The effect of planting dates on the growth and yield of different wheat varieties

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Abstract

The experiment was conducted during the 2025-2026 growing season at the field trial farm of the College of Agriculture - Al-Qasim Green University, located in southern Babylon province, at latitude 32.40°N and longitude 44.39°E. The aim was to study the effect of planting dates on the growth and yield of different bread wheat cultivars. The experimental design was implemented as a factorial experiment with a split-plot arrangement. A randomized complete block design (RCBD) with three replicates was used to distribute the total treatments. The main plots included three planting dates (10 November , 1 December , and December 20), while the subplots included four cultivars (IPA 99, Antlo, Nizar, and Wafia). The results showed that planting on the first date, 10 November , resulted in a significant advantage in most of the studied traits. It achieved the highest average plant height (103.18 cm), flag leaf area (49.18 cm^2), weight of 1000 grains (37.96 g), and grain yield (5.851 tons ha^{-1}). The second planting date was excelled for the remaining studied traits. The results also showed that Wafia cultivar was excelled in the number of days from planting to 50% flowering. The growing period was 96.91 days, with a grain yield of 5.746 tons ha^{-1}. Nizar cultivar excelled in flag leaf area, reaching 47.97 cm^2. However, IPA 99 cultivar excelled in plant height, reaching 103.52 cm, and Antlo cultivar excelled in 1000-grain weight, reaching 38.00 grams. The interaction between planting dates and cultivars showed a significant advantage in most of the studied plants. The interaction between the second planting date (1 December) and the IPA 99 cultivar resulted in the highest average plant height, reaching 112.50 cm. The interaction between the first planting date (10 November) and Nizar cultivar resulted in the highest average leaf area, reaching 55.68 cm^2. The results obtained from the study showed that the interaction between the first planting date (10 November) and Nizar cultivar resulted in the highest 1000-grain weight, reaching 40.68 grams. The second interaction between the second planting date (1 December) and Wafia cultivar also gave the highest results. It achieved the highest grain yield of 8.207 tons ha^{-1}.

Keywords: Planting dates, cultivars

Introduction

Bread wheat (Triticum aestivum L) is a strategic cereal crop belonging to the grass

family. It is the world's leading field crop used for food in terms of economic importance, cultivated area, and annual production volume, and is consumed by more than 4 billion people worldwide [16,18] Its grains are the primary source of energy that humans need due to their high nutritional value, as they contain a high percentage of proteins and carbohydrates, in addition to containing quantities of fats, vitamins, some mineral salts, and essential amino acids that humans need [14] Wheat is at the forefront of strategic grain crops globally and forms the basic pillar on which food security for humanity is based. Confirming this position, statistical data issued by the Food and Agriculture Organization of the United Nations [18] indicates that global wheat production approached 796 million tons, compared to global demand and consumption of about 802 million tons. While the Iraqi agricultural sector demonstrated remarkable resilience in 2025, FAO reports indicate that Iraq's total wheat production reached 5.1 million tons (a 13% increase over the average). The Iraqi Ministry of Trade announced that marketed quantities exceeded 5 million tons, achieving complete self-sufficiency for the third consecutive year, with a record local strategic reserve extending until 2027. Planting date is a crucial factor that can significantly influence yield traits, growth, and quality. It impacts the developmental stages, organ formation, and growth, which vary in timing and duration depending on environmental conditions. Planting date is affected by temperature and light, which influence most physiological processes in plants [25] Delaying planting, coupled with high temperatures during grain filling, leads to reduced grain weight due to a shortened filling period [27].

