00	792.67	10-Mar	846.70	887.30	788.00	840.66
30-Jun	719.00	869.00	772.00	786.67	20-Mar	748.70	902.30	722.00	791.00
10-Jul	780.00	869.00	688.00	779.00	30-Mar	759.00	811.00	649.30	739.76
LSD 0.05		129.70		59.90	LSD 0.05		N.S		66.06
Mean	754.00	876.80	814.20		Mean	837.40	916.44	771.18	
LSD 0.05		58.00			LSD 0.05		29.18		

1000 Seeds Weight (g)

Results in Table (3) show a significant effect of planting dates, cultivars, and their interaction on the weight of 1000 seeds (g) in both the Fall and spring seasons. The planting dates of July 10 (full season) and February 18 (Spring season) recorded the highest averages for the weight of 1000 seeds (85.72 and 78.79g, respectively), significantly outperforming other planting dates. In contrast, the planting dates of June 10 (fall season) and March 30 (spring season) recorded the lowest means (73.86 and 67.34g, respectively). The superiority of the planting dates July 10 (fall season) and February 18 (spring season) in this trait can be attributed to favorable environmental conditions and moderate temperatures during plant growth. These conditions allowed the plants to efficiently utilize light, water, and nutrients, leading to an increases in the weight of 1000 seeds. In contrast, variations in temperature during other planting dates disrupted the physiological processes of the plants, negatively affecting seeds weight. These findings align with those of (Salih & Hamza, 2003; Abdou et al., 2011; Ali et al., 2013; Al-Salem et al., 2014; Ozturk et al., 2017; Mosry et al., 2022), they reported that planting dates significantly affect the weight of 1000 seeds due to the impact of environmental conditions on growth factors. Optimal conditions and timeframes enhance photosynthesis and nutrient absorption, ultimately achieving the highest seed weights. The cultivar Flamme significantly outperformed the other cultivars, achieving the highest average weight of 1000 seeds (80.94 and 78.76 g) in the fall and sprine seasons, respectively. In contrast, the cultivar Aqmar recorded the lowest averages for this trait (76.89 g and 69.96 g) in the autumn and spring seasons, respectively (Table 3). The superiority of the cultivar Flamme in this trait can be attributed to its genetic characteristics, which enable better utilization of photosynthetic products and their efficient translocation to the sinks represented by the seeds. Additionally, the seeds' capacity to store these products contributes to the higher seed weight. These vesults are consistent with those of (Elawi & Zeboon, 2020; Al-Saadi, 2023), who highlighted the significant effect of sunflower cultivar genetics on this trait. The results indicate significant differences in the interaction between planting dates and cultivars on the weight of 1000 seeds. The cultivar Sakha recorded the highest averages (95.30 and 85.33 g) when planted on July 10 (fall season) and February 18 (spring season), respectively. In contrast, the lowest means were observed for the cultivar Sakha on June 10 (67.54 g) and the cultivar Aqmar on March 30 (62.92 g) in the autumn and spring seasons, respectively. This variation can be attributed to the genetic and environmental interaction, as well as the ability of cultivars to benefit from the accompanying environmental conditions (temperature and humidity). The efficiency of converting photosynthetic products from source to sink also plays a significant role. These findings are consistent with those of (Al-Saadi, 2014; Al-Saadi, 2023), who highlighted genetic differences among

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cultivars and their interaction with environmental conditions.

Table 3. Effect of cultivars and planting dates on weight of 1000 seeds (g)in sunflower

fall Season 2023					**Spring Season 2024**				
Planting date	Cultivars Aqmar	Flamme	Sakha	Mean	Planting date	Cultivars Aqmar	Flamme	Sakha	Mean
1-Jun	74.62	79.48	80.09	78.06	18-Feb	73.43	85.33	77.63	78.79
10-Jun	73.45	80.59	67.54	73.86	1-Mar	72.22	81.02	75.05	76.09
20-Jun	77.00	79.93	77.68	78.20	10-Mar	71.96	78.83	75.60	75.46
30-Jun	80.53	81.71	83.05	81.76	20-Mar	69.27	76.76	72.22	72.75
10-Jul	78.86	82.99	95.30	85.72	30-Mar	62.92	71.87	67.23	67.34
LSD 0.05		3.91		2.64	LSD 0.05		2.02		4.04
Mean	76.89	80.94	80.73		Mean	69.96	78.76	73.54	
LSD 0.05		1.75			LSD 0.05		0.90		

