Response of various growth and yield properties of corn (*Zea mays*) to planting dates

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Abstract

A field experiment was conducted in the Al-Jadwal Al-Gharbi region of Karbala Governorate, approximately 22 km from the governorate's center, to examine the effects of planting dates on certain growth and yield parameters of the yellow maize crop. A randomized complete block design (RCBD) was employed, with factorial experiments organized into three replicates and two factors. The initial element comprised planting dates (T1: July 15, T2: July 25, T3: August 4). The second element comprised two genotypes and their resultant hybrids (G2 and G5, and G5×G2). The findings indicated that the hybrid (G5×G2) exhibited superiority, yielding the highest averages for several traits: number of leaves, chlorophyll content, ear length, ear weight, and grain yield (14.00 leaves per plant, 39.80 SPAD, 19.78 cm, 83.0 g, and 9.92 t ha^{-1}, respectively). In terms of planting dates, date (T1) surpassed date (T3) in all features, whereas date (T3) yielded the lowest averages. The hybrid (G5×G2) exhibited enhanced interaction with treatment (T1) regarding chlorophyll content and ear length. The ear, ear weight, and grain yield are 45.33 SPAD, 23.33 cm, and 224.3 g, respectively, yielding 12.26 tons per hectare.

Introduction

Yellow corn (Zea mays L.) is a significant grain crop in numerous nations globally, including Iraq. It is the second most widely cultivated crop globally after wheat and ranks first in terms of total production (5). Research conducted by Hashemi and Herbret (7) and AL-Sadoon (4) underscores the significance of establishing the optimal planting date for yellow corn to enhance yield. Alterations in planting dates substantially influence grain production and its constituents. Postponing autumn planting results in financial losses in grain production. Therefore, timely planting enhances yield components, thereby leading to an increase in overall yield. The timing of planting is as crucial as the selection of variety, as identifying the optimal dates for crop growth underpins the methodologies of yellow corn production. This is necessitated by the requirement for optimal temperatures to ensure effective pollination and fertilization (16). Optimal yield can be attained by effectively leveraging the compatibility between genetic composition and the available growth factors in a certain region (17). (3) asserted that identifying the ideal planting date is an essential agricultural activity, observing that fall planting dates differ in their growth characteristics and production. This study seeks to determine the ideal autumn planting date and the most suitable genetic composition of yellow maize for agriculture in central Iraq.

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Materials and Methods

A field experiment was conducted in the Al-Jadwal Al-Gharbi district of Karbala Governorate to investigate the effects of different sowing dates on certain growth and yield parameters of the yellow maize crop. I employed a randomized complete block design (RCBD) including a factorial arrangement with three replicates and two factors. The initial element comprised the sowing dates (T1: July 15, T2: July 25, T3: August 4). The second element comprised two genotypes and their resultant hybrid: G2 (the second line of an Italian variety), G5 (the fifth line of an Italian variety), and G5 × G2 (a single-cross hybrid). Soil preparation involved plowing and harrowing, and the experimental area was segmented into 27 sections, each measuring 9 m² (3 m × 3 m). Seeds were planted in rows with a spacing of 75 cm between plants and 25 cm between plants within each row, yielding a plant density of 53,333 plants per hectare. Phosphate fertilizer was applied at a rate of 54 kg P per hectare in the form of NPK (18-46-0), Potassium fertilizer was applied at a rate of 144 kg, and the initial application was supplied in the form of potassium sulfate (50%) and nitrogen fertilizer (320 kg N) in the form of urea (46%). Fifty percent of the fertilizer was administered at planting, with the subsequent application occurring at the elongation stage (12). Seedlings were thinned to maintain one plant per hill, while weed control was carried out manuall , and the corn stem borer was managed with diazinon 10% granular at a dosage of 6 kg per hectare, applied 20 and 40 days post-germination by grafting onto the apical region of the stem (1). Data were collected at the flowering stage from all plants within the experimental unit by randomly selecting five plants from the two central rows, and the following traits were measured: Characteristics examined in the experiment

1- **Duration from planting to 50% male flowering (days)**

The date of 50% male blooming was documented for the plants in each experimental unit, followed by the calculation of the number of days from planting to the date of 50% male flowering.

