ESTIMATION OF SOME GENETIC PARAMETERS OF THREE-WAY CROSSES OF MAIZE UNDER DIFFERENT SOWING DATES

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ABSTRACT

With aim of estimation of some genetic parameters of three-way crosses of maize and testing them under different sowing dates. A field experiment was carried out at Station A in the Department of Field Crops - College of Agricultural Engineering Sciences - University of Baghdad / Al-Jadriyah, for the fall season 2022.The experiment was carried out in a split-plot arrangement according to a randomized complete block design (RCBD) with three replications.The sowing dates (15July, 25July, 5 August) allocated to the main plot, while the six superiorthree-way cross hybrids and the local control cultivar (Fajr 1) represented the sub-plot.The three-way hybrids were obtained from crossing five pure inbred lines of maize, namely ZM43WIZE, ZM60, ZM49W3E, ZM19 and CDCN5.The results showed that the values of standard error SE and the coefficient of variation (C.V) for the studied traits at the three planting dates were low and within acceptable limits, as evidence of the homogeneity of the data.The genetic variance was higher than the environmental variance for most of the studied traits.While the genetic variance was less than the environmental variance for a number of traits studied at the two dates July 25 and August 5.The percentage of heritability in the broad sense (%h2b.s) for the studied traits differed according to the sowing dates,its values were higher than 70% at the date of planting July 15th for the characteristics of 75% tasseling and silking, plant height, leaf area, LAI, ear number, ear number, TDM, CGR, and HI(89.5, 92.1, 85.9, 91.1, 91.1, 80.1, 95.4, 78.8, 74.7, and 84.6%) respectively. Whereas at the second date, the traits that achieved values greater than 70% were leaf area, LAI, ear number, TDM, CGR, plant yield, unit area, and HI (77.0, 77.0, 92.3, 94.8, 93.1, 84.3, 84.3, and 90.4%) respectively.While its values were higher than 70% at the date of planting August 1 for the characteristics of 75% silking, plant height, leaf area, LAI, number of grains per ear, number of ears, weight of 100 grains, TDM, and CGR (77.3, 71.6, 76.8, 76.8, 82.2, and 94.2). And 92.2, 84.5, and 86.4 %) respectively.We propose to study the three-way cross hybrids at sowing dates in the spring season to demonstrate their ability to environmentally adapt to the climate of Iraq, and to test them under abiotic stresses such as drought.

Keywords: Maize, Three-way cross hybrid, genetic parameters, sowing dates.

*Part of Msc thesis of first author

INTRODUCTION

Maize crop (Zea mays L.) has received great attention from plant breeders because it is unisexualand monoecious at the same time, whether by selection or cross-breeding or both. Many researchers conducted genetic research on it extensively due to the ease of conducting self-pollination and cross-breeding and obtaining large numbers of resulting seeds to improve desirable traits (7 and 8).Maize crop is characterized by high genetic and phenotypic variation, and understanding the nature of the genetic actions that control the inheritance of traits helps to choose the appropriate breeding method. The maize crop is an excellent model for the study of genetic regulation because it has a wide genetic base that is available for testing and then adapts to environmental conditions (11 and 23.(

The main objective of the study of genetic variations is to determine the genetic ratios of the components of variation, the most important of which is to estimate genetic variance and heritabilitypercentage in the broad sense, which is the degree of inheritance of quantitative traits from productive parents to resulting offspring.Genetic variations are the basis for any successful breeding program, the improvement of the maize plant depends mainly on the size of the genetic variations that exist between the plants, whether by producing hybrids through cross-breeding or obtaining new varieties through selection.The heritability of the qualitative trait is high due to the small number of genes controlling the trait and its less affected by environmental conditions.While the heritability of the quantitative trait is low due to the large number of genes controlling the trait and its great influencedby environmental conditions.The phenotypic variations represent both genetic and environmental variations, as well as the interaction between them and growth factors (G×E Interaction). To have a better idea of the efficiency of selection, it is necessary to estimate the coefficient of genetic variation and heritability ratios (10 and 21 and 22.(