Total Seeds Yield (Mg ha⁻¹)

The results in Table (4) indicate a significant effect of planting dates and cultivars on total seed yield (Mg ha⁻¹). However, no significant interaction was observed between the autumn and spring seasons. The planting dates of June 1 (fall season) and February 18 (Spring season) showed the highest averages for total seed yield (4.462 and 4.892 Mg ha⁻¹, respectively), significantly outperforming other dates. In contrast, the lowest averages were recorded for June 20 (4.128 Mg ha⁻¹) and July 30 (4.206 Mg ha⁻¹) in the autumn and spring seasons, respectively. The superiority of the June 1 and February 18 planting dates is attributed to moderate weather conditions, which enhanced biological activity, increased fertility rates, the number of seeds per head, and the 1000-seed weight (Tables 1, 2, and 3), ultimately boosting production. Conversely, low humidity and high temperatures during other planting dates shortened the growth period, slowed biological processes, and reduced fertility rates, leading to a gradual decrease in yield. These findings align with those of (Baghdadi et al., 2014; Paul et al., 2021; Debata, 2024), they emphasized the significant relationship between planting dates and the productivity of cultivars, as planting dates directly influence plant traits and seed yield. The cultivar Flamme significantly outperformed the others, achieving the highest total seed yield (4.749 and 4.752 Mg ha⁻¹) in the fall and Spring seasons, respectively. In contrast, the cultivar Aqmar recorded the lowest averages (3.847 and 4.236 Mg ha⁻¹) in the fall and spring seasons, respectively. The superiority of Flamme is attributed to its higher fertility percentage, greater number of seeds per head, and heavier 1000-seed weight (Tables 1, 2, and 3). These findings are consistent with those of (Salih & Hamza, 2003; Al-Naemi, 2018; Elawi & Zeboon, 2020), who reported significant differences among sunflower cultivars in total seed yield, which is closely linked to fertility percentage and yield components such as the number of seeds per head and 1000-seeds weight.

Table 4. Effect of cultivars and planting dates on total seed yield (Mg ha⁻¹)in sunflower

fall Season 2023					**Spring Season 2024**				
Planting date	Cultivars Aqmar	Flamme	Sakha	Mean	Planting date	Cultivars Aqmar	Flamme	Sakha	Mean
1-Jun	4.002	5.018	4.366	4.462	18-Feb	4.600	5.145	4.930	4.892
10-Jun	3.638	4.772	4.381	4.264	1-Mar	4.394	4.942	4.650	4.662
20-Jun	3.666	4.551	4.168	4.128	10-Mar	4.124	4.622	4.371	4.372
30-Jun	3.839	4.620	4.363	4.274	20-Mar	4.084	4.584	4.230	4.299
10-Jul	4.092	4.783	4.373	4.416	30-Mar	3.977	4.468	4.174	4.206
LSD 0.05		N.S		0.200	LSD 0.05		N.S		0.064
Mean	3.847	4.749	4.330		Mean	4.236	4.752	4.471	

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LSD 0.05	0.051	LSD 0.05	0.051

Biological Yield (Mg ha^{-1})