Grain yield is the final product of its components (number of spikes per unit area, number of grains per spike, and weight of 1000 grains). High temperatures accelerate the plant's physiological processes and shorten its growth period. The products of photosynthesis may become insufficient to meet the plant's requirements for completing growth stages and optimal organ precursor formation. Determining the appropriate planting date ensures that cultivars have the necessary temperature and photoperiod requirements for different plant growth stages, despite some differences in the behavior of cultivars in responding to these conditions [26]. The economic yield of any crop is affected by the genetic factor represented by the cultivar. Many studies have indicated clear differences in the behavior of cultivars in terms of growth and production due to different planting dates. Cultivars differ genetically in their degree of response to and utilization of surrounding environmental factors, which directly affect the photosynthesis process, which is reflected in crop productivity. Cultivars are the primary source of diversity in wheat traits and are considered one of the most important factors

in agriculture. They directly influence vegetative traits, yield and its components, productivity, and quality, in addition to their adaptability to various surrounding environmental conditions. Most recent scientific studies and research have shown that the interaction between cultivars and environmental conditions has a significant impact on improving and increasing the quality of production [22].

Materials and Methods:

The experiment was conducted in one of the fields of the College of Agriculture, Department of Field Crops, during the 2025-2026 growing season, south of Babylon province, at latitude 32.40°N and longitude 44.39°E. The aim was to determine the effect of planting dates on the growth and yield of different bread wheat varieties. Five soil samples were taken from different locations in the field at a random depth of 0-30 cm before planting to determine some of the physical and chemical properties of the soil. (page et al., 1982). The samples were tested at the Adwaniyah Station Laboratory/Scientific Center for Modern Agricultural Technologies. A homogeneous sample was obtained by mixing the five samples, drying them by exposure to sunlight, grinding them, and then passing them through a 2 mm sieve for the required tests. The results are shown in Table 1. The experimental design was a factorial experiment with a split-plot arrangement as the main design, and a block design was used. Complete randomization with three replicates was used to distribute the total treatments. The main plots included planting dates, while sub plots included varieties. The first factor included three planting dates: (October 11, December 1, and December 20). The second factor included four wheat varieties: (IPA 99, Antlo, Variety Nizar and Wafia). The land was plowed perpendicularly using a moldboard plow. The soil was then smoothed and leveled, and the main furrows were opened using a furrow opener. The land was then divided into three sections, each containing 12 experimental units. Each experimental unit measured 6 m² (2 x 3 m), for a total of 36 experimental units. Planting was then carried out in rows with a spacing of 20 cm between rows, resulting in 10 rows of 3 m length each. The seeding depth was 5 cm, and a spacing of 50 cm was maintained between experimental units. Another method, with a 1-meter spacing between sections, was used. The seeding rate for the varieties was 120 kg.ha-1 (Abu Al-Eis, 2004). Crop management operations, including irrigation, hoeing, and weeding, were carried out continuously according to the plant's needs (Kamal et al., 2016). Urea was then added as a nitrogen fertilizer source at a rate of 200 kg in three applications: the first at planting, the second at the elongation stage, and the third at the budding stage (Hamza and Jadou, 2016). Triple superphosphate fertilizer was also

added at a rate of 100 kg.ha-1 in two applications at planting (Jadou, 1995). Due to the spread of aphids in neighboring fields, they were controlled by spraying the plants with suberin. The crop was harvested sequentially according to its ripening schedule when it reached full maturity.

Table 1: Some Physical and Chemical Properties of Field Soil

sample	pH	EC(ds.m^{-1})	Available elements			Organic matter g/kg -1 soil	Soil separators			Soil mixture
Soil	7.30	4.10	Nitrogen 14.00	phosphorus 21.40	potassium 315.1	0.48	clay 409	silt 338	sand 253	loamy

Some vegetative growth traits were measured at flowering by taking the average of a random sample of 10 plants from the midlines of each experimental unit. The number of days from planting to 50% flowering, as well as plant height, flag leaf area, and 1000-grain weight were studied.

