Genotypic, phenotypic correlation of genotypes of *Zea Mays* L.

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Abstract

In this study, 10 genotypes of maize (Zea mays L.) from Al-Dabbaneh Modern Agriculture Co. Ltd. were used. This study was conducted during the Autumn planting season of (2021). It included a field experiment conducted in two sites, the first in Nineveh province (Al Rashidiya), and the second in Erbil province (Al-Dabbaneh Modern Agriculture Company Ltd.) for three replications. The traits were studied: date to tasseling, date to silking, plant height, number of leaves per plant, area of main leaf ear, number of ear, ear length, Number of rows per ear, number of grains per row, number of grains per ear, weight of 300 grains, grain yield per plant and oil percent %. The results showed that the mean squares of the genotypes were significant at the 1% probability level for most of the studied traits and for both locations. The genotype (Reserave) for the Mosul location, and the genotype (215472) for Erbil location were excelled for most of the studied traits. The genetic correlation was significant and positive for the location of Erbil between the grain yield per plant and each of the number of rows per ear and the number of grains per ear

Key words: Maize, analysis of variance, genotypes genetic, environmental and phenotypic correlations

Introduction

Maize (*Zea mays* L.) is considered one of the important crops belonging to the Maydeae tribe and the Poaceae family. It is an important food and industrial grain crop in many countries of the world, including Iraq, where it is considered direct food for humans and animal feed and constitutes an important source of income for millions of people in countries around The World [12]. This is because its grains contain starch, protein, oil, vitamins and minerals, as well as being used as a source of biofuel, such as producing ethanol [2]. The global production rate of this crop reached 1148.49 million tons, while the cultivated area amounted to 197.2 million ha-[1], with a productivity rate of 5.8 tons' ha-[1]. [6], while the cultivated area of the maize crop in Iraq for the year (2021) amounted to about (325.9) thousand dunums, and the production reached (374.4) thousand tons to the [5]. Genetic variations are the basic material on which plant breeders build in improving the studied traits. As specialists were interested in studying the components of genetic and phenotypic variations for the studied traits, the selection programs depend mainly on the presence of genetic variation, knowledge and understanding of genetic behavior and the correlations between those traits, and the identification of the most influential traits as a criterion for selection comes by knowing the amount of correlations between these traits and the yield [3]. Knowing the correlation between pairs of important traits facilitates laying the right foundation for the most efficient breeding programs, and because of the interdependence of genes and the multiplicity of their influence, selection is either positive in which the improvement of one of the two traits follows the development of the other trait in the desired direction, or it is negative[14]. [7]indicated through their

study on maize yield, that the genetic variances were higher than the environmental variances for the traits which are plant height, number of leaves per plant, ear length, number of rows per ear, number of grains per row and number of perches per plant. [1]found that genetic variance is greater than environmental variance for the trait of a date to tasseling, date to silking, plant height, number of rows per ear, number of grains per ear, weight of 100 grains and grain yield per plant, While the environmental variance was higher than the genetic variance for ear length of maize crop. [9]reached the excelled of one of the genotypes for the characteristics of plant height and grain yield per plant by studying several genotypes of maize. [15]observed the superiority of one of the genotypes for the plant height, number of rows per ear and percentage of oil when they studied 4 genotypes of maize. [17]found significant and positive values of genetic correlation of grain yield per plant traits with plant height traits, number of ears per plant, when they were studied on the genotypes of maize crop. [11]concluded through their study on 10 genotypes of maize plant that the trait of the grain yield per plant was phenotypically significantly positively correlated with the number of grains per ear, the length of the ear and the number of grains per row.

Materials and methods

The field experiment was conducted during the Autumn season (2020-2021) in two environmentally different locations, the first in Nineveh province (Al Rashidiya) and the second in Erbil province (Al-Dabbaneh Modern Agriculture Company Ltd.). The distance between the two location is (95 km).10 genotypes of maize (Zea Mays L.) from Al-Dabbaneh Research Station were grown as shown in Table (1) using The Randomized Complete Block Design (RCBD) for three replications, As the planting was done by placing (2-3) seeds in each hole and the distance between one hole was (25 cm) and a thinning was done for the cultivated plants by leaving one plant in each hole. The plants grown during the season were irrigated regularly for both location and DAP (Diammonium phosphate) fertilizer was added with the addition of urea fertilizer. According to the fertilizer recommendations, the necessary processes for plant germination and growth under different environmental conditions were performed. The harvest was conducted for the two locations, Erbil and Mosul, on 4/11/5/11/2021, respectively. The studied traits were studied after the harvest process, date to tasseling, date to silking, plant height, number of leaves per plant, main ear leaf area (cm2), number of ear per plant, ear length (cm), number of grains per row, number of grains per ear, weight of 300 grains (gm), grain yield per plant (gm/plant), oil percent (%). The analysis of variance was conducted for the studied traits according to the randomized complete block design (R.C.B.D) and according to what was reported by [4], the correlation coefficients, genetic (rG), environmental (rE) and phenotypic (rP) between the studied traits were estimated in the manner explained by [16] according to the following equations:

$$rG = \frac{\sigma_{g_x g_y}}{\sqrt{\sigma^2{}_{G_x} \cdot \sigma^2{}_{G_y}}} \quad , \quad rP = \frac{\sigma_{p_x p_y}}{\sqrt{\sigma^2{}_{p_x} \cdot \sigma^2{}_{p_y}}} \quad ,$$

$$rE = \frac{\sigma_{E_x E_y}}{\sqrt{\sigma^2{}_{E_x} \cdot \sigma^2{}_{E_y}}}$$

Table (1) Names and source of genotypes from maize and their numbers used in the study.

