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Effect of Cultivars and Planting Date on the Field Emergence of Sunflower.

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ABSTRACT

This study aimed to investigate effect of genetic and environmental factors and their interaction on field establishment of sunflower, due to the weakness and variability of emergence. A field experiment was conducted during the fall of 2023 and spring of 2024 seasons at station A, one of the research stations affiliated to the College of Agricultural Engineering Sciences, University of Baghdad. The goal was to improve field emergence rates, reduce emergence duration, and enhance chlorophyll content and photosynthesis. A split plot arrangement within Randomized Complete Block Design with four replications was used. The main factor was planting dates, and the secondary factor was three sunflower cultivars (Aqmar, Flammy, and Sakha). Results showed that the July 10 planting date had the best field emergence, while June 1 resulted in better plant height and leaf area index in the fall. Similarly, the March 30 planting date showed superior emergence rates and plant height in the spring. The Flammy cultivar consistently outperformed others in emergence and growth characteristics across both seasons. This suggests that genetic factors significantly influence emergence rates and plant performance under varying environmental conditions.

Key words: Chlorophyll index; Field establishment; Leaf area index; Photosynthesis.

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INTRODUCTION

The cultivation of sunflower (*Helianthus annuus* L.) in Iraq is often accompanied by weak, delayed, and uneven germination, which is influenced by environmental conditions and their interaction with cultivars. This results in reduced yield later in the season. Seed vigor can be improved to increase field emergence rates, reduce emergence duration, and enhance chlorophyll content and photosynthesis through a number of effective agricultural practices (Iqbal *et al*,. 2015). Most seeds germinate at temperatures ranging between 20°C and 30°C, which are considered optimal for maximizing metabolic processes. When seeds are exposed to extreme temperatures, whether high or low, it can disrupt these processes, even if some seeds show a degree of tolerance and response (30). According to Hamd and Hamza (2024), seed germination is primarily dependent on soil temperature, and the rate of germination can either accelerate or slow down depending on temperature fluctuations. Increased moisture levels, combined with lower temperatures during germination, enhance the activity of microorganisms that attack seeds, leading to germination failure (Pinkovskyi and Tanchyk ,2021). Sunflower is cultivated using various cultivars depending on its intended use and its adaptability to the environmental conditions of the region. In Iraq, sunflower is grown in two seasons (spring and fall), despite significant differences in soil temperature during germination and overall climate temperature between the two seasons, which greatly affect both germination and growth. Additionally, it is crucial to consider the timing or stage at which essential nutrients are provided for the plant's growth and development (Catiempo *at el.*, 2021). The planting date is a critical factor in sunflower cultivation, as it determines the crop’s success, with some farmers choosing to plant earlier or later depending on the optimal

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temperatures for germination and seedling development. Planting dates influence not only germination but also all subsequent growth stages. Temperature and photoperiod variations due to early or late planting lead to differences in plant characteristics and dry matter accumulation. High temperatures exceeding the optimal levels shorten the growth period, reducing dry matter accumulation. Research has demonstrated that planting dates and sunflower cultivars significantly affect seedling emergence, growth periods, and all growth indicators of the sunflower crop (Ndor et al., 2018). Debata (2024) found that the planting date had a significant effect on all growth indicators of the sunflower plant, with one of the most notably affected traits being plant height. Plant height decreased with later planting dates, which was attributed to insufficient moisture availability, limiting the absorption of essential nutrients necessary for plant growth. This resulted in suboptimal growth outcomes for the later planting dates. In contrast, plant height was significantly greater with earlier planting dates, where conditions were more favorable for growth. The selection of suitable genetic structures based on their inherent potential is one of the fundamental steps for achieving good growth and yield. Growth varies between genetic structures depending on the extent to which internal and external factors may either limit or enhance it. Understanding the nature of the genetic-environmental interaction provides a knowledge platform for the behavior of genetic structures by synchronizing growth stages with the most influential environmental factors (temperature, light, relative humidity, etc.). This synchronization positively affects both yield and quality (Al-Saadi, 2014). Al-Nuaimi (2018) concluded in his findings that the Aqmar cultivar significantly outperformed the Banam and Flammy cultivars in terms of plant height, reaching 197.91 cm. Al-Haidari (2021), in his study of five sunflower genetic lines (Ishaqi 1, Ishaqi 2, Flammy, Aqmar, Tarsan), found that Ishaqi 2 showed significant superiority over the other lines in leaf area, reaching 0.91 cm^2, with a leaf area index of 6.526. This was likely due to genetic differences between the cultivars and their varying responses to prevailing environmental conditions. The research aims to increase the field emergence rate, reduce its duration, and enhance chlorophyll content and photosynthesis.

