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Impact of planting dates on the growth and yield of wheat genotypes (*Triticum aestivum*).

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Abstract

A field experiment was conducted in Al-Muthanna Governorate during the winter agricultural season of 2024-2025 at the second agricultural experiment station associated with the College of Agriculture - Al-Muthanna University, Al-Bandar station. The objective was to investigate the impact of planting dates on the growth and yield of four genetic varieties of bread wheat: AXAD 33, AXAD 59, AXAD 899, and Bohouth 22, with planting dates set for 11/15, , 11/30 ,15/12 , and 12/30. The randomised complete block design (R.C.B.D) was implemented with a split plot layout with three replicates, where the primary plots denote the planting dates and the secondary plots signify the genetic compositions. The treatments were allocated randomly across the replicates. The findings revealed that the fourth date excelled in the attribute of 50% blooming, averaging 106 days, whereas the second date (11/30) excelled in spike length, biological yield, and growth index. The harvest yielded the highest averages of 10.86 cm, 12.98 tonnes e-, and 31.62% for the respective traits, whereas the fourth date (12/30) recorded the lowest averages for spike length, vital yield, harvest index, 50% until full maturity, grain filling period, and 1000 grain weight, amounting to 10.11 cm, 8.13 tonnes e-, 19.25%, 19.20%, 1 day, 17.00 days, and 26.25 g respectively. Conversely, the first date (11/15) achieved the highest averages for 50% until full maturity, grain filling period, and 1000 grain weight, totalling 56.67 days, 59.92 days, and 57.08 g respectively, while also presenting the lowest average overall. The trait of 50% flowering was recorded at 89.00 days, with the G4 combination demonstrating superiority in the traits of 50% flowering, time to full maturity, grain filling period, and harvest index, achieving averages of 102.92 days, 40.00 days, 37.17 days, and 30.20%, respectively. The G1 combination exhibited the highest averages for spike length and thousand grain weight, measuring 11.23 cm and 43.17 g, respectively. Additionally, the G2 combination excelled in biological yield, attaining an average of 11.68 tonnes per hectare. The G1 combination exhibited the lowest average for the attributes measured (from 50% blooming to full maturity and harvest index), recording values of 35.58 days and 22.41%, respectively. Consequently, the combination G2 exhibited the lowest averages for two traits, specifically 50% flowering and grain filling period, at 96.50 days and 33.67 days, respectively. In contrast, the combination G3 recorded the lowest average for the thousand-grain weight trait at 39.75 g. Meanwhile, the combination G4 demonstrated the lowest averages for two traits, namely spike length and biological yield, at 9.90 cm and 9.84 tonnes ha-1, respectively. The interaction results demonstrated the superiority of the D4G3 combination in the trait of 50% flowering, yielding an average of 114.33 days, in contrast to the D1G1 combination, which recorded the lowest average of 88.67 days for the same trait. Additionally, the D1G1 combination surpassed both D1G2 and D1G3, with no significant difference, averaging 60.00 days across the three combinations. The combination D4G1 yielded the lowest average for the specified attribute, recorded at 17.00 days. The combination D2G1 yielded the largest average spike length at 12.23 cm, whilst the combination D4G4 produced the lowest average for this feature at 8.63 cm. The combination D1G1 yielded the highest average for the thousand-grain weight trait at 60.00 g, whereas the combination D4G3 produced the lowest average at 22.67 g.