The results in Table (5) revealed a significant effect of planting dates and cultivars on biological yield (Mg ha^{-1}). Additionally, the interaction effect was significant in the fall season but not in the spring season. The planting dates of June 1 (fall season) and February 18 (Spring season) recorded the highest means for biological yield (38.655 and 38.430 Mg ha^{-1}, respectively), significantly surpassing other planting dates. Conversely, the planting dates of July 10 (autumn season) and March 30 (spring season) recorded the lowest means (32.827 and 30.167 Mg ha^{-1}, respectively). The superior performance of June 1 and February 18 planting dates could be attributed to higher numbers of seeds per head, greater 1000-seed weight, and increased seed yield (Tables 2, 3, and 4). These findings align with those of (Al-Waeli, 2018), they indicated that environmental conditions have a significant effect on the biological yield of sunflower. The cultivar Flamme achieved the highest means biological yield (38.708 and 36.290 Mg ha^{-1}) in the full and spring seasons, respectively, with a significant difference compared to the other cultivars in both seasons. In contrast, the cultivar Aqmar recorded the lowest means biological yield (32.685 and 32.380 Mg ha^{-1}) in the full and Spring seasons, respectively (Table 5). The superior performance of Flamme can be attributed to its excellence in most plant traits, including the number of seeds per head, 1000-seed weight, and seed yield (Tables 2, 3, and 4). These results are consistent with those of (Al-Dulaimi, 2005; Al-Saadi, 2023), they highlighted that differences in biological yield among sunflower cultivars are primarily due to variations in plant traits. The results demonstrated that the cultivar Flamme significantly outperformed other treatments when planted on June 1 in the autumn season, achieving the highest means biological yield (42.383 Mg ha^{-1}). In contrast, the cultivar Aqmar recorded the lowest means biological yield (27.960 Mg ha^{-1}) when planted on March 30 in the spring season (Table 5). This superiority can be attributed to favorable environmental conditions and the genetic-environmental interaction of the cultivars, which influenced key growth factors. These interactions affected the number of seeds per head, 1000-seed weight, and plant yield for the cultivar (Tables 1, 2, and 3), thereby increasing the biological yield. These findings are consistent with those (Al-Waeli, 2018), who reported that the biological yield of sunflower is influenced by both genetic and environmental factors.

Table 5. Effect of cultivars and planting dates on biological yield (Mg ha^{-1})in sunflower

Full Season 2023					Spring Season 2024				
Planting date	Cultivars			Mean	Planting date	Cultivars			Mean
	Aqmar	Flamme	Sakha			Aqmar	Flamme	Sakha	
1-Jun	35.892	42.383	37.690	38.655	18-Feb	35.560	41.260	38.470	38.430
10-Jun	32.600	38.100	34.391	35.031	1-Mar	35.200	38.400	35.600	36.400
20-Jun	34.361	38.960	36.000	36.441	10-Mar	32.150	35.420	33.890	33.820
30-Jun	30.322	39.071	33.742	34.385	20-Mar	31.030	34.660	34.490	33.393
10-Jul	30.230	34.974	33.263	32.827	30-Mar	27.960	31.710	30.830	30.167
LSD 0.05		1.11		1.53	LSD 0.05		N.S		1.360
Mean	32.685	38.708	35.026		Mean	32.380	36.290	34.656	
LSD 0.05		0.852			LSD 0.05		0.852		

Harvest Index %

The results in Table (6) show a significant effect of planting dates, cultivars, and their interaction on the harvest index % in both seasons.The planting dates of July 10 (full season) and March 30 (Spring season) recorded the highest means for harvest index (13.34% and 13.96%, respectively), significantly outperforming other dates. In contrast, the planting dates of June 20 (full season) and February 18 (Spring season) recorded the lowest means (11.30% and

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12.73%, respectively).The superiority of the July 10 and March 30 planting dates in this trait can be attributed to the environmental conditions during the growth and maturation periods of the sunflower crop, which positively affected total seed yield and biological yield (Tables 4 and 5). These results align with those of (Jalab & Fanoon, 2017; Abed, 2018), they reported that planting dates significantly impact the harvest index of sunflower. The cultivars Sakha and Flamme significantly outperformed the others, achieving the highest harvest index averages (12.36% and 13.21%) in the autumn and spring seasons, respectively. In contrast, the lowest means were recorded for the cultivars Aqmar and Sakha (11.75% and 12.97%) in the autumn and spring seasons, respectively (Table 6). This superiority could be attributed to differences in genetic composition and environmental factors, which influenced total seed yield and biological yield (Tables 4 and 5). These findings are consistent with those of (Al-Haidari, 2021; Al-Saadi, 2023), they highlighted that sunflower cultivars have a significant impact on the harvest index due to variations in their genetic sources. The results indicate a significant interaction between planting dates and cultivars in both the spring and autumn seasons. The cultivar Aqmar recorded the highest harvest index averages (13.51% and 14.25%) when planted on July 10 (full season) and March 30 (Spring season), respectively, with significant differences compared to other treatments. In contrast, the lowest means were observed for the cultivars Aqmar and Flamme when planted on June 20 (full season) and February 18 (Spring season), at 10.66% and 12.46%, respectively. This variation can be attributed to favorable environmental conditions and the genetic-environmental interaction of the cultivars, which influenced seed yield and biological yield (Tables 4 and 5). These findings align with those of (Abed, 2018), who reported that the harvest index of sunflower is significantly affected by genetic and environmental factors.