MATERIALS AND MEHODS

A field experiment was conducted during the fall of 2023 and the spring of 2024, at Station A, one of the research stations affilied with College of Agricultural Engineering Sciences, University of Baghdad. The study involved two factors (cultivars and planting dates) using a Randomized Complete Block design withium split plot arrangement with four replications. The main factor consisted of five planting dates: June 1, 10, 20, and 30, and July 10 for the fall season, and February 18, and March 1, 10, 20, and 30 for the spring season. The sub-plot factor included three oilseed sunflower cultivars: Aqmar, Flammy, and Sakha. The experimental field was plowed twice using a moldboard plow in perpendicular directions. The soil was then leveled and smoothed with disc harrows, and the field was divided into furrows. The dimensions of the experimental unit were 3 m × 2 m, consisting of four furrows with a spacing of 75 cm between furrows and 20 cm between planting holes. Seeds were sown at a depth of 3 cm, with three seeds per hole, and thinned to one plant after seedlings reached 20 cm height. Phosphorus fertilizer was applied at a rate of 88 kg P ha^{-1} in one application two weeks after planting, 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 at 77 kg K ha^{-1}, both in two equal applications: the first two weeks after planting and the second at the beginning of flower bud formation. The field was irrigated, and weeds were removed as necessary. The sunflower heads were covered with perforated cloth bags after pollination to protect them from bird damage. The plants were harvested when signs of full maturity appeared, such as the back of the heads turning yellow and the outer bracts beginning to brown (Martin and Leonard, 1959). The seeds were obtained from the Field Crops Department at the College of Agriculture,

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University of Anbar. Soil samples were taken from the field before planting at a depth of 0–30 cm from various locations within the field, and then mixed together to obtain a representative sample of the field soil. Climatic data, including temperature, photoperiod, solar radiation intensity, thermal accumulation, and rainfall amounts, were collected from the relevant authorities. The following traits were studied:

-First day of field emergence (days): This is the day on which the first emergence occurs, with lower values indicating faster initiation of emergence (Kader, 2005).

-Last day of field emergence (days): This is the day on which the final emergence occurs, with lower values indicating a faster completion of emergence (Kader, 2005).

-Field emergence percentage (%): The percentage of seedlings that have emerged after 10 days from the planting irrigation**.**

-Number of days from planting to emergence (days): The number of days from the first day of planting (initial irrigation) to the first emergence, with lower values indicating faster initiation of emergence (Kader, 2005).

-Plant height (cm): The height of the plant measured from the base of the stem to the tip of the floral disk for 10 plants at physiological maturity (when the disk has completely yellowed) (Jassim, 2009).

-Leaf area index (LAI): The leaf area index was calculated following Isa (1990) Formula for leaf area index:

$$\mathbf{LAI} = \frac{\textbf{total leaf area of the plant } (\mathbf{cm^2})}{\textbf{ground area occupied by the plant } (\mathbf{cm^2})}$$

-Chlorophyll index (SPAD): The chlorophyll index was measured using a SPAD device, with three readings taken per plant, averaging ten plants per treatment. The chlorophyll content was measured using the SPAD-502 chlorophyll meter, provided by Minolta Co. LTD, Japan.

