Estimating some genetic parameters in growth traits and yield of Sweet corn Zea mays L. var saccharata hybrids

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Abstract:
This study was conducted at the Research Station of the Department of Horticulture and Landscape Engineering/Open Field affiliated to the College of Agriculture, Tikrit University, in the spring agricultural season of 2024. The aim was to evaluate the performance of four hybrids of Sweet Corn plants: Sweet Spirit, 007R, SS3006 and 6800R, and to estimate some genetic parameters in terms of their adaptation to the environmental and agricultural conditions of Salah al-Din Governorate and to determine the best of them. It was implemented according to the split plot system (design plot Split) using the randomized complete block design (RCBD) and with three replicates. The results of the experiment were analyzed using the (SAS) program and the averages were compared statistically according to Duncan's multiple-nomial test at a probability level of 0.05. The results of the analysis of variance showed significant differences between the hybrids for the traits of plant height, number of leaves, leaf area, cob length, cob diameter, number of grains per cob, yield of fresh cobs with sheaths, and total grain yield, where the hybrid SS3006 outperformed all other hybrids in most of the studied traits, as the number of leaves reached 9.322 leaves/plant1-, leaf area reached 3378.9 cm2 plant-1, cob length reached 19.36 cm.cob-1, cob diameter reached 46.50 mm, number of grains per cob 527.4 grains . cob-1, yield of fresh cobs with sheaths reached 13.46 ton.ha-1 and total grain yield 5184.0 kg.ha-1, while the hybrid 6800R excelled in the trait of plant height and recorded 128.2 cm.plant1-. The results of the study showed that the phenotypic variance recorded values higher than the genetic variance values for the studied traits, which led to an increase in the value of the phenotypic variation coefficient compared to the genetic variation coefficient. The heritability ratio in its broad sense was high for most of the studied traits and ranged between 89.38 - 99.97%, indicating that most of the phenotypic variance between the hybrids was genetic. Experiment also showed that the total grain yield was positively and highly significant associated with the trait of fresh cob yield with husks, number of grains per cob, cob diameter, cob length, leaf area and plant height, and thus they can be adopted as selective indicators for the purpose of increasing productivity.

Introduction:

Yellow corn is one of the most important agricultural crops in the world, as it ranks first after wheat and rice in terms of cultivated area and grain productivity due to its nutritional and industrial importance, as well as its medical importance and fodder uses [21], so it is called the miracle crop ([15] and at the level of Iraq, the cultivated area amounted to about 360 thousand dunums, producing 538 thousand tons [13[

Sweet corn (Zea mays L. var saccharata) is one of the field corn groups and belongs to the Gramineae family. It is a monocotyledonous plant with a chromosome number of 20 = 2n. Its original habitat is Central America and

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Mexico. Its plants contain a recessive pair of genes, SU (genes for sugar), whose function is to prevent the conversion of sugar to starch [35] It is believed that it arose as a mutation from yellow corn at the sugar site on chromosome 4, both of which belong to the plant species Zea mays. Sweet corn differs from field corn in that its grains contain a high percentage of sugar in both the milk stage and the early dough stage, and in that its dry grains are wrinkled and translucent, which differ according to the genetic makeup[3,29].The sweet taste of sweet corn grains distinguishes them from the rest of the yellow corn groups, and therefore they are used soft and sometimes eaten uncooked in salads and are also used in other food fields. Sweet corn grains contain 70–72% water, 5–6% sugars, 10–11% starch, 3% soluble sugars, in addition to moderate levels of proteins, vitamins and potassium [28] Sweet corn plays an important role in the healthy human diet because it contains minerals, vitamins, antioxidants, carotenoids and a low percentage of cholesterol [38]. Sweet corn is considered one of the most popular vegetables in Europe and developed countries in the world [17]. The lack of information and scientific research on the cultivation of Sweet corn in Iraq prompts us to study many factors that affect the increase in its production, in addition to the fact that this crop is not of interest to producers and researchers in Iraq and has not been introduced as a food crop to contribute to the provision of food. Despite this, the climatic conditions are favorable for the cultivation and production of this crop, as its environmental requirements of temperature and the length of the light period are completely similar to the conditions for growing yellow field corn, in addition to being an economically profitable crop for the farmer due to its short planting season, especially for the early maturing genetic compositions that allow the cultivation of two crops in the same field, in addition to the low production costs compared to other vegetable crops and its effect on reducing weeds in the field when planted in succession with wheat or barley [20] Therefore, by studying the genetic and phenotypic components of different genetic structures of Sweet corn, we can show their relationship with the genetic and physiological components of the yield and their reflection on the grain yield, as the production efficiency of this crop can be increased by studying some of its genetic features and studying the genetic behavior of the morphological traits of the plant and cob, which are among the traits that must be followed up during breeding and improvement programs due to their importance in marketing operations, as well as the color and taste of the grains [30]. In addition to studying the genetic behavior of the yield and its components, whose behavior is controlled by a large number of genes [8] and which are greatly affected by environmental conditions, which makes studying their behavior difficult [36.[