Keywords: planting dates, genetic structures, bread wheat

Introduction

Wheat, scientifically known as Triticum aestivum L., is an essential strategic crop all over the world, but it is especially important in Iraq because of the nutritional value it possesses. Through the provision of essential amino acids, minerals, and vitamins, it functions as a primary source of food. It is estimated that grains provide approximately 25 percent of the protein that individuals require and more than 50 percent of the calories that they require [1]. The Directorate of Agricultural Statistics estimates that the overall production in Iraq during the winter season (2023/2024) will be around 5,234 thousand tonnes per hectare [2]. Alterations in the climate are a significant obstacle that humanity must overcome in the present day. Examples of modern phenomena are the rise in the amount of carbon dioxide (CO_2) in the atmosphere, the increase in temperatures, and the decrease in the amount of precipitation that is occurring. These elements have caused changes to occur in the physiological activities of crops in general, and wheat in particular. These changes are particularly noticeable in the enhancement of photosynthesis, the escalation of respiration, and the contraction of the growth period that is required to finish its life cycle [3]. Currently, there is a considerable shift in climatic conditions that has had a big impact on plant life. This has prompted a reevaluation of a number of aspects, including genetic structures that have a high degree of adaptability to these settings. A reevaluation of planting dates has also been brought about as a result of this, with the objective of optimising them by reducing the timeframe in response to changes in the environment. This will result in an increase in the growth and development of plant organs, which will help to counteract the negative consequences. Researchers are tasked with the responsibility of determining the most appropriate time to plant wheat, which is an essential step in the process of developing efficient agricultural methods. It is of the utmost importance to provide guidance to farmers and cultivators regarding the significance of selecting the appropriate planting date. This is because the yield per unit area and the consistency of traits exhibited by the genetic compositions in subsequent seasons serve as significant indicators of their stability and suitability for a particular environment or location [4]. This transition has brought about significant alterations in plants, particularly field crops, as well as in their capacity to adjust to different levels of temperature and humidity environments. As a result of the unpredictability of the climate conditions that are affecting the entire world, particularly the Arab region, these changes have come about as a consequence. In spite of the fact that there are some crops that have adapted to these conditions, the production of the types that are now being used has significantly dropped as a consequence of these changes. Consequently, it is of the utmost importance to educate professionals in the disciplines of breeding and plant enhancement on the development of novel genetic frameworks that have the ability to produce enormous production while displaying resilience to environmental settings that are not usual.

Materials and Methods

The field experiment was executed at the Second Research Station of the College of Agriculture at Al-Muthanna University in the Al-Bandar region, situated southwest of Al-Muthanna Governorate, 2 km from the governorate's centre, during the winter agricultural season of 2024-2025. The objective was to analyse the estimation of various genetic characteristics for multiple genetic compositions affected by planting dates. Random samples were collected from various sites within each replication prior to planting and combined to create a composite sample reflecting the experiment, extracted from a depth of 0-30 cm. A Randomised Complete Block Design (R.C.B.D.) was employed following a split-plot arrangement with three replications. The primary plots illustrated the planting dates, whilst the subsidiary plots depicted the genetic compositions. Treatments were randomly allocated among the replicates. The experimental land was prepared by ploughing it twice with a rotary tiller following the conclusion of the summer season. The area was partitioned into panels based on the utilised design, resulting in a total of 48 experimental units, comprising three replicates, with each replicate containing 16 experimental units. Planting occurred in rows, with a spacing of 20 cm between each row, and the secondary panels were distanced from one another by 1 m. The field was fertilised in accordance with the recommended application for wheat, utilising 120 kg ha-1 of nitrogen in the form of urea (46% N) in two applications: the first during the tillering stage and the second during the elongation stage [5]. Phosphorus was incorporated as per the fertiliser recommendation using triple superphosphate (P2O5, 21% P) at a rate of 84 g per experimental unit, along with potassium in the form of potassium sulphate at 96 g per experimental unit, both applied in a single batch prior to planting [6]. Irrigation and weeding were performed as necessary. The table presents several physical and chemical parameters of the soil prior to planting.