-Statistical analysis: The data were statistically analyzed using analysis of variance (ANOVA) with the GenStat program. Treatment means were compared using the Least Significant Difference (LSD) test at a 5% probability level. The simple correlation coefficient between the studied traits was also calculated (Steel and Torrie, 1986)

RESULTS AND DISCUSSION

First Day of Field Emergence (days): The results in Table (1) show a significant effect of planting dates, cultivars, and their interaction on the first day of field emergence in both seasons. The planting dates of June 30 and July 10 in the fall season, and March 30 in the spring season, significantly outperformed the other dates, with the lowest averages (4.0, 4.0, and 4.7 days, respectively). In contrast, June 1 in the fall and February 18 in the spring had the highest averages (4.6 and 8.1 days, respectively). These results did not differ significantly from June 10 and March 1 but were significantly different from the other planting dates within the respective growing seasons. The superiority of June 30 and July 10 in the fall and March 30 in the spring in this trait can likely be attributed to environmental conditions (temperature and humidity). In February, lower temperatures hinder seed germination and development, slowing the movement of water molecules into the seeds and embryo cells due to increased viscosity. This reduced the rate of cell division and elongation, delaying germination and requiring more days for the first field emergence. In contrast, higher temperatures on June 30 and July 10 accelerated physiological processes within the seed, reducing the number of days needed for the first field emergence.This result is in agreement with the findings of Catiempo et al., (2021), emergence concluded that sunflower seed germination is influenced by environmental conditions (temperature), which affect the timing of germination and seedling emergence. They found that the planting date of December 16 required more days to reach the first day of field emergence, whereas the March 15 planting date required fewer days for field emergence. The results showed that the Flammy cultivar significantly outperformed others by recording the lowest average for the first day of field emergence (4.0 and 5.8 days) in both the fall and spring seasons, respectively. It differed significantly from the Sakha cultivar, which recorded the highest, averages (4.4 and 7.1 days) in the fall and spring seasons, respectively. This

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difference is likely due to the varying physiological performance of the cultivars, influenced by their genetic makeup and differing hereditary traits, which affect seed vigor, vitality, and the time taken for field emergence. These results are consistent with those of Sfaeean and Alani (2021) and Elsahookie and Cheyed (2023), who indicated that differences in germination and emergence rates among cultivars vary from year to year due to genetic influences and the varying physiological performance of each cultivar, which in turn affect the duration of germination and the time taken to reach the first day of field emergence. The results indicate that the Flammy cultivar recorded the lowest average for the first day of field emergence (4.0 days) across all planting dates in the fall season. It also demonstrated a significant difference in the spring season, achieving the lowest value (4.0 days), which was significantly different from the other planting dates. This may be attributed to the nature of the genetic-environmental interaction of the cultivars and their varying responses to environmental changes associated with each planting date. This interaction allows seeds to better utilize optimal temperature and moisture conditions for germination, thereby reducing the number of days required to reach the first day of field emergence. These findings align with those of Sfaeean and Alani (2021), who highlighted the influence of genotype-environmental interactions on germination and field emergence, and the ability of cultivars to benefit from the environmental conditions of each planting date.

Table 1. Effect of cultivars and planting date on the first day of field emergence (days) in sunflower.

