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EVALUATION OF THE PERFORMANCE OF DOUBLE CROSSES OF MAIZE UNDER PLANTING DATES SUITABLE FOR THE FALL SEASON IN THE MIDDLE REGION (YIELD COMPONENTS)

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ABSTRACT

In order to evaluate the performance of double-cross maize hybrids in planting dates suitable for fall growing season in the middle region of Iraq, a field experiment was conducted at the fields of the College of Agricultural Engineering Sciences - University of Baghdad - Jadriya for the fall season of 2022 using double-cross maize hybrids selected from fifteen double cross hybrid maize resulted from crossing ten single hybrids resulting from crossing five inbred lines using the half-diallel method. These included Hybrid 1 = (1×4)(3×5) from the crossing of (ZM49W3E x CDCNS) (ZM43WIZE x ZM19), Hybrid 2 = (1×2)(3×5) from the crossing of (ZM49W3E × CDCN5) (ZM43WIZE x ZM60), Hybrid 3 = (1×5)(2×4) from the crossing of (ZM60 × ZM19) (ZM43WIZE ×CDN5), Hybrid 4 = (1×2)(4×5) from the crossing of (ZM19 × CDCN5) (ZM43WIZE ×ZM60), and Hybrid 5 = (1×4)(2×3) from the crossing of (ZM60 × ZM49W3E) (ZM43WIZE × ZM19), and their comparison with the synthetic variety IPA5018, and testing them under three planting dates: July 1st, July 15th, and August 1st.

The experiment used a randomized complete block design with four replications arranged in a split-plot design. The main plots included the three planting dates, while the subplots included the five double-cross maize hybrids and the control variety. Yield and yield components were studied. The results of the experiment showed high significant effects for the third planting date for all traits except for the number of ears per plant, where the third planting date was superior in the number of grains per ears 660.4, weight of 100 grains 37.83 g , days to physiological maturity 99.67 days, crop growth rate 5.644 g plant^{-1} day^{-1}, and yield per unit area 14.95 ton ha^{-1}. The superiority of the hybrid (1×2)(3×5) in the number of grains ear^{-1} and the weight of 100 grains was 542.3 and 36.37, respectively., and this was reflected on the yield per unit area, which reached 11.69 ton ha^{-1}, while hybrid (1×2) (3×5) outperformed in number of ears per plant 1.400 and the same hybrid was the earliest to reach physiological maturity at 97.50 days. The response of the double-cross maize hybrids varied with different planting dates and gave significant interaction for all studied traits except for the number of ears per plant.

Keywords: Single cross, Double cross hybrids, planting dates, yield, yield components.

[*] **The research is taken from a master's thesis by the first researcher.**

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تقييم اداء هجن زوجية من الذرة الصفراء تحت مواعيد زراعة تلائم العروة الخريفية في المنطقة الوسطى (مكونات الحاصل)