2- **Plant Height (cm)**

The height of the plant at full flowering was recorded for five randomly chosen plants per experimental unit, utilizing a measuring tape from the soil surface to the leaf apex. The average was then computed (8).

3- **Stem diameter (millimeters)**

The stem diameter at 100% blooming was measured using a Vernier caliper after the second node on the stem, ensuring the removal of the leaf sheath. The identical plants employed to assess height were utilized for this assessment, and the average was then computed (15).

4- **Number of leaves (plant leaf - 1)**

The total leaf count was obtained from the identical plants utilized for measuring height, followed by the calculation of the average (15).

5- **Chlorophyll concentration (SPAD)**

The chlorophyll content was assessed utilizing a SPAD chlorophyll meter. Measurements were obtained from four leaves per plant, and the mean was computed for five plants (11).

6- **Length of the ear (cm)**

The mean length of five ears, measured from base to tip, was recorded using a graduated measuring ruler for each experimental unit.

7- Ear weight (g)

The average weight of five randomly selected ears was recorded for each experimental unit and subsequently adjusted to a moisture content of 15.5% (15).

8- Grain yield (ton ha⁻ ¹)

was determined by multiplying the average grain yield per plant (g plant) by plant density, adjusting for 15.5% moisture content, and converting the result to tons ha⁻ ¹ (14).

Results and Discussion

1- Number of Days from Planting to 50 %Male Flowering (days)

The results (Table 1) indicate a considerable disparity across the genotypes, planting dates, and their interaction with the duration from planting to 50% tasseling. The G5 genotype exhibited the maximum average duration of 58.56 days, whilst the G2 genotype recorded the lowest average at 53.56 days. This discrepancy may arise from changes in this attribute among the genotypes attributable to their genetic effects. Treatment T1 exhibited the highest average planting date of 58.00 days, whilst treatment T3 recorded the lowest average of 53.56 days. This increase may be ascribed to the extended photoperiod and elevated temperature from planting to 50% male flowering during this period. The interaction revealed that treatment T1 for the G5 genotype had the highest average of 61.33 days, whereas the lowest average was seen for treatment T3 in the G5×G2 hybrid at 50.33 days.

Table (1) Effect of sowing dates and genetic compositions on the trait of 50 %male flowering (day).

sowing dates	varities			
	G2	G5	G5×G2	
T_1	55.00	61.33	57.67	58.00
T_2	53.67	56.00	55.00	54.89
T_3	52.00	58.33	50.33	53.56
LSD 0.05 TO interaction		2.98		
The average	53.56	58.56	54.33	LSD 0.05 To sowing dates
LSD 0.05 To varities		1.72		1.72

2- Plant Height (cm)

The results (Table 2) indicate substantial variability across genotypes, planting dates, and their interaction regarding plant height. Genotype G2 exhibited the highest average plant height of 167.2 cm, whilst genotype G5 displayed the lowest at 136.2 cm. This difference may be attributed to variations in plant height among genotypes based on their genetic makeup. These consist with (10). Treatment T1 yielded the highest average plant height of 170.3 cm, whilst treatment T3 produced the lowest at 138.7 cm. The

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augmented plant height may result from an extended photoperiod and elevated temperatures from planting to 50% flowering. These findings align with (9). The T1 therapy for the G2 genotype exhibited superiority, achieving a maximum rate of 201.7 cm, whereas the T3 treatment for the G2 genotype yielded the minimum rate of 120.7 cm.

Table (2) shows the effect of sowing dates and genotypes on plant height (cm).

sowing dates	varities G2	G5	G5×G2	The average
T_1	201.7	140.0	169.3	170.3
T_2	179.3	136.3	143.7	153.1
T_3	120.7	132.3	163.0	138.7
LSD 0.05 TO interaction		13.7		
The average	167.2	136.2	158.7	LSD 0.05 To sowing dates
LSD 0.05 To varities		7.9		7.9

3- Stem Diameter (mm)

The results (Table 3) indicated substantial differences across genotypes, planting dates, and their interaction for stem diameter. Genotype G2 exhibited the highest mean stem diameter (2.19 mm), whereas genotype G5 recorded the lowest mean value (1.86 mm). This may result from changes in this attribute among the genotypes according to their genetic composition. Treatment T1 had the maximum average stem diameter of 2.23 mm, whereas treatment T3 recorded the lowest at 1.81 mm. The augmentation in stem diameter may be ascribed to the advantageous climatic conditions during this period conducive to vegetative development, including stem diameter. (3) and (2) shown that stem diameter is influenced by planting dates. The interaction indicated that treatment T1 for genotype G2 was superior. achieving the maximum rate of 2.63 mm, while treatment T3 for the G2 genotype exhibited the lowest rate of 1.53 mm.