(9) when studying the genetic variance, environmental variance, and heritability ratios of the yield traits of a number of maize inbred lines and their single cross hybrids, found that the genetic and environmental variance for all studied traits was greater than zero.When comparing the value of environmental variance with genetic variance, we notice that the values of genetic variance are greater than the values of environmental variance for all studied traits.The heritability values, in the broad sense, for the autumn season ranged from 72.7% to 95.3%, and for the spring season from 73.9% to 97.3% for the two traits, ear length and individual plant yield, respectively for both seasons.When studying the genetic parameters of some traits in maize, (6) found that the values of genetic variance were greater than the values of environmental variance for all traits except for the yield, where the value of environmental variance was higher than the value of genetic variance. (15 and 16) obtained when calculating the heritability ratio and some genetic parameters of six single cross hybrids of maize, that there was a variation in the heritability ratio in the broad sense of the two characteristics of leaf area and grain yield per unit area, which were 55.0% and 94.0%, respectively.In a study carried out by (2) to estimate some genetic parameters of nine strains of maize, they found that the values of heritability in the broad sense were high for all the studied traits,it reached 99.5% for the plant grain yield and 67.5% for the number of ears in the plant.The reason for this is the high value of genetic variance compared to environmental variance. (14) noted that a small increase in the coefficient of phenotypic variation when compared to the coefficient of genetic variation indicates a slight influence of the environment. This means that most of the variations are due to genetic action.This was confirmed by the high heritability values in the broad sense of most of the studied traits. (13) when studying the genetic behavior of several inbred lines of maize and their hybrids, obtained significant differences between the genotypes, most of the strains gave the highest grain yield, while the genetic variance decreased while the environmental variance increased in most of the studied traits. (3), when studying three-way crosses and their parents, found that the triple cross 5× (2×1) outperformed its parents and the control cultivarwith the highest yield per area unit of 12.75 tons ha-1 as a result of having the highest average plant height of 219.33 cm and the highest average number of rows per ear (15.58 row ear-1), and the highest average number of grainsper ear (637 grains ear-1). (18) when they studied the performance of several maize genotypes under three planting dates and two sites,the genetic variance of these genotypes is higher than the

environmental variance for most of the studied traits.The coefficient of phenotypic variance is close to the coefficient of genetic variance.This indicates that the studied traits are genetically controlled and that the influence of environmental factors is small.The heritability values in the broad sense h2b.s in the Baghdad site for each of the characteristics of leaf area and leaf area index, dry matter weight and number of days to physiological maturity were high (more than 90%) at the first planting date.The leaf area, leaf area index, and number of days to maturity were also high (more than 90%) at the second planting date.Whereas for the third planting date, it was more than 90% for the number of days of silking, leaf area and leaf area index, number of ears, weight of dry matter, number of days to maturity, crop growth rate, plant yield, and unit area yield.In the Diyala site, the heritability was high and for the three planting dates, for each of the leaf area and its index, the number of days of physiological maturity, the plant yield, and the yield per unit area. (11), when studying the genotypes of maize, found that the heritability in the broad sense was high for all studied traits, ranging from 83% for leaf area to 99% for ear height, ear weight, dry matter yield, and individual plant yield in the spring season. (19) when studying different genotypes of maize found that the introduced cultivar 6315DKC gave the highest average individual plant yield of 168.2 g due to its superiority in ear length of 18.73 cm, the highest number of grains per row (35.97 grain row-1), and the highest number of ears of the plant reaching 1.2 ear plant-1.