Table (1) Physical and chemical parameters of the experimental field before to planting.

parameter		value	unit
pH		8.62	
E.C(1:1)		5.2	ديسيسمنزم$^{-1}$
Available nitrogen		15.4	mg kg-1 soil
available phosphorus		44.22	mg kg-1 soil
available potassium		286.92	mg kg-1 soil
organic matter		0.517	%
Soil Classifiers	clay	33.89	g kg-1
	silt	50.64	
	sand	15.25	
Soil Texture		clay mixture	

Soil samples were analyzed in the Soil Physics Laboratory of the College of Agriculture, Al-Muthanna University, and Al-Amin Research Laboratory in Najaf.

Results Analysis: The data were statistically analysed utilising the Genstat statistical analysis tool, and the arithmetic means were compared employing the LSD test at a 5% probability level [7].

Results and Discussion

Growth Traits:

Number of Days from Planting to 50% Flowering:

The statistical study results in Table (2) demonstrated a significant impact of genetic compositions, planting dates, and their interaction on this feature. Table (2) demonstrated a substantial influence of genetic compositions on the number of days to 50% blooming, with the G4 genotype exhibiting the greatest average at 102.92 days, while the G2 genotype presented the lowest average at 96.50 days. This may result from variations in genetic makeup regarding their temperature and photoperiod requirements. This demonstrates the degree of genetic difference between introduced genotypes and sanctioned cultivars, in accordance with the findings of [8]. Table (2) showed shown substantial effects of planting dates on the duration till 50% flowering. The fourth date, D4, produced the highest average for this feature at 106.92 days, whereas the first date, D1, recorded the lowest average at 89.00 days. This may result from early and late planting causing an extension or overlap of the growth phase, as noted by [8]. The analysis of overlap revealed that the combination (G3D4) was best, requiring the greatest duration to achieve 50% flowering at 114.33 days, whereas the combination (G1D1) exhibited the smallest duration at 88.67 days.

Table. (2) shows the effect of genetic compositions and planting dates on the trait of 50% flowering percentage and the interaction between them.

genetic compositions	planting dates				average
	D1	D2	D3	D4	
G1	88.67	98.33	104.00	98.00	97.25
G2	89.33	98.33	97.00	101.33	96.50
G3	88.67	97.67	105.33	114.33	101.50
G4	89.33	100.33	108.00	114.00	102.92
average	89.00	98.67	103.58	106.92	
	planting dates		genetic compositions		interaction
L.S.D	3.458		3.259		6.522

Number of days from 50% flowering to full maturity:

Table (3) demonstrated a significant effect of genotypes and planting dates, with no significant interaction effect on this feature. Table (3) demonstrates that the G4 genotype exhibited superior performance, achieving the maximum average of 40.00 days, whereas the G1 genotype recorded the lowest average for this attribute at 35.58 days. This may be ascribed to genetic variance among the genotypes.

Table (3) demonstrates that the D1 date excelled in this attribute, producing the highest average of 56.67 days, whilst the D4 date recorded the lowest average of 19.25 days. The former can be ascribed to the presence of advantageous climatic circumstances, such as temperature and light intensity, along with the absence of overlap in growth periods.

Table (3) shows the effect of genetic compositions, planting dates and the interaction between them on the trait of number of days from 50% flowering to full maturity.

genetic compositions	planting dates				average
	D1	D2	D3	D4	
G1	56.67	37.33	29.33	19.00	35.58
G2	54.33	39.00	30.67	18.67	35.67
G3	55.00	43.33	29.67	18.33	36.58
G4	60.67	44.67	33.67	21.00	40.00
average	56.67	41.08	30.83	19.25	
	planting dates		genetic compositions		interaction
L.S.D	1.991		3.164		N.S

Grain filling time:

Table (3) demonstrated a considerable influence of genotypes, planting dates, and their interaction on this feature. Table (3) reveals considerable differences across the genotypes, with the G4 genotype exhibiting the highest average of 37.17 days, whilst the G2 genotype displays the lowest average of 33.67 days. This may be attributable to the influence of hereditary variables, resulting in variations in averages among genotypes. This may align with the assertions made by [9,10]. The results in Table (4) indicate that the D1 date exhibited . superiority, with the highest average of 59.92 days, in contrast to the D4 date, which recorded the lowest average of 17.00 days. This may be ascribed to the variation in the duration necessary for plants cultivated at distinct periods from pollination and fertilisation to reach physiological maturity. This aligns with the conclusions of [11,12]. The interaction results in Table (4) demonstrated that the D1G1, D1G2, and D1G3 combinations exhibited the highest average of 60.00 days, whilst the D4G1 combination yielded the lowest average of 17.00 days