The study of the coefficient of phenotypic variation and the coefficient of genetic variation is useful not only for comparing the relative value of phenotypic and genetic differences between different traits, but also very useful for estimating the extent of improvement achieved through selection [19] as it enables us to determine the nature of the genetic behavior of the studied traits. This can be observed when evaluating the same genetic material under different planting dates, and these traits are significantly affected by environmental factors[1,26] . Inheritance in the broad sense and genetic improvement are important genetic criteria that aim to know the

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possibility of transferring the desired traits from parents to offspring [12,41] . Studying the correlation between the crop and its components on the one hand and between the components of the crop itself on the other hand is an important requirement in plant breeding programs [16], especially measuring the correlation between traits through the genetic and phenotypic correlation coefficient, which is determined through data taken in the field [39]. Choosing the performance of these hybrids is one of the necessary matters that are done on the basis of their distinction in a number of qualities that enable them to give a high and desirable quantitative yield to the consumer, as well as their tolerance to different environmental conditions and the extent of their resistance to different types of pests [4] One of the main important factors that contribute to increasing production is the cultivation of hybrids with high productivity and desirable specifications that are suitable for the environmental conditions of a specific region [32]. [9] concluded, when studying the purpose of evaluating six genetic compositions of Sweet corn, that there was a positive and significant correlation between the total grain yield and plant height of 0.57, cob length 0.68, and 100-grain weight 0.66. [34] indicated that the degree of heritability was high for most of the studied traits when studying 15 genetic compositions of Sweet corn, and the results of the same study showed the presence of A significant correlation between the studied traits, and the results of the study conducted by [40] when studying the genetic compositions of Sweet corn plants showed significant differences between them, as the phenotypic variation coefficient gave values ranging between 4.57 - 36.41, while the genetic variation coefficient recorded values between 4.57 - 25.35, and the degree of heritability showed average levels for the trait of plant height and cob diameter, reaching 0.73 and 0.61, respectively. The results of the experiment conducted by [33] through their study for the purpose of evaluating 46 genetic compositions of Sweet corn plants indicated that the levels of the values of the phenotypic and genetic variation coefficients and the degree of heritability were medium to high, in addition to the occurrence of a significant and positive correlation between the traits of the yield and its components, as the cob weight with the covers was positively and significantly associated below the probability level of 1% with the number of grains The cob length and cob length were recorded as 0.9777 and 0.2865 respectively. [12] showed when they studied the five genetic compositions of Sweet corn that the degree of heritability was high for all the studied traits, ranging between 0.65-0.96. This study aimed to test and evaluate the genetic compositions of the newly introduced Sweet corn hybrids to the country and estimate some of their genetic parameters under the environmental conditions of Salah al-Din Governorate and determine the best of them in giving an increase in growth traits, yield and its components.

Materials and methods

This study was carried out during the spring season of 2024 at the Horticultural Research Station affiliated to the Department of Horticulture and Landscape Engineering - College of Agriculture - Tikrit University - open field. The crop was irrigated in this experiment using the drip irrigation method, and random samples were taken from different places in the experimental field before planting at a depth of (0 - 30) cm. Table 1 shows the physical and chemical properties of the soil.