MATERIALS AND METHODS

With aim of estimation of some genetic parameters of three-way crosses of maize and testing them under different sowing dates,determining which of the introduced genotypes gives a higher yield and at what date of cultivation.A field experiment was carried out at Station A in the Department of Field Crops - College of Agricultural Engineering Sciences - University of Baghdad / Al-Jadriyah, for the fall season 2022.The experimental site land has been prepared for planting from perpendicular to plowing, smoothing and leveling according to the recommendations.The experiment was carried out in a split-plot arrangement according to a randomized complete block design (RCBD) with three replications. The sowing dates (15 July, 25 July, 5 August) allocated to the main plot, while the six superior three-way cross hybrids and the local control cultivar (Fajr 1) represented thesub-plot.The three-way hybrids were obtained from crossing five pure inbred lines of maize, namely ZM43WIZE, ZM60, ZM49W3E, ZM19 and CDCN5with its single cross hybrids (The origin of the first four strains is Yugoslavia and the fifth strain is Italy.(

The land was divided into 84 experimental units in the form of plots (2 x 3 m). The plot was divided into 4 lines. The distance between lines was 75 cm, and between one plant and another was 25 cm.Sowing was done on July 15, July 25, and August 5, respectivelyby placing 2-3 seeds in the hole, they were thinned to one plant after the plants reached the stage of two leaves per plant.Fertilization was done with triple superphosphate fertilizer (46% P2O5) at a rate of 200 kg P2O5ha-1 in one batch before planting,and nitrogen fertilizer 350 kg N ha-1 in the form of urea (46% N) in three batches, the first two weeks after germination, the second in the elongation stage, and the third at the beginning of the flowering stage.Preventive control of corn stem borer (Sesamia cretica L.) was carried out using granular diazinon at a concentration of 10% at a rate of 4 kg ha-1 (Ministry of Agriculture, 2015).Manual weeding and other field operations were carried out whenever needed.Five plants were randomly selected from the midline of each experimental unit with the exclusion of the guard plants. The plants were harvested on three dates: 17/10, 31/10 and 11/11 for the three sowing dates, respectively.The studied traits were number of days to 75% tasseling and silking, plant height, ear height, stem diameter, number of leaves, leaf area, leaf area index (LAI), days to physiological maturity (DTM), ear weight, ear length, ear diameter, number of rows, number of grains per row, number of grains per ears, number of ears, weight of 100 seeds, weight of dry matter (TDM), crop growth rate (CGR), yield of individual plant, yield per unit area, harvest index (HI.(

Statistical analysis was performed for each traits according to analysis of variance (ANOVA) in split-plot arrangement, and significance was tested by F-test at a significant level of 0.05, and the arithmetic means were compared using LSD (least significant difference) at a significant level of 0.05, using Genstat 2014 program.Then the genetic analysis was done and the standard error SE was estimated to estimate the homogeneity between the data of the traits for each of the studied traits. The coefficient of variation C.V% was calculated to estimate the homogeneity between the samples.Genetic, environmental, phenotypic and heritability variance were estimated in the broadest sense for each plant density using the SPAR 2.0 genetic analysis program, according to Singh and Chaudhary (1985), and were calculated as follows:

$$\sigma^2_G = \frac{MS_g - MS_e}{r}$$

$$\sigma^2_E = MS_e$$

$$\sigma^2_P = \sigma^2_G + \sigma^2_E$$

MS_g: mean squares of genotypes
MS_e: mean squares experimental error
r : the number of replicates

$\sigma^2_G, \sigma^2_E, \sigma^2_P$: genetic, environmental and phenotypic variance respectively
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The genetic coefficient of variation (GCV) and the phenotypic coefficient of variation (PCV) were estimated as follows:

$$GCV\% = \frac{\sqrt{\sigma^2_g}}{\bar{X}} X\,100$$

$$PCV\% = \frac{\sqrt{\sigma^2_p}}{\bar{X}} X\,100$$

The degree of heritability in the broad sense, $h^2_{b.s}$, was also calculated according to the following equation:

$$h^2_{bs} = \frac{\sigma^2_g}{\sigma^2_p}\ x\,100$$

The ranges were adopted for heritability in the broad sense, according to what was stated by Al-Athari (1982), as follows:

- Less than 40% low, between 40-60% is medium, more than 60% high.