Fall season 2023					Spring season 2024				
Planting Date	Cultivars			Mean	Planting Date	Cultivars			Mean
	Aqmar	Flammy	Sakha			Aqmar	Flammy	Sakha	
June-1	5.0	4.0	4.7	4.6	February-18	8.3	7.3	8.7	8.1
June-10	4.3	4.0	5.0	4.4	March-1	8.3	7.0	9.0	8.1
June-20	4.0	4.0	4.3	4.1	March-10	6.3	5.7	7.3	6.4
June-30	4.0	4.0	4.0	4.0	March-20	6.0	5.0	5.7	5.6
10th July	4.0	4.0	4.0	4.0	March-30	5.0	4.0	5.0	4.7
LSD 0.05		0.4		0.3	LSD 0.05		0.5		0.8
Mean	4.3	4.0	4.4		Mean	6.8	5.8	7.1	
LSD 0.05		0.2			LSD 0.05		0.2		

Last day of field emergence (days): The results of Table (2) indicate no significant effect of planting dates on the last day of field emergence in the fall season, while there was a significant effect in the spring season. The effect of cultivars was significant in both seasons, and the interaction between planting dates and cultivars also had a significant effect in both seasons for the last day of field emergence. The March 30 planting date recorded the lowest average (5.7 days), significantly outperforming the other dates. In contrast, the February 18 planting date recorded the highest average for the last day of field emergence (11.8 days) in the spring season. The superior performance of the March 30 planting date in the spring season may be attributed to temperature effects, as temperatures were low in February and gradually increased as planting progressed into March, reducing the number of days required for field emergence. This finding aligns with Sadras and Villalobos (1993) and Catiempo *et al.*, (2021), who noted that temperature and moisture are critical factors in controlling the speed of chemical reactions in the seed's physiological processes. Lower temperatures increase the time required for germination due to the slower movement of water molecules into the seeds and embryo cells, increasing viscosity and slowing the rate of cell division and elongation, thereby delaying germination and the appearance of seedlings above the soil surface. The Flammy cultivar recorded the lowest mean for the last day of field emergence (6.3 and 7.6 days) in both seasons, significantly differing from the other cultivars. In contrast, the Sakha cultivar significantly outperformed the others, recording the highest averages for this trait (7.6 and 9.2 days) in

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both seasons (Table 2). The superior performance of the Flammy cultivar in this trait may be attributed to the genetic variability among the cultivars and the genes responsible for this trait, as well as their response to prevailing environmental conditions. These findings are consistent with those of Elsahookie and Cheyed (2023), who found that cultivars differ in their growth rates, and that the same cultivar can exhibit variability from year to year due to genetic-environmental interactions. They attributed this to the metabolic compounds and raw materials received from the mother plant during seed development, which vary between cultivars, alongside the potential genetic control exerted by the seed itself, leading to differences in germination characteristics.

Table 2. Effect of cultivars and planting date on the last day of field emergence (days) in sunflower.

Fall season 2023					Spring season 2024				
Planting Date	Cultivars			Mean	Planting Date	Cultivars			Mean
	Aqmar	Flammy	Sakha			Aqmar	Flammy	Sakha	
June-1	7.6	6.0	8.3	7.3	February-18	12.3	10.6	12.6	11.8
June-10	7.6	6.6	7.6	7.3	March-1	11.0	10.0	11.6	10.8
June-20	7.6	6.3	8.0	7.3	March-10	8.0	6.6	8.3	7.6
June-30	7.0	6.6	7.6	7.1	March-20	7.3	6.0	7.3	6.8
10th July	6.6	6.0	6.3	6.3	March-30	6.0	5.0	6.3	5.7
LSD 0.05		N.S		N.S	LSD 0.05		N.S		0.8
Mean	7.3	6.3	7.6		Mean	8.9	7.6	9.2	
LSD 0.05		0.5			LSD 0.05		0.3		