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الخلاصة

بهدف تقييم اداء هجن زوجية في مواعيد زراعة تلائم العروة الخريفية في المنطقة الوسطى من العراق، اجريت تجربة حقلية في حقول كلية علوم الهندسة الزراعية، جامعة بغداد، الجادرية للموسم الخريفي 2022 باستخدام هجن زوجية من الذرة الصفراء متفوقة اختيرت من خمسة عشر هجين زوجي من الذرة الصفراء تم الحصول عليها من تضريب عشرة هجن فردية ناتجة من تضريب خمس سلالات نقية بطريقة التضريب التبادلي النصفي وهي هجين 1 (ZM43WIZE × ZM19)(ZM49W3E × CDCNS) من تضريب (1×4)(3×5)=(1×2)(3×5) = هجين 2، (ZM43WIZE× ZM60)(ZM49W3E×CDCN5) من تضريب (1×5)(2×4)=3 هجين، (ZM43WIZE×CDN5) (ZM60× ZM19) من تضريب (1×2)(4×5)=4 هجين، (ZM43WIZE×ZM60) (60×ZM49W3E) من تضريب (1×4)(2×3)=5هجين، (ZM43WIZE× ZM19) (ZM19 × CDCN5) ومقارنتها مع الصنف التركيبي اباء5012 واختبارها تحت ثلاثة مواعيد زراعة هي 1تموز و15 تموز و1 اب، استخدم تصميم القطاعات الكاملة المعشاة RCBD بأربع مكررات بترتيب الالواح المنشقة، تضمنت الالواح الرئيسية مواعيد الزراعة الثلاث والالواح الثانوية خمسة هجن زوجية مع صنف المقارنة، تمت دراسة صفات الحاصل ومكوناته اظهرت نتائج التجربة تأثيرات عالية المعنوية للموعد الثالث لجميع الصفات ماعدا صفة عدد العرانيص اذ تفوق الموعد الثالث في صفة عدد حبوب العرنوص (660.4) وبوزن 100 حبة (37.83غم)وعدد الايام للنضج الفسلجي (99.67 يوم) ومعدل نمو المحصول (5.644 غم نبات يوم $^{-1}$) وحاصل وحدة المساحة (14.95 طن هـ$^{-1}$). تفوق الهجين (5×3)(4×1) في صفة عدد حبوب العرنوص ووزن 100 حبة بلغ 542.3 و36.37 بالتتابع وانعكس على حاصل وحدة المساحة اذ بلغ 11.69 طن هكتار$^{-1}$ فيما تفوق الهجين (5×3)(2×1) في صفة عدد العرانيص واعطى (1.400) وابكر الهجين ذاته بوصوله الى النضج الفسلجي بعدد ايام (97.50 يوم). اختلفت استجابة الهجن الزوجية باختلاف مواعيد الزراعة واعطت تداخلا معنويا لجميع الصفات قيد الدراسة باستثناء عدد العرانيص.

الكلمات المفتاحية: هجين فردي، هجن زوجية، مواعيد الزراعة، الحاصل، الحاصل ومكوناته.

INTRODUCTION

The cultivation of maize has spread widely throughout the world due to cross pollinated nature and adaptability to different environments, with each environment having its suitable hybrids and varieties. The objectives of plant breeders can be broadly defined into three main areas: eliminating defects from the crop, increasing yield, or breeding for a specific purpose **(Sedgley, 1991).**

The dry weight of the plant and the grain yield decrease with the influence of the planting date, and this is a result of a high decrease in temperature and radiation during the grain filling period **(Andrade *et al.*, 1995).** One of the most important aims of breeders is to increase crop productivity, which can be achieved by increasing the planted area, the production rate, or both, and is related to several factors, including environmental factors, of which determining the appropriate planting date is one of the most important. The behavior of the crop differs depending on the planting date, with a crop producing well in certain environmental conditions and not producing well in others. Each genotype has a suitable planting date, and early and late planting leads to a decrease in yield due to unsuitable climatic conditions during the growth season caused by environmental changes such as sunlight and temperature. Changes in planting dates can also affect the growth and yield of maize **(Nielsen *et al.*, 2002; Al-Mashhadani, 2015; ;Kazem 2020).**

The expansion of the cultivation of maize at different planting dates is one of the important amis in developing this crop as one of the important tasks for increasing the total production. The highest yield can be obtained when there is a suitable compatibility between