RESULTS AND DISCUSSION

Some genetic parameters of the traits at the sowing date July 15th

The results show that for some of the genetic parameters of the studied traits at the date of planting July 15th, the standard error values were very low for all traits except for the leaf area trait, which had a high value of 28.29 (Table 1).The results show that standard error values some of the genetic parameters of the studied traits at the date of planting July 15thwere very low for all traits except for the leaf area, which had a high value of 28.29 (Table 1).The low values of the standard error (SE) values indicates that the data of the traits are similar and that they are close to the arithmetic mean.The table also shows that the values of the coefficient of variation (CV) were low (less than 20), and this is evidence of the homogeneity of the samples of the studied traits.

Genetic variance values were greater than environmental variance for all traits except stem diameter.This indicates that the studied traits of the genotypes (three-way crosses and the control variety) were mostly genetic, and the effect of the environment on these genotypes was small. In case of stem diameter, the environmental variation was greater than its genetic variation, and the percentage of low genetic variation compared to the environmental reached 6.84%.This means that the influence of the environment for this trait was greater in its heterogeneity with less contribution of heredity to show this trait,and the ratio of genetic to environmental variance was less than one for this trait, which means that selection for this trait is difficult and it takes a longer period to not distinguish the phenotype of the plant, whether it was the result of the environment or genetic.On the contrary, the genetic variance was higher than the environmental variance for the rest of the traits,and the ratio of genetic variance to environmental variance is greater than 1 (ranged between 1.403 and 24.00),and the percentage of genetic variance from the phenotypic variance for these traits ranged between 58% and 95% for the number of leaves and number of ears, respectively. The values of the coefficient of genetic variation (GCV) were very close to or equal to the values of the coefficient of phenotypic variation (PCV) for traits whose genetic variance was high (greater than the environmental variance),it represents a high rate of phenotypic variance.This is evidence that these traits are governed by genetic variance, which is responsible for their transmission from one generation to the next. Whereas,in the case of the stem diameter whose environmental variance was greater than the genetic and constituted the largest proportion of the phenotypic variation, the environment is the one that controls this trait and its transmission from one generation to another is affected by the environment to a greater degree, and this confirms the results of (10) and (1),who found that most of the characteristics of maize had genetic variance higher than environmental variance.The results also agreed with what was found by (17) and (18) and (23), who found a difference in genetic parameters when planting dates differed in the autumn cultivation.

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Table t the lowest value of heritability in the broad sense was 48.2% (stem diameter) and the highest value of heritability was 95.4% (number of ears),and that almost most of the traits had a high heritability rate in the broad sense, such as the number of days of tasseling and silking flowering, plant height, ear height, leaf area, LAI, DTM, ear weight, ear length, ear diameter, number of rows, number of grains, number of ears, grain weight, TDM, CGR, number of earwigs, weight of 100 grains, and harvest index, they reached 89.5%, 92.1%, 85.9%, 63.1%, 91.1%, 91.1%, 69.8%, 65.0%, 60.3%, 60.2%, 66.1%, 80.1%, 95.4%, 65.9%, 78.8%, 74.7%, and 84.6%, respectively.The reason for the high heritability in the broad sense of these traits is the low effect of environmental variance when compared to genetic variance that was close to phenotypic variance and its ratio ranged between 1.40 and 24.0.While the percentage of heritability in the broad sense was intermediate for the characteristics of stem diameter, number of leaves, number of grains per row, individual plant yields, and unit area yield, it ranged between 48.2% and 59.2%. This result confirms what was reached by (20) and (4) and (12.(

Table 1.Some genetic parameters of the studied traits of triple crosses of maize at the date of sowting July 15th for the fall season 2022.