Results and Discussion

Number of days from planting to 50% flowering (days)

The results in Table (2) indicate a significant effect of planting dates, cultivars, and their interaction on the number of days from planting to 50% flowering (days). Table (2) shows a significant advantage for the third planting date,20 December, which recorded the lowest average number of days at 100.28 days. This did not differ significantly from the second planting date, which recorded an average of 102.90 days, compared to the first planting date, which gave the highest average of 109.86 days. The reason for the decrease in the number of days from planting to 50% flowering in the third (late) planting date is due to the high temperatures and increased day length during the growth period. This led to an accelerated plant growth rate and the accumulation of the heat units required to transition to the flowering stage in a shorter period. This, in turn, prompted the plant to begin flowering early (escaping late heat stress). This result is consistent with what [5,21] ,

Table (2) The effect of planting dates, cultivars and the interaction between them on the number of days from planting to 50% flowering (days)

cultivars	planting dates			Average effect of cultivars
	10 November	1 December	20 December	
IPA99	117.30	103.06	113.27	111.21
Antlo	112.45	104.01	100.09	105.52
Nizar	113.78	103.74	93.77	103.76
Wafia	95.92	100.80	94.00	96.91
L.S.D 0.05	5.117			3.275
Average effect of planting dates	109.86	102.90	100.28	
L.S.D 0.05	2.123			

The table data also indicates that Wafia cultivar recorded the lowest average number of days from planting to 50% flowering, which was 96.91 days, while the IPA 99 cultivar recorded the longest period for this trait, at 111.21 days. The reason for the variation in this trait among the cultivars is attributed to their genetic nature and their response to surrounding environmental conditions (temperature and light). Wafia cultivar is genetically considered an early cultivar and requires fewer heat units to transition to the flowering stage, leading to a faster completion of the vegetative growth stage. In contrast, the IPA 99 cultivar is genetically late and requires a longer vegetative growth period and the accumulation of more heat units to complete the vegetative growth stage before transitioning to the flowering stage. These results are consistent with the findings of [3,13] who indicated a difference in the time from planting to 50% flowering among the cultivars.

Table (2) data indicates that there is a significant overlap between planting dates and cultivars. Regarding the effect on the number of days from planting to 50% flowering (days), Nizar cultivar, planted at the third planting date, showed the highest average of 93.77 days, while the IPA 99 cultivar, planted at the first planting date, gave the lowest average for this trait at 117.30 days. Regarding

Plant height (cm)

Table (3) shows significant differences in plant height based on planting date, cultivar, and their interaction. The data in Table (3) indicates a significant difference in plant height between planting dates. The first planting date, 10 November , gave the highest average height of 103.18 cm, while the third planting date, 20 December , gave the lowest average height of 90.45 cm. The excelled of the first planting date, 10 November , may be attributed to the earlier date leading to faster emergence and growth compared to other planting dates that coincided with a relatively lower temperature, as shown in the temperature table. This is due to slow growth rates, and this is consistent with the findings of both[15,24].

Table (3) Effect of planting dates, cultivars and their interaction on plant height (cm(

cultivars	planting dates			Average effect of cultivars
	10 November	1 December	20 December	
IPA99	110.37	112.50	87.70	103.52
Antlo	109.38	91.14	87.36	95.96
Nizar	98.46	94.86	93.27	95.53
Wafia	94.50	92.92	93.46	93.63
L.S.D 0.05	7.283			4.491
Average effect of planting dates	103.18	97.85	90.45	
L.S.D 0.05	3.974			

This trait was significantly affected by the cultivar, with the IPA99 cultivar exhibiting the highest average height at 103.52 cm, while the 'Wafia' cultivar had the lowest average at 93.63 cm. This aligns with the findings of [4,12] The reason for this variation is attributed to genetic differences among the cultivars in internode lengths, particularly the upper internode, which represents approximately half the plant's height. The results shown in the same table demonstrate a significant interaction between planting dates and cultivars in plant height. The IPA99 cultivar, planted on 1 December , achieved the highest height at 112.50 cm, while Antlo cultivar, planted on 20 December , gave the lowest average at 87.36 cm.