the genotypes and growth factors in that region, which occurs when these factors are optimally utilized **(Wuhaib, 2012).** The planting dates for maize vary with the climatic conditions and geographical situations, which are determinants for selecting the variety or relative maturity of the hybrid by maize producers. Late spring rains or early fall rains may harm maize production in terms of grain quantity and quality. Early planting works to improve the quality of maize grains, as plants reach the physiological maturity stage before a decrease in temperature or rain occurs **(Djamam *et al.*, 2020). Shrestha *et al.* (2018)** indicated that in late planting, the low temperature prolongs the physiological maturity period of the silk stage. In their study, **Regab & Jassim (2016)** found that four planting dates (July 10, July 20, July 30, and August 10) affected six hybrids of maize (Ronahdo, ZP 314, ZP434, DKC5401, ZP606, and R1001Shahd). The R1001Shahd hybrid and the DKC5401 hybrid gave the highest rate for the number of rows per ear (13.88 and 13.75 row ear^{-1}, respectively, while the Ronaldo hybrid gave the lowest rate of 9.64 row ear^{-1}. His study showed a significant effect of planting dates on the number of rows per ear where the fourth date, August 10, gave the highest mean of 12.86 rows ear^{-1}, while the first date, July 10/7, gave the lowest mean of 12.11 rows ear^{-1}. For the trait of number of grains per row, the hybrid ZP434 gave the highest mean of 28.84 grains row^{-1}, and did not differ significantly from the hybrids ZP314 and ZP606, while the hybrid Ronaldo gave the lowest mean of 19.37 grains row^{-1}, and no significant effect of planting dates was found. In their study about five maize hybrids for different planting dates, **Ramadhan & Kazem (2013)** found significant effects of planting dates on these traits. Plants planted on July 25 achieved the highest mean of number of rows ear^{-1} at 16.98 rows and number of grains at 630.58 grains ear^{-1} for the autumn season, while the August 10 date recorded the lowest mean at 576.68 grains ear^{-1}. On the other hand, the first date, March 1, for the spring season, outperformed in the trait of number of grains per ear at 611.50 grains ear^{-1} , Results from **(Abed Al-Amir , 2018)** study showed a significant effect of grain yield, where the hybrid (4×5) (2×3) outperformed and gave the highest yield at 185.8 grams, and did not differ significantly from the hybrids(1×3) (4×5), (1×2) (3×5), and (1×4) (2×5), which gave yields of 182.3, 177.3, and 170.8 grams, respectively, while the hybrid (1×4) (3×5) gave the lowest yield at 122.0 grams. **(AL-Badri ,2019)** mentioned significant differences among planting dates, and the third date, August 4, gave the highest mean of individual plant yield at 109.92 grams and total yield at 7.374 tons ha^{-1}. **(Kazem ,2020)** found significant differences in plant yield and planting dates at two locations in Diyala and Baghdad for three planting dates:1st July ,15 th July , and 1stAugust. In the Baghdad location, the latest date, August 1, gave the highest mean plant yield at 213.7 grams and the first date, July 1, gave the lowest mean at 107.1 grams plant^{-1}. In the Diyala location, the second date gave the highest mean yield at 182.3 grams plant^{-1}, while the first date gave the lowest mean at 158.0 grams plant^{-1}.

MATERIALS AND METHODS

A field experiment was conducted in the fields of the College of Agricultural Engineering Sciences - University of Baghdad, in the Department of Field Crops during the fall season of 2022 to evaluate five double cross hybrids of maize that were selected from fifteen double cross maize hybrids obtained from crossing ten individual hybrids resulting from crossing five inbred lines using the half-diallel crossing method. The selected hybrids were Hybrid 1=(1×4)(3×5) resulting from the crossing of (ZM49W3E × CDCNS)(ZM43WIZE × ZM19), Hybrid 2=(1×2) (3×5) resulting from the crossing of (ZM49W3E×CDCN5) (ZM43WIZE×ZM60), Hybrid 3=(1×5)(2×4) resulting from the crossing of (ZM60×ZM19) (ZM43WIZE×CDN5), Hybrid 4=(1×2)(4×5) resulting from the crossing of (ZM19 ×CDCN5)

(ZM43WIZE×ZM60), and Hybrid 5=(1×4)(2×3) resulting from the crossing of (ZM60 × ZM49W3E)(ZM43WIZE × ZM19). The evaluation was conducted by comparing them with the synthetic variety IPA5018 and testing them under three planting dates (July 1st, July 15th, and August 1st).

The land was prepared for cultivation and the experimental site was prepared by perpendicular plowing, leveling, and Disking or Harrowing according to recommendations. The land was divided into plots of (3×3) m^2 with a distance of 75 cm between rows and 25 cm between plants. The soil was fertilized with 200 kg P_2O_5 ha^{-1} of triple superphosphate (46% $P_2O_5$5) in a single application before planting, and 350 kg N ha^{-1} of urea (46% N) was applied in three applications: the first two weeks after germination, the second when the plants reached a height of 30 cm, and the third after flowering. Manual weeding was carried out several times during the season as needed, and the field was irrigated as needed. Seeds were planted at a rate of 2-3 seeds per hole, and the number of plants was thinned to one. The experimental site was divided into four replicates according to the randomized complete block design (RCBD) with split plots arrangement, where planting dates allocated to the main plots and the double crossed hybrids and synthetic variety as sub-plots, with four replications. Five middle plants were randomly selected from each experimental unit, excluding the edge plants, and the following traits were measured:

1. Number of grains per ear: calculated by multiplying the number of rows per ear by the number of grains per row.
2. Number of ears per plant: measured as the mean number of ears for five plants per experimental unit.
3. Weight of 100 grains (g): calculated by weighing 100 randomly selected grains after moisture adjustment (15.5%) according to (**Elsahookie, 1990).**
4. Days to physiological maturity: calculated from planting to 95% of the plots reaching physiological maturity (indicated by hand pressure on the grains without denting or the appearance of a black layer) according to **(Elsahookie, 2009).**
5. Crop growth rate (g $plant^{-1}$ day^{-1}): calculated by dividing the dry weight by the number of days to physiological maturity according to **(Elsahookie, 2009).**
6. Total grain yield (ton ha^{-1}): calculated by multiplying the mean grain yield per plant by the number of plants per hectare and converting it to ton ha^{-1} according to **(Elsahookie,2009).**

RESULTS AND DISCUSSION

Number of kernels per ear

The plants at the third planting date (1st August) showed the highest mean number of grains per ear (660.4 grains ear^{-1}) with an increase of 100% and 48.5% compared to the first and second planting dates (1st July and 15th July), respectively, which gave 330.2 and 444.8 kernels ear^{-1}, respectively (Table 1). The reason for the superiority of the third planting date is attributed to the superiority in the number of grains $rows^{-1}$ and grains rows per ear. This result is consistent with the findings of (**Ibrahim & Abed, 2015 ; AL-Mashhadani, 2015 ; Hadi *etal*., 2019 ; Kazem, 2020 ; Hadi and Hassan 2021 ; Hisham 2021).** The results also showed a significant difference among the double cross hybrids in the number of kernels ear^{-1}, where the hybrid (3×5) (1×4) showed the highest mean of 542.3 grains ear^{-1}, while the hybrid(1×2) (3×5) gave the lowest mean of 441.4 grains ear^{-1}, a decrease of 18.6%, 6.2%, 4.7%, 8.2%, and 6.4% compared to the hybrids(1×4) (3×5), (2×4) (1×5), (1×2) (4×5), (1×4) (2×3), and the synthetic variety IPA5018, respectively. The superiority of the hybrid (1 × 2) (3 × 5) is

attributed to its superiority in the length of the ear, the number of rows ear^{-1}, and the number of grains row^{-1}.

The (table, 1) shows significant interaction between the double cross hybrids and planting dates. We notice an increasing trend in the number of kernels per ear from the first planting date (1st July) to the third (1st August) for all hybrids except the hybrid(1×4) (2×3), which showed a decrease of 5.3 grains ear^{-1}. The hybrid (1×4) (3×5) showed the highest mean of 755.6 grains ear^{-1} on the first planting date, An increase of 46.33% for the second date over the first and 45.98% for the second date over the third. The hybrid (1×2) (3×5) had the lowest response of 275.1 grains ear^{-1} on the first planting date (1st July).

Table (1): The effect of sowing dates on the number of grains ear^{-1} of double crosses of maize in the fall season 2022.

Hybrids	Sowing dates			Mean
	1st July	15 th July	1st August	
(1×4)(3×5)	353.7	517.6	755.6	542.3
(1×2)(3×5)	275.1	404.7	644.5	441.4
(1×5) (2×4)	291.1	426.5	694.7	470.8
(1×2)(4×5)	279.2	458.9	652.0	463.4
(1×4)(2×3)	395.3	390.0	657.8	481.0
IPA5018	387.0	470.9	557.6	471.9
LSD $_{0.05}$	101.10			58.37
Mean	330.2	444.8	660.4	
LSD $_{0.05}$	52.06			