Characters	SE	C.V	$\sigma^2 p$	$\sigma^2 g$	$\sigma^2 e$	σ^{2g}/σ^{2e}	P.C.V	G.C.V	h^2.b.s
days to tasseling	0.344	1.162	4.476	4.004	0.472	8.483	3.579	3.385	0.895
days to silking	0.302	0.986	4.607	4.242	0.365	11.622	3.504	3.363	0.921
plant height	3.318	3.331	312.117	268.082	44.03	6.088	8.868	8.219	0.859
ear height	3.624	7.476	142.207	89.687	52.52	1.708	12.30	9.770	0.631
stem diameter	0.392	4.024	1.185	0.572	0.614	0.932	5.594	3.885	0.482
leaf number	0.273	3.950	0.716	0.418	0.298	1.403	6.120	4.674	0.583
leaf area	28.28	2.747	349713.3	3185338	31179	10.216	9.201	8.781	0.911
LAI	0.047	2.747	0.099	0.091	0.009	10.111	9.201	8.781	0.911
DTM	0.558	1.231	4.131	2.885	1.246	2.315	2.241	1.872	0.698
ear weight	4.787	7.200	262.111	170.439	91.67	1.859	12.17	9.817	0.650
ear length	0.264	2.805	0.705	0.425	0.280	1.518	4.451	3.456	0.603
ear diameter	0.341	1.693	1,169	0.704	0.465	1.514	2.685	2.084	0.602
row ear^{-1}	0.259	3.656	0.790	0.522	0.268	1.948	6.279	5.105	0.661
grain row^{-1}	0.951	5.726	8.865	5.247	3.618	0.741	8.964	6.896	0.592
grain ear^{-1}	13.58	5.766	3704.87	2966.97	737.9	1.015	12.91	11.562	0.801
ear number	0.005	1.039	0.0025	0.0024	0.000	24.000	4.829	4.715	0.954
100 grain weight	0.951	6.973	10.612	6.994	3.617	1.934	11.94	9.696	0.659
TDM	11.26	5.176	2400.08	1892.08	507.9	0.595	11.25	9.990	0.788
CGR	0.119	4.968	0.224	0.168	0.057	2.947	9.879	8.539	0.747
individual plant	5.406	10.22	284.059	167.180	116.8	1.430	15.94	12.231	0.589
yield of unit area	0.288	10.22	0.807	0.475	0.332	1.430	15.94	12.231	0.589
harvest index	1.201	9.685	37.588	31.816	5.772	3.137	24.71	22.739	0.846

Some genetic parameters of the traits at the sowing date July 25th

The standard error (SE) values were low for all traits except for leaf area, for which the standard error value was high at 14.15 (Table 2).However, in general, it is statistically acceptable because it is less than 20.The low values of standard error values are evidence of the similarity of the trait data and its closeness to the arithmetic mean.Also, the values of the coefficient of variation (CV) for all the studied traits were also low and less than 10, and this indicates the homogeneity of the samples for the studied characteristics,and that these values are statistically acceptable.The values of genetic variance for most of the studied traits were higher than the environmental variance, except for the traits of the number of days of tasseling and silking, ear height, stem diameter, ear diameter, number of rows, and number of grains per row.This means that the percentage of genetic variance to the environmental variance was 37.48, 41.73, 11.11%, 50.63, 12.74%, 29.96%, and 63.83%, respectively.The percentage of genetic variance to phenotypic variance was high in the characteristics of plant height, number of ear rows, leaf area, leaf area index, number of days to physiological maturity, ear weight and length, number of grains per ear, number of ear, weight of 100 grains, dry matter weight, crop growth rate, individual plant yield, unit area yield, and harvest index,and that the ratio of genetic to environmental variance for these traits was high (more than 1) and ranged between 1.07 for the crop growth rate and 18.15 for the total dry matter weight,and that this percentage was less than 1 for the characteristics of the number of days of tasseling and silking, ear height, stem diameter, ear diameter, number of rows per ear, and number of grains per row.These traits are difficult to select because they are affected by the environment, the values of the coefficient of genetic variation (GCV) were very close to the values of the coefficient of phenotypic variation (PCV) for the traits whose genetic variation was higher than the environmental variation, and this is evidence that the phenotypic variation was mostly of Hereditary and that these traits are governed by genes (heredity) in their transmission from one generation to another, and that the influence of the environment is minimal.Whereas for the traits whose environmental variance was greater than the genetic variance.The coefficient of genetic variation was far from the coefficient of phenotypic variation, and thus these traits are governed by the environment.The heritability percentages in the broad sense for these traits were low, ranging between 26.6% for the number of grains per row and 47.1% for the ear height,and the percentage of heritability in the broad sense was intermediate for the characteristics of ear height, number of rows, number of days of physiological maturity, ear weight, diameter, and number of rows were 47.1%, 55.7%, 57.0%, 55.2%, 46.6%, and 41.2%, respectively.Whereas for plant height, number of rows per ear, leaf area and index, number of days to physiological maturity, ear weight and length, number of grains, number of ears, weight of 100 grains, dry matter weight, crop growth rate, individual plant yield, area unit yield and harvest index, the heritability in the broad sense was high at 64.4% and 77.0%. %, 77.0%, 61.9%, 62.0%, 92.3%, 63.0%, 94.8%, 93.1%, 84.3%, 84.3%, and 90.4%, respectively,which indicates the possibility of improving these traits by selection for having high genetic heterogeneity. These results are consistent with the results of (5) and (23), as they found that most of the traits were genetically controlled and heritability rates in the broad sense were high. The results also agreed with (17), and (18) who found a difference in genetic parameters when planting dates differed in the autumn season.