Flag Leaf Area (cm^2):

The data in Table (4) clearly demonstrate the significant effect of planting dates, cultivars, and their interaction in flag leaf area. The first

planting date, 10 November , achieved the highest average for this trait, reaching 49.24 cm^2, while the second planting date, 1 December , gave the lowest average, reaching 42.36 cm2. Perhaps the reason for the excelled of the first planting date, 10 November , is due to providing a longer period of time before the plant transitions to the reproductive growth stage, thus giving the leaves sufficient time for cell division, which is reflected in the increase in leaf length and width. In addition, the first planting date delays leaf senescence, as it protects the leaves from heat waves and early drought, which cause shrinkage, small size, and rapid drying in later planting dates. This is consistent with what[8,19] concluded.

Table (4) Effect of planting dates, cultivars and the interaction between them on the area of the flag leaf (cm^2)

cultivars	planting dates			Average effect of cultivars
	10 November	1 December	20 December	
IPA99	49.45	43.18	40.55	44.39
Antlo	46.67	42.70	48.72	46.03
Nizar	55.68	36.21	52.03	47.97
Wafia	44.92	47.34	39.66	43.98
L.S.D 0.05	4.742			2.938
Average effect of planting dates	49.18	42.36	45.24	
L.S.D 0.05	2.525			

As for the cultivars, the results in Table (4) showed a significant effect of the flag leaf area (cm^2) trait. The results indicated that Nizar cultivar had the highest average for this trait, reaching 47.97 cm^2, which did not differ significantly from Antlo cultivar, which reached 46.30 cm^2. Wafia cultivar, on the other hand, gave the lowest average for this trait, at 43.98 cm^2. The reason for the variation in flag leaf area (cm^2) among the cultivars is attributed to the differences in genetic and physiological factors, in addition to their interaction with environmental conditions. This agrees with Zeidan et al. (2018) and Alzaayid (2011). The data in Table (4) indicate a significant interaction between planting dates and cultivars in influencing the flag leaf area (cm^2) trait. Nizar cultivar, planted on the first planting date of 10 November , gave the highest average, reaching 55.68 cm^2, which did not differ significantly from Antlo cultivar. Significantly, the third planting date, 20

December , showed a difference of 52.03 cm², while the same cultivar, Nizar, planted on the second planting date, 1 December , gave the lowest average for this trait, reaching 36.21 cm².

Weight of 1000 grains:

The results of the statistical analysis and Table (5) showed a significant difference in the weight of 1000 grains trait based on planting date, cultivar, and the interaction between them. The data in the same table shows a significant effect of planting dates. The first planting date, 10 November , recorded an average weight of 37.96 grams, while the third planting date, 20 December , did not differ significantly, with an average weight of 36.40 grams. The second planting date recorded the lowest average weight for this trait at 35.25 grams. This is due to the excellent climatic conditions of the first planting date, which provided double the amount of feed produced through compensatory activities. The decrease in the number of spikes (7) and the number of grains (8) led to the complete conversion of this feed into a smaller number of grains, resulting in better grain filling and a residual increase in the weight per 1000 grains. This is consistent with [10,21]

Table (5) Effect of Planting Dates, Cultivars, and Their Interaction on the Weight of 1000 Grains (g)

cultivars	planting dates			Average effect of cultivars
	10 November	1 December	20 December	
IPA99	34.82	34.80	37.84	35.82
Antlo	38.58	36.84	38.59	38.00
Nizar	40.68	34.41	37.41	37.50
Wafia	37.76	34.94	31.76	34.82
L.S.D 0.05	1.561			0.993
Average effect of planting dates	37.96	35.25	36.40	
L.S.D 0.05	0.689			