Table (4) shows the effect of genetic compositions, planting dates and the interaction between them on the grain filling period trait.

genetic compositions	planting dates				average
	D1	D2	D3	D4	
G1	60.00	33.00	26.33	17.00	34.08
G2	60.00	31.33	26.33	17.00	33.67
G3	60.00	31.33	26.67	17.00	33.75

G4	59.67	44.33	27.67	17.00	37.17
average	59.92	35.00	26.75	17.00	
	planting dates		genetic compositions		interaction
L.S.D	0.947		1.319		1.968

Spike Length:

The statistical analysis results in Table (5) indicated a considerable influence of genetic compositions, planting dates, and their interaction on this feature. Table (5) indicated that the compositions exhibited significant variation in spike length. The G1 genotype had the highest average for this feature at 11.23 cm, whilst the G4 genotype displayed the lowest average at 9.90 cm. This may result from genetic variability, indicating that this feature is more significantly impacted by genetic causes than by environmental variables. This outcome aligns with the findings of [11,13,14], who evidenced variations in spike length among cultivars. Table (5) indicates that postponing the planting date adversely affected the average spike length in comparison to earlier dates. Date D2, with the highest average of 10.86 cm, surpassed plants planted on date D4, which yielded the lowest average for this characteristic at 10.11 cm. This may be ascribed to the efficient use of available photosynthetic products resulting from advantageous conditions prior to the spike-ejection phase. The abbreviated spike length may result from the postponement of the planting date, which causes elevated temperatures during the spike-ejection phase. This outcome parallels the findings of [15,16]. The results demonstrated a substantial interaction between genetic compositions and planting dates for this feature. The D2G1 combination achieved the highest average of 12.33 cm, whereas the D4G4 combination attained the lowest average of 8.63 cm.

Table (5) shows the effect of genetic compositions, planting dates and the interaction between them on the spike length trait (cm).

genetic compositions	planting dates				average
	D1	D2	D3	D4	
G1	10.97	12.33	10.98	10.62	11.23
G2	8.98	10.75	10.47	10.83	10.26
G3	10.05	10.02	10.55	10.35	10.24
G4	11.35	10.33	9.27	8.63	9.90
average	10.34	10.86	10.32	10.11	
	planting dates		genetic compositions		interaction
L.S.D	0.467		0.476		0.893

Yield Traits:

Thousand Grain Weight (g):

Table (6) demonstrated a considerable influence of genetic compositions, planting dates, and their interplay on this feature. Table (6) demonstrated the superiority of the G1 genetic composition, which produced the greatest average of 43.17 g, in contrast to the G3 composition, which gave an average of 39.75 g. The superiority of the G1 composition may be attributed to its lowest average grain count per spike (Table 10). This diminished competition among grains within a single spike for nutrients and resources, resulting in higher grain weight. This finding aligns with the conclusions of [17,12,18], who determined that the weight of a thousand grains differed across the tested kinds. The data in Table (6) demonstrate that date D1 had the highest average for this feature at 57.08 g, whilst date D4 showed the lowest average at 26.25 g. The weight of the grain serves as a significant measure of the efficiency in transferring metabolic materials from the source to the destination, associated with the structural characteristics, grain fullness, and the rate and duration of nutrient preparation from the onset of flowering to physiological maturity. The cause may possibly stem from the differences in structure and grain quantity in the spike, resulting in enhanced possibilities for nutrient storage in the grain due to reduced competition. This outcome aligns with the findings of [19,20,8]. The interaction results in Table (6) demonstrated that the D1G1 combination exhibited the highest average at 60.00 g, whereas the D4G3 combination yielded the lowest average at 22.67 g for this feature.