Table (3) Effect of sowing dates and genotypes on stem diameter (mm).

sowing dates	varities G2	G5	G5×G2	The average
T_1	2.63	1.97	2.10	2.23
T_2	2.40	1.87	2.03	2.10
T_3	1.53	1.73	2.17	1.81
LSD 0.05 TO interaction		0.41		
The average	2.19	1.86	2.10	LSD 0.05 To sowing dates
LSD 0.05 To varities		0.23		0.23

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4- Number of leaves (plant leaf - 1)

The results (Table 4) indicated substantial variations between the genotypes and fertilization treatments; however, there was no significant interaction effect on the number of leaves characteristic. The G5×G2 hybrid had the greatest average, attaining 14.00 leaves per plant, whereas the G5 genotype recorded the lowest average at 11.56 leaves per plant. This may result from the variation in this attribute among the genotypes based on their genetic composition. Treatment T1 exhibited the highest average leaves numbers, totaling 13.78 leaves per plant, whilst treatment T3 recorded the lowest number of leaves 11.44 leaves per plant. The rise in leaf quantity may be ascribed to the favorable environmental circumstances on this date for vegetative development, including the proliferation of leaves. These consist with (6).

Table (4) Effect of sowing dates and genotypes on the number of leaves trait (leaf per plant).

sowing dates	varities			The average
	G2	G5	G5×G2	
T_1	13.33	12.33	15.67	13.78
T_2	12.33	11.67	14.67	12.89
T_3	12.00	10.67	11.67	11.44
LSD 0.05 TO interaction		Ns		
The average	12.56	11.56	14.00	LSD 0.05 To sowing dates
LSD 0.05 To varities		0.95		0.95

5- Chlorophyll content (SPAD)

The results (Table 5) indicated substantial heterogeneity across genotypes, planting dates, and their interaction for the chlorophyll content attribute. The G5×G2 hybrid exhibited the maximum chlorophyll content at 39.80 SPAD, whereas the G5 genotype recorded the lowest at 36.27 SPAD. This may result from the variation in this attribute among the genotypes based on their genetic composition. Treatment T1 exhibited the maximum chlorophyll content at 39.68 SPAD, whilst treatment T3 recorded the lowest at 36.14 SPAD (6) assert that leaf quantity fluctuates with planting dates, and since chlorophyll is a crucial leaf component, its levels also vary with planting dates due to differences in light exposure duration and intensity, which are contingent upon the planting date. The T1 therapy for the G5×G2 hybrid exhibited superior interaction, achieving the greatest SPAD value of 42.16, while the T3 treatment for the G5 genotype resulted in the lowest SPAD value of 35.55.

Table (5) shows the effect of sowing dates and genotypes on the chlorophyll content (SPAD) trait.

sowing dates	varities G2	G5	G5×G2	The average
T_1	39.77	37.11	42.16	39.68
T_2	37.18	36.14	40.91	38.07
T_3	36.54	35.55	36.34	36.14
LSD 0.05 TO interaction		1.71		
The average	37.83	36.27	39.80	LSD 0.05 To sowing dates 0.99
LSD 0.05 To varities		0.99		

6- **Ear length (cm)**

The results (Table 6) indicated substantial differences among the genotypes, planting dates, and their interaction for the ear length (cm) characteristic. The G5×G2 hybrid exhibited the greatest average length at 19.78 cm, whilst the G5 genotype recorded the lowest average at 15.11 cm. This may result from the variation in this attribute among the genotypes based on their genetic composition. Treatment T1 exhibited the maximum average length of 19.89 cm for planting dates, whilst treatment T3 recorded the lowest average at 14.78 cm. The T1 date's superiority can be ascribed to optimal temperatures, but the unfavorable temperatures during the T2 and T3 dates adversely impacted growth and, subsequently, ear length, as evidenced by the findings of (9). The T1 treatment for the G5×G2 hybrid exhibited superiority, achieving a maximum measurement of 23.33 cm, whereas the minimum measurement occurred with the T3 treatment for the G5 genotype, at 13.67 cm.