Regarding the cultivars, wheat cultivars differed significantly in the 1000-grain weight trait. Antlo cultivar excelled, gave the highest average weight at 38.00 g, while Nizar cultivar achieved a similar value of 37.50 g. Wafia cultivar exhibited the lowest average weight at 34.82 g. This variation among cultivars is attributed to the reduced number of spikes,

resulting in less competition for nutrients, which leads to increased grain weight. These findings align with those of [6.7] who demonstrated that cultivars differ in 1000-grain weight. As for interactions, Table (5) indicates a significant interaction between planting dates and cultivars. Nizar plants planted on 10 November gave the highest average weight at 40.68 g, while Wafia plants planted on 20 December gave the lowest. The first lowest average yield was 31.76 g

Grain yield (Mg ha^{-1})

This is one of the most important components of wheat yield, representing the result of the physiological activities carried out by the plant during its growth period and is the final grain yield. Table (6) indicates a significant difference in grain yield based on planting dates, cultivars, and their interaction. The results in the table show a significant difference in planting dates. The second planting date, 1 December , recorded the highest grain yield at 5.851 tons ha^{-1}, and this was not significantly different from the third planting date, 20 December , which gave 5.325 tons ha^{-1}. The first planting date, October 10th, recorded the lowest average yield for this trait at 4.417 tons ha^{-1}. The excelled grain yield of the second planting date is attributed to the direct complementary effect of the numerical and physiological components of the yield. The increase in chlorophyll content (Table 7) led to improved efficiency in food processing, resulting in a decrease in the number of tillers (Table 6) that develop into a larger number of spikes (Table 9), thus bearing a higher number of grains and contributing to the increased grain yield. This aligns with the findings of [2,12] .

Table 6: Effect of Planting Dates, Cultivars, and Interactions on Grain Yield

cultivars	planting dates			Average effect of cultivars
	10 November	1 December	20 December	
IPA99	5.167	5.810	4.757	5.244
Antlo	3.113	4.643	6.567	4.774
Nizar	4.867	4.743	5.467	5.026
Wafia	4.520	8.207	4.510	5.746
L.S.D 0.05	1.003			0.541
Average effect of planting dates	4.417	5.851	5.325	
L.S.D 0.05	0.784			

Table (7) Effect of autumn, varieties and interactions on the number of spikes (spikes.m2

cultivars	planting dates			Average effect of cultivars
	10 November	1 December	20 December	
IPA99	391.7	376.0	357.3	375.0
Antlo	339.0	389.3	356.3	361.6
Nizar	321.0	391.3	376.3	362.9
Wafia	344.0	411.0	435.7	396.9
L.S.D 0.05	15.69			9.54
Average effect of planting dates	348.9	391.9	381.4	
L.S.D 0.05	9.15			

Table (8) Effect of planting dates, varieties and the interaction between them on the number of grains per spike (grain. spike-1)

cultivars	planting dates			Average effect of cultivars
	10 November	1 December	20 December	
IPA99	35.44	46.63	45.38	42.48
Antlo	34.44	48.24	35.01	39.23
Nizar	41.57	42.57	36.54	40.23
Wafia	40.40	45.53	50.85	45.59
L.S.D 0.05	1.968			1.159
Average effect of planting dates	37.96	45.74	41.94	
L.S.D 0.05	1.283			

The cultivar had a significant impact on grainfrom the IPA 99 and Nizar cultivars, which gave yield. Table (6) shows that Wafia cultivar gaveaverages of 5.244 and 5.026 tons ha^{-1}, the highest average for this trait, reaching 5.746respectively. This excelledity is attributed to tons ha^{-1}, which was not significantly differentgenetic differences in productivity and

differences in the efficiency of dry matter conversion between the fruiting and root systems. The interaction between planting dates and cultivars had a significant impact on the total yield. Wafia cultivar, planted on 1 December , recorded the highest average for this trait at 8.207 tons ha^{-1}, while Antlo cultivar, planted on 10 October , gave the lowest average at 3.113 tons ha^{-1}.

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