Table (6) shows the effect of genetic compositions, planting dates and the interaction between them on the trait of 1000-grain weight (g).

genetic compositions	planting dates				average
	D1	D2	D3	D4	
G1	60.00	55.00	33.67	24.00	43.17
G2	54.67	41.00	34.67	30.00	40.08
G3	58.00	42.67	35.67	22.67	39.75
G4	55.67	44.00	39.33	28.33	41.83
average	57.08	45.67	35.83	26.25	
	planting dates		genetic compositions		interaction
L.S.D	2.333		1.740		4.262

Bioyield (tons ha-1):

The statistical analysis results in Table (7) indicated a substantial impact of genetic compositions and planting dates solely on the biological yield trait (tonnes ha-1). Table (7) indicates considerable differences in compositions, with G2 achieving the highest average yield of 11.68 tonnes ha-1, while G4 recorded the lowest average of 9.84 tonnes ha-1. This may result from various factors, including the variability of the compositions in the study, their effectiveness in intercepting solar radiation during the growing season, and differences in plant height, leaf area, and the number of fertile spikes among the compositions. This outcome aligns with the findings presented by [17,21,8]. Table (7) data demonstrated that the D1 date was superior, achieving the maximum average of 12.98 tonnes ha-1, whereas the D4 date exhibited the lowest average of 8.13 tonnes ha-1. This may be due to the brief duration of the crop's presence in the field, along with the hastening of physiological processes within the plant, resulting in a reduced elongation period and a diminished number of tillers, all of which significantly affect the biological yield. This outcome concurred with the findings of [22,8].

Table (7) shows the effect of genetic compositions, planting dates and the interaction between them on the biological yield trait, t.h-1.

genetic compositions	planting dates				average
	D1	D2	D3	D4	
G1	13.90	10.80	9.27	6.82	10.20
G2	13.10	10.65	11.63	11.33	11.68
G3	12.28	10.38	12.33	7.67	10.66
G4	12.65	11.33	8.67	6.70	9.84
average	12.98	10.79	10.48	8.13	
	planting dates		genetic compositions		interaction
L.S.D	1.418		1.207		N.S

Harvest Index:(%)

The statistical analysis results in Table (8) reveal a significant effect of genetic compositions and planting dates, while the interaction between them has no significant effect. The results of Table (8) show that composition G4 outperformed composition, yielding the highest average of 30.20%, while composition G1 yielded the lowest average of 22.41%. The variation in the harvest index between compositions may be attributed to differences in grain yield and biological yield, as well as the genetic structure's ability to efficiently convert produced materials from the source to the outlet. These compositions differ in their ability to distribute net photosynthesis to the outlet. These results are consistent with the findings of [23,20]. The results of Table (8) show that the harvest index decreases as the planting date is delayed, as plants of date D2 gave the highest average of 31.62%, while plants of date D4 gave the lowest average of 19.20%. The reason for this may be due to the superiority of the early dates in increasing both the grain yield and the biological yield, and their increase has a positive effect on increasing the harvest index. This result is consistent with [24,8], who concluded that there are significant differences between the planting dates for the wheat crop in the harvest index trait.

Table (8) shows the effect of genetic compositions, planting dates and the interaction between them on the harvest index% trait.

genetic compositions	planting dates				average
	D1	D2	D3	D4	
G1	18.38	26.77	25.54	18.95	22.41
G2	22.40	32.70	23.48	12.46	22.76
G3	25.19	28.88	21.60	20.76	24.11
G4	29.92	38.13	28.11	24.63	30.20
average	23.97	31.62	24.68	19.20	
	planting dates		genetic compositions		interaction
L.S.D	3.318		3.990		N.S

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