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After selecting the area allocated for cultivation, the field land of the horticultural station was plowed with a rotary plow and smoothed and leveled. Then, the experimental land was divided into panels (experimental units) with dimensions of 1.25 m x 2.8 m with an area of 3.5 m2 with 24 experimental units distributed over three replicates, each replicate included 8 experimental units, and the distance between one line and another was 70 cm, and the distance between one plant and another was 25 cm on the same line. The experimental unit included four lines and in each line 5 plants, meaning that each experimental unit had 20 plants, and spacers were left between one panel and another of 1 m, and a distance of 1 m was also left between the replicates. Then, the soil fertilizer was added according to what was mentioned by [5] nitrogen fertilizer at a rate of 320 kg ha-1 - and triple superphosphate fertilizer at a rate of 200 kg ha-1 - and potassium sulfate fertilizer at a rate of 80 Kg/ha-1, and all preventive measures were carried out against diseases, fungi and insects first hand.As for the genetic compositions used, four Sweet corn hybrids (recently introduced to the country) were used: Sweet Spirit, 007R, SS3006 and 6800R, and the producing company is Syngenta / Switzerland.The experiment was carried out according to the RCBD randomized complete block design with split plot design and three replicates. At the end of the experiment, the averages of the traits were recorded and the results were statistically analyzed using a computer according to the SAS program and the averages were compared according to Duncan's multiple range test at a probability level of 0.05 [2]. The components of phenotypic variance (VP) were estimated assuming no interference between the genetic composition and the environment (VGE) according to the following equation:

VP=VG + VE

Where: Genetic Variance = (VG) Genotypic Variance

Environmental Variance = (VE) Environmental Variance

Environmental Variance and Genetic Variance were calculated from the expected mean squares of the ANOVA table shown below.

VG = M2 – M1 / R

Where:

M2 = Standard mean squares (hybrid(

M1 = Mean square of experimental error and M1=VE

R = Number of replicates

The genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV) were estimated according to [31]and according to the following equations

PCV% = (√( )□□ P / Ỹ) × 100

GCV% = (√( )□□□G / Ỹ) × 100.

H2b.s = Inheritance in the broad sense

( )√ □□G = square root of genetic variance

( )√ □□P = square root of phenotypic variance

Ỹ = arithmetic mean of the trait

The percentage of broad sense heritability (h2 b.s) was estimated according to [22] as follows:

H2b.s = VG / VP × 100 .

The limits of the values of Inheritance in the broad sense mentioned by [7,11] were adopted as follows:

*Heritability less than 40% = low

*Between 40% - 60% = medium

*More than 60% = high.

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The Simple Correlation Coefficient was estimated based on the average value of the trait studied in each experimental unit and replicate [37] according to the following equation:

r =(SXY -(SX SY)/n)/√({ Sx^2 – (SX)^2/n}{ SY^2 - (SY)^2/n({

The significance of the correlation is determined according to the tabular r value

Table 1 Physical and chemical properties of field soil before planting

values	Unit	Physical and chemical properties of soil	values	Unit	Physical and chemical properties of soil
7.35	-	Ph	36.2	mg L^{-1}	Phosphorus
0.51	%	OM	96.2	mg L^{-1}	Potassium
38	%	Sand	325.3	mg L^{-1}	Nitrogen
32	%	silt	165.2	mg kg^{-1}	Gypsum
30	%	Clay	16.60	%	Lime
Sand clay loam		Soil Texture	0.9	$Ds.m^{-1}$	EC

Table 2 Monthly averages of minimum and maximum temperatures and rainfall in Tikrit city during the experimental period for the 2024 season

nfall rate (mm(	erage temperature (°	ximum temperature (°	imum temperature (°C)	Months
1	15	07	7	March
6	48	29	36	April
4	77	16	21	May
	00	36	61	June

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The studied traits: Plant height cm plant1-, Number of leaves leaf plant1-, Leaf area cm2 plant-1, Cob length cm , Cob diameter mm, Number of grains in cob(cob. grain-1, Yield of fresh cobs with covers ton ha-1 and total grain yield kg ha-1.