Table (6) Effect of sowing dates and genotypes on ear length (cm).

sowing dates	varities G2	G5	G5×G2	The average
T_1	20.00	16.33	23.33	19.89
T_2	16.67	15.33	21.00	17.67
T_3	15.33	13.67	15.33	14.78
LSD 0.05 TO interaction		2.16		
The average	17.33	15.11	19.78	LSD 0.05 To sowing dates 1.51
LSD 0.05 To varities		1.51		

7- **Ear weight (g)**

The results (Table 7) indicate substantial differences across genotypes, planting dates, and their interaction with ear weight (g). The G5×G2 hybrid produced the highest average weight (183.0 g), but the G5 genotype exhibited the lowest average weight (127.9 g). This disparity may be ascribed to differences in this property among the

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genotypes due to their genetic composition. Treatment T1 produced the highest average weight at 183.6 g, whereas treatment T3 resulted in the lowest average weight of 124.9 g. This augmentation may be attributed to the enhanced ear length arising from this planting date (Table 6). The interaction revealed that treatment T1 for the G5×G2 hybrid produced the highest average weight (224.3 g), whereas treatment T3 for the G5 genotype resulted in the lowest average weight (102.3 g).

Table(7): Effect of sowing dates and Genotypes on Ear Weight (g)

sowing dates	varities G2	G5	G5×G2	The average
T_1	184.0	142.3	224.3	183.6
T_2	153.0	139.0	195.7	162.6
T_3	143.3	102.3	129.0	124.9
LSD 0.05 TO interaction		31.4		
The average	160.1	127.9	183.0	LSD 0.05 To sowing dates
LSD 0.05 To varities		18.2		18.2

8- **Grain yield (ton ha-1)**

The results (Table 8) indicated substantial differences across the genetic combinations, planting dates, and their interaction with the grain yield attribute (ton ha-1). The G5×G2 hybrid exhibited the maximum yield at 9.92 tons per hectare, whereas the G5 genotype recorded the lowest yield at 6.40 tons per hectare. The cause may be attributed to a substantial enhancement in yield components: ear length (Table 6) and ear weight (Table 7). Treatment T1 produced the highest production at 9.71 tons ha^{-1}, whilst the control treatment T3 recorded the lowest yield at 6.20 tons ha^{-1}. This rise may be ascribed to the appropriateness of temperature and humidity conditions during the blossoming and ripening phases, which are directly correlated with fertilization rates. Furthermore, this date exhibited enhanced performance in yield components, including ear length (Table 6) and ear weight (Table 7), in comparison to the other two dates, resulting in an elevated grain yield. This corresponds with the conclusions of (13), who demonstrated that postponing the planting date results in a reduction in grain yield. The T1 treatment for the G5×G2 hybrid produced the highest crossover yield at 12.26 tons ha^{-1}, whereas the lowest yield was observed in the T3 treatment for the G5 genotype at 5.52 tons ha^{-1}.

Table (8) shows the effect of sowing dates and genotypes on grain yield (ton ha^{-1}).

Planting dates	varities G2	G5	G5×G2	The average
T_1	9.65	7.22	12.26	9.71
T_2	7.14	6.46	11.03	8.21
T_3	6.64	5.52	6.46	6.20
LSD 0.05 TO interaction		1.53		
The average	7.81	6.40	9.92	LSD 0.05 To sowing dates
LSD 0.05 To varities		0.89		0.89

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Conclusions

This study concludes that the hybrid (G5×G2) excels in attaining the greatest rates across most features. We conclude that the planting date significantly influences all features, with July 15 being the optimal day for growing yellow corn. Consequently, we advise planting the hybrid (G5×G2) on the date of 15/7 to achieve optimal vegetative growth and maximize output.

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