Field Emergence Percentage (%): The results in Table (3) indicat a significant effect of planting dates and cultivars on field emergence percentage in both fall and spring seasons. The interaction between these factors was also significant in both seasons. The planting dates of July 10 and March 20 and 30 recorded the highest emergence percentage (100%), significantly outperforming the other dates. In contrast, the June 1 planting date recorded the lowest average (88.89%). The superior performance of the July 10 and March 20 and 30 planting dates in this trait may be attributed to increased temperatures and longer daylight duration, providing optimal conditions for seed cell division, elongation, and growth, which resulted in higher field emergence rates and shorter emergence duration. These findings align with those of Pinkovskyi and Tanchyk (2021), who found that the choice of sunflower planting date depends on soil temperature at seed depth. Similarly, these results are consistent with Al-Shamaa and Bakr (2008), who concluded that delayed emergence at the February 16 planting date was due to insufficient thermal accumulation needed for biological processes, leading to delayed emergence, whereas earlier emergence occurred with higher temperatures in the March 15 planting date. The Flammy cultivar showed significant superiority, recording the highest averages for field emergence percentage (99.33% and 98.66%) in both fall and spring seasons, respectively. In contrast, the Sakha cultivar recorded the lowest averages for this trait, with 86.00% and 89.33% in the fall and spring seasons, respectively (Table 3). The superior performance of the Flammy cultivar in this trait may be attributed to its genetic nature, as well as the vitality and vigor of its seeds. These results align with those of Jiyad *et al.* (2017), who confirmed that sunflower species and cultivars vary in their ability for field emergence. Additionally, these findings are consistent with the results of Ndor et al. (2018) and Pinkovsky and Tanchyk (2019), they found that sunflower cultivars had a significant impact on seedling emergence and all growth indicators of sunflower, including field emergence percentage. The results showed significant differences in the interaction between planting dates and cultivars for field emergence percentage. The Flammy cultivar achieved the highest emergence percentage (100%) in both fall and spring seasons, while the lowest response was recorded for the Sakha cultivar, with 80.00% and 73.33% in the

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fall and spring seasons, respectively. This may be attributed to the genetic-environmental interaction and the cultivars' ability to benefit from the accompanying environmental conditions (temperature and humidity), which had a direct effect on seed germination and seedling emergence. These findings are consistent with Gursoy (2022), who found that cultivars differ in their emergence ability due to genetic-environmental interactions.

Table 3. Effect of cultivars and planting date on the last day of field emergence percentage (%) in sunflower.

Fall season 2023					**Spring season 2024**				
Planting Date	**Cultivars**			**Mean**	**Planting Date**	**Cultivars**			**Mean**
	Aqmar	**Flammy**	**Sakha**			**Aqmar**	**Flammy**	**Sakha**	
June-1	90.00	96.67	80.00	88.89	February-18	83.33	93.33	73.33	83.33
June-10	93.33	100.00	83.33	92.22	March-1	90.00	100.00	80.00	90.00
June-20	93.33	100.00	83.33	92.22	March-10	100.00	100.00	93.33	97.77
June-30	93.33	100.00	83.33	92.22	March-20	100.00	100.00	100.00	100.00
10th July	100.00	100.00	100.00	100.00	March-30	100.00	100.00	100.00	100.00
LSD 0.05		3.71		3.31	LSD 0.05		3.31		2.68
Mean	94.66	99.33	86.00		Mean	94.66	98.66	89.33	
LSD 0.05		1.66			LSD 0.05		1.20		