Table 6. Effect of cultivars and planting dates on Harvest Index (%)in sunflower

full Season 2023					Spring Season 2024				
Planting date	Cultivars Aqmar	Flamme	Sakha	Mean	Planting date	Cultivars Aqmar	Flamme	Sakha	Mean
1-Jun	11.12	11.86	11.58	11.52	18-Feb	12.94	12.46	12.80	12.73
10-Jun	10.84	12.08	12.74	11.89	1-Mar	12.48	12.91	13.06	12.81
20-Jun	10.66	11.68	11.57	11.30	10-Mar	13.09	13.33	13.01	13.14
30-Jun	12.63	11.83	12.78	12.41	20-Mar	13.16	13.29	12.45	12.96
10-Jul	13.51	13.36	13.15	13.34	30-Mar	14.25	14.09	13.54	13.96
LSD 0.05		0.84		1.53	LSD 0.05		0.40		0.23
Mean	11.75	12.16	12.36		Mean	13.18	13.21	12.97	
LSD 0.05		0.37			LSD 0.05		0.17		

CONCLUSION

It can be concluded that genetic factors played a key role in expressing the potential of the studied cultivars, leading to their variation in fertility percentage, number of seeds per head, 1000-seeds weight, seeds yield, biological yield, and harvest index. These traits were particularly influenced by temperature, thermal accumulation, day length, and solar radiation, reflecting differences in their performance under a wide range of environmental conditions represented by planting dates. This highlights the role of environmental suitability in either activating or inhibiting the physiological processes governing the growth of the cultivars. It is recommended to adopt the cultivation of the Flamme cultivar on June 1 in the full season and February 18 in the Spring season.

CONFLICT OF INTEREST

The author declares that they have no conflicts of interest.

DECLARATION OF FUND

The authors declare that they have not received a fund.

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P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/khnz4t18

تأثير الأصناف وموعد الزراعة في نمو وحاصل زهرة الشمس

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المستخلص

تهدف هذه الدراسة إلى تحسين إنبات ونمو الأنبوبة اللقاحية وزيادة نسبة الخصب وحاصل البذور ومكوناته لمحصول زهرة الشمس. نفذت تجربة حقلية في موسمي الخريف 2023 والربيع 2024 باستعمال تصميم القطاعات الكاملة المعشاة بترتيب الألواح المنشقة بأربعة مكررات. شملت العامل الرئيس مواعيد الزراعة (1و 10و 20و 30 حزيران و10 تموز للخريف، و18 شباط و1و 10و 20و 30 آذار للربيع)، وعامل ثانوي ثلاثة أصناف زيتية (أقمار، فلامي، سخا).أظهرت النتائج تفوق الموعد 18 شباط في نسبة الخصب (97.04%) وحاصل البذور (4.892 ميكا غرام هـ$^{-1}$)، بينما تفوق 10 تموز في وزن 1000 بذرة (85.72 غم)، و1 حزيران في الحاصل البايولوجي (38.655 ميكا غرام هـ$^{-1}$). تفوق الصنف فلامي في معظم الصفات، بينما سجل سخا أعلى دليل حصاد (12.36%). تشير النتائج إلى أن التباين الوراثي والبيئي ساهم في تحسين إنتاجية الأصناف وتوجيهها نحو الظروف البيئية المثلى. توصي الدراسة بزراعة الصنف فلامي في الموعدين 1 حزيران و18 شباط.

الكلمات المفتاحية: نسبة الخصب ،عدد البذور في القرص، ،حاصل البذور الكلي، الحاصل البايولوجي، دليل الحصاد.