Table 2.Some genetic parameters of the studied traits of triple crosses of maize at the date of sowting July 25th for the fall season 2022.

Characters	SE	C.V	$\sigma^2 p$	$\sigma^2 g$	$\sigma^2 e$	σ^{2g}/σ^{2e}	P.C.V	G.C.V	h^2.b.s
days to tasseling	0.378	1.326	0.929	0.357	0.571	0.625	1.691	1.048	0.385
days to silking	0.402	1.377	1.024	0.377	0.647	0.583	1.733	1.051	0.368
plant height	3.097	3.010	107.734	69.362	38.373	1.808	5.043	4.046	0.644
ear height	3.571	6.795	96.371	45.351	51.021	0.889	9.339	6.406	0.471
stem diameter	0.422	4.464	1.065	0.352	0.713	0.494	5.457	3.138	0.331
leaf number	0.205	3.051	0.381	0.212	0.169	1.254	4.583	3.419	0.557
leaf area	14.146	4.231	3561728	274209.5	81963.23	3.346	8.819	7.738	0.770
LAI	0.076	4.231	0.101	0.078	0.023	3.391	8.819	7.738	0.770
DTM	0.569	1.326	3.012	1.718	1.294	1.328	2.024	1.529	0.570
ear weight	3.850	3.946	132.509	73.212	59.290	1.235	5.900	4.386	0.552
ear length	0.308	3.030	0.998	0.618	0.380	1.626	4.910	3.863	0.619
ear diameter	0.439	1.958	1.440	0.671	0.769	0.873	2.678	1.828	0.466
row ear^{-1}	0.253	3.234	0.437	0.180	0.257	0.700	4.420	2.710	0.412
grain row^{-1}	0.657	3.348	2.348	0.624	1.725	0.362	3.906	2.013	0.266
grain ear^{-1}	6.577	2.142	455.709	282.703	173.007	1.634	3.477	2.738	0.620
ear number	0.004	0.763	0.0008	0.0007	0.0001	7.000	2.741	2.633	0.923
100 grain	0.389	2.643	1.633	1.024	0.604	1.695	4.345	3.449	0.630
TDM	7.919	3.402	4802.36	4551.53	250.824	18.146	14.888	14.494	0.948
CGR	0.100	3.699	0.585	0.545	0.040	1.073	14.108	13.614	0.931
individual plant	1.524	1.898	59.343	50.052	9.292	5.387	4.797	4.405	0.843
yield of unit	0.081	1.898	0.169	0.142	0.026	5.462	4.797	4.405	0.843
harvest index	0.863	4.903	30.881	27.904	2.977	9.373	15.792	15.012	0.904