Plant Height (cm) : The results in Table (4) indicate a significant effect of planting dates and cultivars on plant height, with no significant interaction effect for the fall season, while the interaction was significant for the spring season. The planting dates of June 1 and March 30 significantly outperformed other dates, recording the highest averages for plant height (216.78 cm and 221.56 cm) in the fall and spring seasons, respectively. These values were significantly different from the other planting dates. In contrast, the July 10 and February 18 planting dates recorded the lowest averages for plant height (200.32 cm and 215.57 cm) in the fall and spring seasons, respectively (Table 4). The superiority of the June 1 and March 30 planting dates in both seasons can likely be attributed to higher temperatures and longer daylight duration during the flower bud stage through to full flowering, which promoted plant growth and increased plant height. In contrast, the lower temperatures during the other planting dates either stayed within optimal ranges, supporting regular growth, or dropped below optimal levels, negatively affecting plant growth and resulting in shorter plants. These findings are consistent with those of Al-Jabouri and Abdullah (2002), Surhaid *et al*. (2015), and Debata (2024), who all reported that higher temperatures accelerate plant elongation and help plants reach the flowering stage faster. The Flammy cultivar significantly outperformed the others, recording the highest plant heights (213.13 cm and 221.01 cm) in the fall and spring seasons, respectively. In contrast, the Aqmar cultivar recorded the lowest average plant heights (205.09 cm and 215.35 cm) in the fall and spring seasons, respectively. The reason for this may be related to the genetic traits of the cultivar, which utilized its genetic and physiological capacity to efficiently convert the products of photosynthesis in the leaves to support stem cell elongation, rather than accumulation, thereby increasing plant height. These results are consistent with the findings of Elsahookie (1994), Ahmed (2016), Atiya and Kazem (2017), and Ghazi (2020), who found that cultivars differ due to genetic factors, performance, and physiological variations. The results in Table (4) show that the Flammy cultivar significantly outperformed others at the March 30 planting date, recording the highest average plant height (225.833 cm) in the spring season, which was significantly different from the other treatments. In contrast, the Aqmar cultivar recorded the lowest average plant height (213.013 cm) at the June 1 planting date, also significantly differed from the other treatments. The reason for this could be attributed to the favorable environmental conditions, genetic-environmental interactions, higher temperatures, and longer daylight duration at the March 30 planting date, which

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had a clear and significant impact on increasing plant height. These findings are in agreement with the results of Al-Shamaa and Bakr (2009), and Shamran *et al.* (2022), they noted that cultivars interact with environmental conditions, and that cultivars planted under lower temperatures showed reduced plant height compared to those planted at dates with higher temperatures.

Table 4. Effect of cultivars and planting date on plant height (cm) in sunflower.

Fall season 2023					Spring season 2024				
Planting Date	**Cultivars**			**Mean**	**Planting Date**	**Cultivars**			**Mean**
	Aqmar	**Flammy**	**Sakha**			**Aqmar**	**Flammy**	**Sakha**	
June-1	211.3	221.8	217.2	216.8	February-18	213.0	218.0	215.7	215.6
June-10	209.3	216.7	212.8	212.9	March-1	214.0	218.8	216.5	216.5
June-20	206.2	213.7	208.9	209.6	March-10	215.0	220.0	217.1	217.3
June-30	202.1	209.1	204.5	205.2	March-20	216.8	222.3	218.3	219.1
10th July	196.6	204.3	200.1	200.3	March-30	218.0	225.8	220.8	221.6
LSD 0.05		N.S		1.01	LSD 0.05		0.98		0.92
Mean	205.1	213.1	208.7		Mean	215.4	221.0	217.7	
LSD 0.05		0.76			LSD 0.05		0.44		