Number of ears per plant

This trait is one of the components of yield, and the origin of the ear is present archaeologically under each leaf axil in most genotypes of maize. Under conditions of abundant growth factors and low plant density, many plants give two or more ears **(Elsahookie, 2009)**. (Table, 2) shows no significant differences between planting dates in number of ears per plant, and these results are consistent with (**Al-kaisy, 2015**) who reported no significant differences between planting dates, but disagreed with (**Aziz & Mohammed, 2012; Al-Mashhadani, 2015 Ibrahim and Abed, 2015; Regab & Jassim, 2016; Hassan and *etal.* (2018)**; **Hashim, 2021**). The data in (table, (2) showed significant differences between the double cross hybrid in the number of ears plant^{-1}, where the hybrid (1×2) (2×4) excelled with the highest mean of 1.400 ears plant^{-1}and did not differ significantly from the hybrid (1×4) (2×3), which gave an mean of 1.283 ears plant^{-1}, while the hybrid (1×5) (2 ×4) gave the lowest mean of 1.083 ears plant^{-1}. This hybrid decreased by 4.4% compared to the hybrid (1×4)(3×5), by 22.6% compared to the hybrid (1×2) (3×5), by 11.01% compared to the hybrid (1×2) (4×5), by 15.5% compared to the hybrid (1×4) (2×3), and by 7.19% compared to the control synthetic variety, IPA5018. This result is consistent with what was found by **(Aziz & Mohammed, 2012; Al-kaisy, 2015 ; Al-Mashhadani, 2015; Regab & Jassim, 2016; Kazem, 2020).** The same table also shows no interaction between planting dates and double cross hybrids in the trait of number of ears plant^{-1}.

Table (2): The effect of sowing dates on the number of ear plant^{-1} of double crosses of maize in the fall season 2022.

Hybrids	Sowing dates			Mean
	1st July	15th July	1st August	
(1×4)(3×5)	1.150	1.050	1.200	1.133
(1×2)(3×5)	1.350	1.400	1.450	1.400
(1×5) (2×4)	1.050	1.150	1.050	1.083
(1×2)(4×5)	1.150	1.250	1.250	1.217
(1×4)(2×3)	1.300	1.200	1.350	1.283
IPA5018	1.200	1.150	1.150	1.167
LSD 0.05	N.S			0.0897
Mean	1.200	1.200	1.242	
LSD 0.05	N. S			

Weight of 100 grains (gm)

The grain weight is one of the important yield components in maize, as the weight of the grain expresses the speed of its growth, which is genetically related to the variety, as well as its environmental influence, and depends on the amount of nutrients provided by the source **(Bektash and Jlou, 2005).** (Table, 3) shows that the third date (1st August) had the highest mean weight of 100 grains of 37.83 gm, with an increase of 40.00% compared to the first date (1st July), and an increase of 14.98% compared to the second date (15th July). The superiority of the third date is attributed to the delay in the planting dates for the fall harvest causes a prolongation of the filling capacity, elongation of the leaves, and its effectiveness in carbon metabolism and the transfer of its products to grain., due to the low temperatures. Whereas, for the early planting dates, they lead to an increase in the speed of transport processes in a short period, which accelerates the aging of the leaves, and reduces the production and transfer of dry matter due to the high temperatures during seed formation and filling. These results are consistent with those of (**Wuhaib, 2012a; Al-kaisy, 2015; Regab & Jassim, 2016; Kazem 2020; Hashim, 2021; khalaf & Hassan, 2022)** in favor of the third date for this trait.

The double cross hybrids differed significantly in the weight of 100 gm. The hybrid (1×4) (3×5) had the highest mean weight of 36.37 grams, with an increase of 13.09% compared to the hybrid (1×2) (3×5), an increase of 16.87% compared to (1×5) (2×4), an increase of 18.7% compared to (1x2) (4×5), and an increase of 18.8% compared to (1×4) (2×3), and an increase of 6.18% compared to the control synthetic variety IPA5018 (Table 3). There was a variation in the response of double cross hybrids to changes in planting dates, resulting in a significant interaction effect. The weight of 100 grains increased significantly with the third date (1st August) compared to the first date (1st July) and the second date (15th July). The hybrid (1x4) (3x5) had the highest mean weight of 43.49 grams on the third date (1st August), compared to the other double cross hybrids, with an increase of 37.97% for the second date (15th July) compared to the first date (1st t July), and an increase of 14.32% for the third date (1st August) compared to the second date (15th July). The hybrid (1×2) (4×5) had the lowest response, with a weight of 23.35 grams on the first date (1st July).

Table (3): The effect of sowing dates on weight of 100 grain (gm) of double crosses of maize in the fall season 2022.