The standard error (SE) values were low for all traits except for leaf area, ear weight, grain number, TDM, and individual plant yield, for which the standard error value was high, amounting to 14.31, 13.52, 12.49, 15.47, and 11.42 for the traits, respectively (Table 3).But in general, it is statistically acceptable because it is less than 20.The low value of standard error is evidence of the similarity of the trait data and its closeness to the arithmetic mean.Also, the values of the coefficient of variation (CV) for all studied plants were also low and less than 10, except for the traits of ear weight, plant yield, and yield per unit area. The value was slightly more than 10, and it is generally acceptable in the field.This is evidence of the homogeneity of the samples for the studied characteristics and that these values are statistically acceptable.The values of genetic variance for most of the studied traits were higher than the environmental variance, except for stem diameter, number of leaves, number of days to physiological maturity, ear weight and length, individual plant yield and yield of unit area (Table 3),where the values of environmental variance were higher than genetic variance, and this means that the percentage of genetic variance decreased from environmental variance was 28.92, 39.29, 43.42, 17.38, 9.52, 33.77, and 33.87%, respectively.While the percentage of genetic variance from phenotypic variance was high in the number of days of tasseling and silkin, plant height, ear height, leaf area and leaf area index, ear diameter, number of rows, row number of grains, number of ear beans, number of ears, weight of 100 grains, weight of dry matter,crop growth rate,and harvest index, and the ratio of genetic to environmental variance for these traits was high (more than 1), ranging between 1.02 for the number of grains per row and 16.67 for the number of ears,and that this ratio was less than 1 for the characters of stem diameter, number of leaves, number of days to physiological maturity, ear weight and ear length, individual plant yield, and yield of unit area. It ranged between 0.49 for the number of leaves and 0.91 for ear length.These traits are difficult to select because they are greatly affected by the environment. The values of the coefficient of genetic variation (GCV) were very close to the values of the coefficient of phenotypic variation (PCV) for the traits whose genetic variance was higher than the environmental variance.This is evidence that the phenotypic variation was mostly from genetic variation, and that these traits are governed by genes (heredity) in their transmission from one generation to the next, and that the influence of the environment is minimal.Whereas the traits whose environmental variance was greater than the genetic variance,the coefficient of genetic variation was far from the coefficient of phenotypic variation, and thus these traits are governed by the environment.The percentage of heritability in broad sense of these traits was low to medium. The low was 36% for the number of days of physiological maturity and 38% for the number of leaves.The percentage of heritability in broad sense was intermediate for the characters of stem diameter, ear weight, ear length, plant yield, and yield per unit area, reaching 42%, 45%, 48%, 40%, and 40%, respectively. Whereasthe characters of the number of days of tasseling and silking, plant height, ear height, leaf area, leaf area index, ear diameter, number of rows per ear, number of grains per row, number of grains per ear, number of ears, weight of 100 grains, weight of dry matter, crop growth rate, and harvest index, the heritability in the broad sense was intermediate and high, reaching 69%, 77%, and 72. %, 52%, 77%, 77%, 54%, 65%, 50%, 82%, 94%, 92%, 84%, 86%, and 50%, respectively.Which indicates the possibility of improving these traits through selection because they have high genetic heterogeneity.These results agree with the results of (15) and (23), as they found that most of the traits were genetically controlled, and the rates of heritability in the broad sense were high. The results also agreed with what was found by (17) and (18) who found a difference in genetic parameters when planting dates differ in the autumn date.

Table 3.Some genetic parameters of the studied traits of triple crosses of maize at the date of planting August 5th for the fall season 2022.