Leaf Area Index (LAI): The results in Table (5) show a significant effect of planting dates and cultivars on the leaf area index (LAI). There was no significant interaction effect in the fall season, while the interaction was significant in the spring season. The planting date of February 18 recorded the highest average LAI (4.77), significantly outperforming the other planting dates. In contrast, the June 30 planting date recorded the lowest LAI average (3.23) in the fall season. The superior performance of the February 18 planting date in the spring season may be attributed to the favorable environmental conditions and extended growth period, which enhanced the leaf area index for this date. Meanwhile, the June 30 planting date, due to higher temperatures and longer daylight during the flower bud formation stage, shortened the growth period and reduced both the leaf area and its index. These findings are consistent with the results of Al-Dulaimi (2005), they found that higher-than-optimal temperatures and lower moisture levels reduced the lifecycle of the sunflower crop, leading to a decrease in leaf area and LAI, as well as accelerating plant senescence. The Flammy cultivar recorded the highest average leaf area index (3.59 and 4.34) in both fall and spring seasons, significantly outperforming the other cultivars. In contrast, the Aqmar cultivar recorded the lowest average (3.06 and 3.55) in the spring and fall seasons, respectively (Table 5). This difference may be attributed to the genetic nature and leaf area of these cultivars and their natural response to the accompanying environmental growth conditions. These findings are consistent with the results of Elsahookie *et al*. (1994), Al-Shamaa (2002), Salem *et al.* (2014), and Al-Haidari (2021), they indicated differences in the leaf area index among sunflower cultivars due to variations in leaf area. The results in Table (5) indicat that the Flammy cultivar significantly outperformed others at the February 18 planting date in the spring season, recording the highest average leaf area index (5.09), which was significantly different from the other treatments. In contrast, the Aqmar cultivar recorded the lowest average (3.057) at the June 30 planting date in the fall season. This could be attributed to the favorable environmental conditions and the genotype-environmental interaction of the cultivars, as well as the interaction of plant growth factors with the environmental conditions and leaf area of the cultivar, which contributed to an increased leaf area index. These findings are consistent with the conclusions of Al-Shamaa and Bakr (2008) and Elawi and Zeboon (2020), they indicated that genetic patterns generally differ due to the dominance of genetic interactions affecting growth stages, physiological differences among genetic patterns, and their response to growth conditions, leading to variations in the growth and yield of genetic structures.

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Table 5. Effect of cultivars and planting date on leaf area index in sunflower.

Fall season 2023					Spring season 2024				
Planting Date	**Cultivars**			**Mean**	**Planting Date**	**Cultivars**			**Mean**
	Aqmar	**Flammy**	**Sakha**			**Aqmar**	**Flammy**	**Sakha**	
June-1	3.24	3.67	3.41	3.44	February-18	4.46	5.09	4.76	4.77
June-10	3.23	3.74	3.47	3.48	March-1	3.72	4.93	4.28	4.31
June-20	2.99	3.47	3.35	3.27	March-10	3.29	4.13	3.85	3.76
June-30	2.96	3.57	3.55	3.36	March-20	3.26	3.94	3.47	3.56
10th July	2.90	3.49	3.30	3.23	March-30	3.05	3.62	3.34	3.34
LSD 0.05		N.S		0.16	LSD 0.05		0.19		0.92
Mean	3.06	3.59	3.41		Mean	3.55	4.34	3.94	
LSD 0.05		0.12			LSD 0.05		0.08		

Chlorophyll Index (SPAD): The results in Table (6) indicat a significant effect of planting dates and cultivars on the chlorophyll index (SPAD). However, the interaction effect did not significant in either the fall or spring seasons. The planting dates of June 1 and February 18 recorded the highest SPAD chlorophyll index averages (42.49 and 44.26) in the fall and spring seasons, respectively. In contrast, the June 30 and March 20 planting dates recorded the lowest averages (41.29 and 41.93 SPAD) in the fall and spring seasons, respectively. The superior performance of the June 1 and February 18 planting dates in both seasons could be attributed to the increases efficiency of utilizing the available climatic conditions during these periods, such as temperature, relative humidity, light intensity, and daylight duration, all of which positively influenced the chlorophyll content. These findings align with the results of Elsahookie et al. (1994), they noted that environmental conditions are critical and limiting factors for chlorophyll content in sunflower plants. The Flammy cultivar significantly outperformed the others, recording the highest average chlorophyll content (42.52 and 43.67 SPAD) in the fall and spring seasons, respectively. In contrast, the Sakha and Aqmar cultivars recorded the lowest average chlorophyll content (41.52 and 41.99 SPAD) in the fall and spring seasons, respectively. This difference could be attributed to the genetic makeup responsible for this trait. These findings are consistent with the results of Atiya and Kazem (2017), Al-Nuaimi (2018), Elewi (2020), and Al-Saadi (2023), who highlighted the significant effect of sunflower cultivars on total chlorophyll content, influenced by their genetic source and environmental factors.

Table 6. Effect of cultivars and planting date on chlorophyll index (SPAD) in sunflower.