Results and discussion:

Analysis of variance for Sweet corn hybrids:

Table 3 shows significant differences between genetic compositions based on square means for all studied traits, and these highly significant differences between genetic

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compositions help to select superior compositions.

Table 3 Analysis of variance for Sweet corn hybrids for various vegetative growth and yield traits

Mean Squares								d.f	Sources of variation S.O.V
Total grain yield kg ha^{-1}	Yield of fresh cobs with hulls ton/ha-1^{-}	Number of grains in cob	Cob Diameter mm	Cob length cm	Leaf area cm2 plant1-	Number of leaves -1plant leaf	Plant height -1cm plant		
570554.0	0.1532	41836.0	29.59	7.198	387341.1	1.873	21.98	2	
21774570.9**	4.918**	95957.5**	70.57**	5.104**	224629.2**	0.4802$^{n.s}$	288.66**	3	Replicates
6279.5	0.0018	939.7	0.5505	0.0771	11174.4	0.0510	0.8804	6	genotype

*Significant at 0.05 probability level, ** Significant at 0.05 and 0.01 probability levels, n.s not significant.

-2The effect of Sweet corn hybrids on vegetative growth and yield traits and estimation of some of their genetic parameters:

Table 4 shows significant differences between Sweet corn hybrids, as the hybrid SS306 significantly outperformed the other hybrids in the trait of number of leaves, leaf area, cob length, cob diameter, number of grains per cob, yield of fresh cobs with husks and total grain yield, and gave the highest values of 9.322 leaves/plant1-, 3378.9 cm2 plant-1, 19.36 cm.cob-1, 46.50 mm, 527.4 grains . cob-1, 13.46 ton.ha-1 and 5184.0 kg.ha-1 respectively, while the hybrid 6800R significantly outperformed the other hybrids in the trait of plant height and gave the highest value of 128.2 cm.plant1-. The results of the same table showed that the values of phenotypic variance were higher than the values of genetic variance for the studied traits, and this was reflected in giving the coefficient of phenotypic variation higher levels compared to the coefficient of genetic variation. The difference between the coefficient of phenotypic and genetic variation for these structures was small, as the values were close to each other, which indicates that genetic variance contributes mainly to the phenotypic variance of these genetic structures. In addition, the same table indicated that the percentage of Inheritance in the broad sense was high for most traits and ranged between 89.38 - 99.97%.

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Table 4 Effect of Sweet corn hybrids on vegetative growth and yield traits and estimation of some of their genetic parameters

Total grain yield kg ha^{-1}	Yield of fresh cobs with hulls ton/ha-1^{-}	Number of grains in cob	Cob Diameter mm	Cob length cm	Leaf area cm2 plant1-	Number of leaves -1plant leaf	Plant height -1cm plant	traits / Sweet corn hybrid
3416.2 c	12.55 c	476.9 b	42.77 c	18.43 c	3206.4 c	9.117 b	122.0 b	Sweet Spirit
2924.6 d	12.41 d	354.0 d	42.05 d	18.12 d	3120.1 d	8.922 c	119.9 c	007R
5184.0 a	13.46 a	527.4 a	46.50 a	19.36 a	3378.9 a	9.322 a	119.5 c	SS3006
4877.8 b	13.28 b	442.6 b	44.49 b	18.68 b	3295.2 b	9.117 b	128.2 a	6800R
4100.7	12.93	450.2	43.95	18.65	3250.2	9.120	122.4	Mean trait
21768291.4	4.916	95017.8	70.02	5.027	213454.8	0.4292	287.8	Genetic variance V.G
21774570.9	4.918	95957.5	70.57	5.104	224629.2	0.4802	288.7	Phenotypic variance V.P
113.78	17.16	68.47	19.04	12.03	14.22	7.184	13.86	Genetic coefficient of variation G.C.V
113.79	17.16	68.81	19.11	12.12	14.58	7.599	13.88	Phenotypic coefficient of variation P.C.V
99.97	99.96	99.02	99.22	98.49	95.03	89.38	99.69	Inheritance in the broad sense h^2b.s

The averages that carry the same alphabetical letters for the individual factors and their interactions do not differ significantly from each other according to Duncan's multiple range test at the probability level of 0.05