Hybrids	Sowing dates			Mean
	1st July	15 th July	1st August	
(1×4)(3×5)	27.57	38.04	43.49	36.37
(1×2)(3×5)	24.79	35.36	36.32	32.16
(1×5) (2×4)	28.29	29.01	36.05	31.12
(1×2)(4×5)	23.35	30.11	38.45	30.64
(1×4)(2×3)	26.38	29.04	36.34	30.59
IPA5018	30.61	35.82	36.31	34.25
LSD 0.05		3.217		1.857
Mean	26.83	32.90	37.83	
LSD 0.05		1.105		

Days to physiological maturity

The earliest date, 1st August, showed the earliest physiological maturity, taking 99.67 days, with a difference of 1.16 days compared to the second date, 15th July, and 4.16 days compared to the first date, 1st July, which took 100.83 and 103.83 days, respectively (Table 4). The reason for the early maturity at the third date, 1 st August, was due to earlier tasseling and silking, resulting in earlier physiological maturity before the other dates. Similarly, the hybrid (1×2) (3×5)reached physiological maturity earliest, taking 97.50 days, while the other hybrids were delayed, taking 102.00, 102.17, 103.00, and 100.00 days, respectively. While, the synthetic control variety IPA5018 took the longest time to reach physiological maturity (104.00 days), because the hybrid was also earlier in tasseling and silking(Table 4). The results of the same table showed significant differences in the interaction between the sowing dates and the double cross hybrids in this trait, with the interaction resulting in a decrease in the number of days to reach physiological maturity by delaying the planting dates. The hybrid (1×2) (3×5) had the best response, taking 96.00 days for both 15 July and 1 August, while the hybrid (1×2) (4×5) was delayed in physiological maturity, taking 107.00 days on 1 July.

Table (4): The effect of sowing dates on days to physiological maturity of double crosses of maize in the fall season 2022.

Hybrids	Sowing dates			Mean
	1st July	15 th July	1st August	
(1×4)(3×5)	104.50	102.50	99.00	102.00
(1×2)(3×5)	100.50	96.00	96.00	97.50
(1×5) (2×4)	103.50	103.00	100.00	102.17
(1×2)(4×5)	107.00	100.50	101.50	103.00
(1×4)(2×3)	102.50	99.50	98.00	100.00
IPA5018	105.00	103.50	103.50	104.00
LSD 0.05		2.130		1.230
Mean	103.83	100.83	99.67	
LSD 0.05		0.384		

Crop growth rate (g plant^{-1} day^{-1}):

One of the most important traits that plant breeders are interested in improving is yield per unit area, and that the growth rate is related to the supply of metabolites that are related to the process of carbon metabolism **(Elsahookie, 2009).** The crop growth rate is the result of dividing the total dry matter by the number of days of physiological maturity. Results indicate significant differences among the planting dates (Table 5), where plants in the third planting date gave the highest rate of 5.644 g plant^{-1} day^{-1}, with an increase of 19.90% compared to the plants in the first planting date (1st July) and 43.17% compared to the plants in the second planting date (15th July) (Table 5). This is due to the superiority of the third planting date in terms of dry weight and its earlier physiological maturity (Table 4). The double cross hybrids showed significant differences in their growth rates. Hybrid (1×5) (2×4) gave the highest rate of 5.066 g plant^{-1} day^{-1}, and it did not differ significantly from the hybrid (1 × 4) (3 × 5) and the hybrid (1× 4) (2 × 3) as it gave 5.019 and 5.052 gm plant^{-1} day^{-1}. The same hybrid had an increase of 19.56% compared to hybrid (1×2) (3×5), which gave the lowest rate of 4.237 gm plant^{-1} day^{-1}. The differences in growth rates are due to the variation between the genotypes, which is consistent with the results of (**Wuhaib, 2012b; Abed-Al-Amir, 2018; Al-Mowsawi, 2019; Kazem, 2020; Hashim, 2021**). The interaction between the study factors was significant, as shown in Table 5. Most hybrids responded significantly to changing planting dates, while some hybrids showed responses in the opposite direction with delayed planting dates. The interaction was towards increasing the growth rate, which increased in the first and third planting dates compared to the second planting date, where growth rates decreased except for hybrids (1×4) (3×5), which increased in the second planting date and continued to increase in the third planting date, giving hybrid (1×2) (4×5) the highest growth rate of 6.465 gm plant^{-1} day^{-1} in the third planting date, while hybrid (1×2) (3×5) gave the lowest growth rate of 2.926 gm plant^{-1} day^{-1} in the second planting date (15th July).