Characters	SE	C.V	$\sigma^2 p$	$\sigma^2 g$	$\sigma^2 e$	σ^{2g}/σ^{2e}	P.C.V	G.C.V	h^2.b.s
days to tasseling	0.506	1.284	1.643	1.131	0.512	2.209	2.301	1.909	0.688
days to silking	0.465	1.151	1.905	1.472	0.433	3.399	2.415	2.123	0.773
plant height	3.118	2.265	68.446	48.999	19.447	2.520	4.250	3.596	0.716
ear height	5.063	7.086	105.993	54.728	51.265	1.068	10.189	7.322	0.517
stem diameter	0.495	4.137	0.840	0.349	0.491	0.711	5.413	3.491	0.416
leaf number	0.410	4.441	0.541	0.204	0.336	0.492	5.629	3.460	0.378
leaf area	14.307	4.046	293083.2	225144.8	67938.	3.314	8.404	7.366	0.768
LAI	0.0983	4.046	0.083	0.064	0.019	3.368	8.404	7.366	0.768
DTM	0.563	0.935	0.988	0.357	0.631	0.566	1.170	0.704	0.361
ear weight	13.524	10.045	688.219	302.405	365.81	0.814	13.576	9.133	0.453
ear length	0.469	3.382	0.841	0.399	0.441	0.905	4.669	3.219	0.475
ear diameter	0.832	2.565	3.009	1.623	1.386	1.171	3.780	2.776	0.539
row ear^{-1}	0.363	3.291	0.742	0.479	0.263	0.633	5.525	4.439	0.645
grain row^{-1}	0.662	2.469	1.771	0.893	0.878	1.017	3.507	2.491	0.504
grain ear^{-1}	12.490	2.985	1757.649	1445.639	312.01	1.412	7.086	6.426	0.822
ear number	0.013	1.735	0.006	0.005	0.0003	16.667	7.184	6.972	0.942
100 grain weight	5.340	6.087	1468.538	1354.63	114.26	11.855	21.367	20.679	0.922
TDM	15.471	5.951	3086.42	2607.742	478.67	5.330	15.112	13.891	0.845
CGR	0.176	5.735	0.453	0.391	0.062	5.551	15.533	14.436	0.864
individual plant	11.416	10.338	433.282	172.619	260.66	0.662	13.329	8.413	0.398
yield of unit area	0.608	10.338	1.231	0.490	0.741	0.661	13.329	8.413	0.398
harvest index	1.993	6.595	15.923	7.969	7.945	1.003	9.269	6.514	0.504

When comparing the genetic parameters at the three sowing date (Tables 1, 2, and 3), we find that the standard error (SE) and the coefficient of variation (CV) for the vegetative growth traits increased as the planting date advanced towards August.The yield, yield components, and growth parameters, in which (SE) and (CV) also increased as the sowing date advanced from 15 to 25 July and 5 August, and in general their values at the three sowing dates were low and statistically acceptable.We also notice that all traits have a lower heritability in the broad sense in the second planting date than in the first,that is, by advancing the planting date to the second date (July 25), it became more affected by the environment because the plants became more heterogeneous,that is, the environment was the one that controlled this characters on the date of July 25, with the exception of the total dry weight, the growth rate of the crop, the plant yield, the yield per unit area, and the harvest index.Whereas for the last date (August 5), some traits returned to be heritable in a broadsense than the second date, and others decreased.The characteristics of the number of days of tasseling and silking flowering, plant height, ear height, and the stem diameter the heritability in broad sense was higher than second date (25 July),but it is generally less than the first date.While the characters of the number of leaves, leaf area,leaf area index, number of days of physiological maturity, and the weight and length of the ear, its heritability decreased in the third date as compared to the second planting date.heritability returned to increase in the characteristics of the ear diameter, rows per ear, the number of grains per row, the number of ears, and the weight of 100 grains, with the advancement of the planting date from July 25 to August 5.Whereas dry matter weight, crop growth rate, individual plant yield, yield per unit area, and harvest index, the heritability decreased in the third date from the second.The most important characteristics of the yield components are the number of ears and the weight of the grain, and the heritability of the number of ears was very high at the three dates, reaching 95%, 92%, and 94%, respectively.Whereas for the weight of 100 grains, it reached 66% and 63% at the first and second planting dates, and it was very high at the third planting dates, reaching 92%.While the number of grains per ear (the third component of the yield), the heritability was high at the first date, reaching 80%, and decreased at the second date, reaching 62%, and returning to the highest at the third date, reaching 82%.This result agrees with (6)and (23) who found that the values of genetic variance were greater than the values of environmental variance and that heritability in the broad sense was high for most traits.These results confirm what (15) obtained and what (17) and (18) found, who found a difference in genetic parameters when planting dates differ in the autumn date.

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