-3Estimation of Simple Correlation Coefficient between vegetative growth traits and yield of Sweet corn hybrids:

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Studying the correlation relationship between the yield and its components on the one hand and between the components of the yield itself on the other hand is an important requirement for understanding the nature of the relationship and determining its type between the studied traits and through which grain productivity can be increased [24], especially measuring the correlation between traits through genetic and phenotypic correlation coefficients, which is determined through data taken in the field (phenotypic variation, genetic variation, environmental variation), which is a way to determine the extent of convergence between growth traits and yield [25] and that obtaining Genetic correlation is attributed to the multiple effects of genes in addition to the existence of a correlation between these genes [16], while the phenotypic correlation between two or more traits is attributed to the correlation of the effects of the genes of these traits with environmental effects [39] therefore, estimating the correlation coefficient between the traits of vegetative growth and the yield and its components is considered one of the most important factors that help plant breeders in evaluating plant breeding and improvement programs, whether positive or negative, especially traits with a positive correlation [6,27] therefore, when there are multiple genetic structures, it is necessary to conduct the analysis process for the coefficients and know the strength of the relationship between the crop and its components [18]. The results of Table 5 showed that the total grain yield was positively and highly significant correlated with the traits of fresh cob yield with hulls, number of grains per cob, cob diameter, cob length, leaf area and plant height, reaching 0.9632, 0.6104, 0.6755, 0.4755, 0.4408 and 0.3209, respectively, and was positively and moderately significant correlated with the number of leaves, recording 0.2501. Therefore, selection for the trait of total grain yield can be achieved through selection for the above traits .

Table 5 Simple Correlation Coefficient between the studied traits of Sweet corn hybrids

Total grain yield kg ha^{-1}	Yield of fresh cobs with hulls ton/ha-1^{-}	Number of grains in cob	Cob Diameter mm	Cob length cm	Leaf area cm2 plant1-	Number of leaves -1plant leaf	Plant height -1cm plant	traits
0.3209**	0.3873**	0.2637*	0.3808**	0.4706**	0.5152**	0.5373**	1	Plant height
0.2501*	0.4268**	0.6149**	0.7574**	0.8141**	0.8281**	1	0.5373**	Number of leaves
0.4408**	0.5712**	0.6577**	0.7709**	0.7856**	1	0.8281**	0.5152**	Leaf area
0.4755**	0.5820**	0.7305**	0.8230**	1	0.7856**	0.8141**	0.4706**	cob length
0.6755**	0.7669**	0.7706**	1	0.8230**	0.7709**	0.7574**	0.3808**	cob diameter
0.6104**	0.6332**	1	0.7706**	0.7305**	0.7163**	0.6149**	0.2637*	Number of

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								grains per cob
0.9632**	1	0.6332**	0.7669**	0.5820**	0.5712**	0.4268**	0.3873**	Yield of fresh cob with hulls
1	0.9632**	0.6104**	0.6755**	0.4755**	0.4408**	0.2501*	0.3209**	Total grain yield

*

Significant at 5% probability level, ** Significant at 1% probability level. The results of the statistical analysis of plant height, number of leaves, leaf area per plant, cob length, cob diameter, number of grains per cob, yield of fresh cobs with husks, and total grain yield in Tables 3, 4, 5 indicated that the genetic compositions of Sweet corn plants varied significantly based on the square averages for all the studied traits, which reflects the presence of variations in the genetic structure. The results of the study were consistent with the experiences of many researchers through their studies for the purpose of evaluating Sweet corn hybrids. The results they obtained indicated that the genetic compositions of Sweet corn hybrids differed significantly in the studied vegetative growth and yield traits, including [9,10,23[

Recommendations:

The results of this study showed significant variation between the genetic compositions used in the experiment, and indicated the superiority of the hybrid SS3006 in most of the studied traits, in addition to considering the traits of fresh cob yield with covers, number of grains per cob, cob diameter, cob length, leaf area and plant height as selective indicators for the purpose of increasing productivity due to the presence of a positive and highly significant correlation with the trait of total grain yield. Therefore, it is recommended to conduct future studies that complement this study to determine the genetic stability of promising Sweet corn hybrids.

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