Table (5): The effect of sowing dates on crop growth rate (gm plant^{-1} day^{-1}) of double crosses of maize in the fall season 2022

Hybrids	Sowing dates			Mean
	1st July	15 th July	1st August	
(1×4)(3×5)	4.448	4.694	5.715	5.019
(1×2)(3×5)	4.132	2.926	5.654	4.237
(1×5) (2×4)	6.281	3.460	5.298	5.066
(1×2)(4×5)	4.224	3.720	6.465	4.784
(1×4)(2×3)	4.702	4.765	5.605	5.052
IPA5018	4.455	3.774	5.126	4.451
LSD $_{0.05}$		0.422		0.244
Mean	4.707	3.942	5.644	
LSD $_{0.05}$		0.260		

Total grain yield in unit area (ton ha^{-1})

The results show that the third planting date (1stAugust) outperformed the other two planting dates (Table, 6), with the highest mean yield per unit area of 14.95 tons ha^{-1}, which was significantly different from the first and second planting dates with an increase of 178.92% and 74.04% respectively. The reason for the superiority of the third planting date can be attributed to the superiority of the individual plant yield, which is consistent with the findings of (**AL-Mashhadani, 2010; Aziz & Mohammed, 2012; AL-Mashhadani, 2015; Al-kaisy, 2015; Wuhaib *et al.*, 2016; Regab & Jassim, 2016).** The double cross hybrids showed

significant differences, where hybrid (1×4) (3×5) outperformed the others with the highest rate of 11.69 tons ha^{-1}, with no significant differences from hybrid (1×2) (3×5) and IPA5018 with the yields of 10.18- and 9.60-tons ha^{-1} respectively, and hybrid (1×5) (2×4) gave the lowest rate of 8.14 tons ha^{-1}. The reason for the superiority of hybrid(1×4) (3×5) is its genetic nature and its different response to environmental conditions, as well as the high mean of many studied traits such as, number of grains per ear and crop growth rate (Table 1-6), which resulted in an increase in the individual plant yield and yield per unit area. These results are consistent with the findings of **(Aziz & Mohammed, 2012; Al-kaisy, 2015; AL-Mashhadani, 2015; Regab & Jassim, 2016).** The response of the double cross hybrids varied with different planting dates, resulting in significant interactions (Table, 6), and the interaction was towards increasing the trait rate for all hybrids as we moved towards the third planting date, where hybrid (1×4) (3×5) outperformed the others, with a yield of 19.08 tons ha^{-1}, with an increase percentage of 83.99% for the third planting date compared to the second and 84.19% for the second planting date compared to the first. while, hybrid (1×2) (4×5) gave the lowest rate of 3.92 tons ha^{-1} in the first planting date (1st July).

Table (6): The effect of sowing dates on total grain yield in unit area (ton ha^{-1}) of double crosses of maize in the fall season 2022.

Hybrids	Sowing dates			Mean
	1st July	15th July	1st August	
(1×4)(3×5)	5.63	10.37	19.08	11.69
(1×2)(3×5)	4.19	9.88	16.45	10.18
(1×5) (2×4)	4.49	7.31	12.63	8.14
(1×2)(4×5)	3.92	7.30	16.23	9.15
(1×4)(2×3)	6.89	6.78	13.48	9.05
IPA5018	7.06	9.90	11.84	9.60
LSD $_{0.05}$	3.628			2.095
Mean	5.36	8.59	14.95	
LSD $_{0.05}$	1.416			

CONCLUSION

We conclude from the research that the third sowing date , 1st August , was the best among the sowing dates by giving it the highest yield and its components from the 1stJuly and 15th July. The double crosses **(1×4)(3×5)** were distinguished by their superiority over the comparative variety, IPA5018 and did not differ significantly from double hybrid (1×2)(3×5) which confirm the superiority of the single hybrid (3×5) which was one of the parents of these two hybrids.

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