Fall season 2023					Spring season 2024				
Planting Date	**Cultivars**			**Mean**	**Planting Date**	**Cultivars**			**Mean**
	Aqmar	**Flammy**	**Sakha**			**Aqmar**	**Flammy**	**Sakha**	
June-1	42.44	43.17	41.88	42.49	February-18	43.78	45.40	43.58	44.26
June-10	41.04	43.00	42.36	42.13	March-1	42.30	44.09	43.06	43.15
June-20	40.33	42.37	40.73	41.14	March-10	41.41	43.08	41.76	42.09
June-30	40.19	42.10	41.31	41.20	March-20	40.93	42.84	42.03	41.93
10th July	40.49	41.94	41.44	41.29	March-30	41.54	42.93	42.18	42.21
LSD 0.05		N.S		0.75	LSD 0.05		N.S		0.87
Mean	40.90	42.52	41.54		Mean	41.99	43.67	42.52	
LSD 0.05		0.41			LSD 0.05		0.44		

CONCLUSION

The study confirmed that field emergence and early growth of sunflower were significantly influenced by cultivar, planting date, and, for several traits, their interaction. In the fall season, the 10 July planting date gave the best field emergence, whereas 1 June was superior for plant height and leaf area index. In the

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spring season, 30 March showed the best overall performance for emergence-related traits and plant height. Among the tested cultivars, Flammy consistently produced better field emergence percentage, faster emergence, and superior growth characteristics compared with Aqmar and Sakha. These results indicate that selecting a suitable cultivar together with an appropriate planting date is essential for improving field establishment and subsequent growth of sunflower under Baghdad conditions

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this manuscript

AUTHOR/S DECLARATION

The authors declare that this manuscript is original, has not been published previously, and is not under consideration for publication elsewhere. The authors also confirm that all data presented in this study are authentic and that all authors for submission have approved the manuscript

AUTHOR'S CONTRIBUTION STATEMENT

Mushtaq A. Hassan contributed to the conception of the study, field experimentation, data collection, statistical analysis, and manuscript drafting. Jalal H. Hamza contributed to the study supervision, experimental design, data interpretation, manuscript revision, and final approval of the manuscript

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تأثير الأصناف وموعد الزراعة في البزوغ الحقلي لزهرة الشمس.

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المستخلص

هدفت الدراسة الى معرفة تأثر التأسيس الحقلي لمحصول زهرة الشمس بالعوامل الوراثية والبيئية وتداخلها، بسبب ضعف وتباين البزوغ الحقلي. تم إجراء تجربة حقلية خلال موسمي الخريف 2023 والربيع 2024 في محطة A وهي احد المحطات البحثية التابعة لكلية علوم الهندسة الزراعية بجامعة بغداد، لتحسين نسبة البزوغ الحقلي وتقليل مدته، بالإضافة إلى زيادة محتوى الكلوروفيل والتمثيل الضوئي. تم استخدام تصميم القطاعات الكاملة المعشاة بترتيب الألواح المنشقة مع أربع مكررات. شملت التجربة مواعيد زراعة مختلفة وأصناف زيتية من زهرة الشمس (أقمار، فلامي، سخا). أظهرت النتائج أن موعد الزراعة 10 تموز كان الأفضل من حيث نسبة البزوغ الحقلي، بينما كان موعد 1 حزيران الأفضل من حيث ارتفاع النبات ودليل المساحة الورقية في الخريف. وفي الربيع، حقق موعد 30 آذار تفوقاً في نسبة ومدة البزوغ وارتفاع النبات. تميز صنف فلامي بتفوقه في جميع الصفات المدروسة، مما يشير إلى أن العوامل الوراثية تلعب دوراً كبيراً في تحسين الأداء تحت ظروف بيئية مختلفة.

الكلمات المفتاحية: دليل الكلوروفيل ، التأسيس الحقلي، دليل المساحة الورقية ، التمثيل الضوئي