No.	***Genotype name***	***Source***
1	*AGN 720*	*American Genetics*
2	*Jameson*	*American Genetics*
3	*Reserave*	*American Genetics*
4	*Konsens*	*Syngenta*
5	*215479*	*KWS*
6	*215475*	*American Genetics*
7	*215480*	*American Genetics*
8	*215481*	*American Genetics*
9	*215482*	*American Genetics*
10	*215472*	*American Genetics*

Results and discussion

Table (2) shows the mean squares of the genotypes for Al-Mosul location were significant for most of the studied traits except for the number of leaves (cm) and number of ears per plants. While Table (3) shows the mean squares of the genotypes for Erbil location that they were significant for most traits except for the two traits of the date to silking, Number of ears per plants and the percentage of oil (%). This finding is in line with what was found by [7], [1] and [10].This is an indication of the possibility of benefiting from significant traits in plant breeding and improvement programmers, such as selection for significant traits.

Table (2): Analysis of variance for genotypes according to a randomized complete block design for the studied traits of the Mosul location.

ources of ariation	degrees of freedom	studied traits												
		date to tasseling	date to silking	plant height (cm)	number of leaves per plant	Area of the main ear leaf (cm2)	Number of ears per plant	ear length cm))	Number of rows per ear	Number of grains per row	Number of grains per ear	Weight 300 grains (gm)	Grain yield per plant(g/plant)	Oil percent %.
plications	2	1.348	3.249	10.169	3.959	139.545	0.037	0.289	0.232	0.427	481.359	60.447	35.845	0.0003
enotypes	9	** 1.540	** 3.600	** 133.516	N.S. 0.586	** 1100.707	N.S. 0.043	** 2.319	** 0.979	** 9.553	** 4031.312	** 130.905	** 856.795	** 0.0003
xperimental ror	18	0.385	0.302	2.162	0.241	105.746	0.014	0.397	0.118	0.454	161.514	11.658	10.930	0.00003

** Significant at probability level (1%).

Table (3): Analysis of variance for genotypes according to a randomized complete block design for the studied traits for Erbil location.

sources of variation	degrees of freedom	studied traits												
		date to tasseling	date to silking	plant height (cm)	number of leaves per plant	Area of the main ear leaf (cm2)	Number of ears per plant	ear length (cm)	Number of rows per ear	Number of grains per row	Number of grains per ear	Weight 300 grains (gm)	Grain yield per plant(g/plant)	Oil per %.
replications	2	0.192	3.448	0.295	0.087	56.050	0.013	0.992	0.030	1.271	7.367	34.560	0.502	0.0
genotypes	9	** 3.326	N.S. 0.684	** 183.240	** 0.704	** 3820.789	N.S. 0.050	** 2.263	** 1.603	** 12.202	** 5902.572	** 111.703	** 1744.413	N.S 0.0
experimental error	18	0.274	0.505	0.646	0.059	123.307	0.033	0.403	0.140	0.354	8.650	6.674	3.542	0.0

** Significant at probability level (1%)

The results of Table (4) show the means of the genotypes of the studied traits for Mosul location, in which the genotypes (215475) (Reserave) and (Konsens) showed an early date to tasseling. For the trait of the date to silking, the genotype (AGN 720) excelled. The two genotypes (215472) (215482) had the highest plant height, as for the trait number of leaves per plant, the genotypes (215,475), (215482) and (Konsens) excelled. The genotypes (Konsens) and (Reserave) showed significantly for the traits of number of ears per plants. For the ear length trait, the genotype (215481) gave the highest value for the trait, which differed significantly from the rest of the genotypes. When estimating the trait of the number of rows in the ear, the genotypes (Konsens) and (Reserave) were distinguished by the highest value. As for the number of grains in the row, the genotype (Konsens) showed the highest mean, which does not differ significantly from the two genotypes (Reserave) (215472). As for the number of grains in the ear, it gave the genotype (Reserave) the highest value and the genotype (215482) showed significantly for the trait of weight of 300 grains. While the genotype (Reserave) showed the highest mean for the grain yield per plant, and the two genotypes (Reserave) and (215481) for the oil percentage trait. From the foregoing, it is clear that the genetic structure (Reserave) is superior for 7 traits, which are the date to tasseling, number of ears per plants, the number of rows per ear, the number of grains per row, the number of grains per ear, grain yield per plant and the percentage of oil. Table (5) indicates the means of the genotypes of the studied traits for the Erbil site, as it showed that the genotype (Jameson) exceeded date to tasseling, which did not differ significantly from the genotype (215481). While the genotypes (Jameson) and (Konsens) were recorded. (215475) and (215482) excelled for the date to silking. The genotypes (Reserave) and (Konsens) gave the highest plant height. The genotypes (215480), (215482) and (215472) were superior to the number of leaves per plant. For the main ear-leaf area trait, the genotype (Jameson) showed the highest value for the trait. The genotype (215479) showed the highest mean for the trait of number of ears per plant. The genotype (Jameson) gave the highest mean for the ear length, which did not differ significantly from the genotype (Reserave). The genotypes (215472) and (AGN 720) for the traits excelled on the number of rows per ear, the number of grains per row, the number of grains per ear. While the two genotypes (215480) and (215481) recorded the highest mean for the weight of 300 grains. The two genotypes (215472) and (AGN 720) gave the highest value for the trait of grain yield per plant. When estimating the percentage of oil, the two genotypes (Reserave) excelled (215481) with the highest value. We note from Table (5) that the genotype (215472) was excelled for 5 traits, namely number of leaves per plant, number of rows per ear, number of grains per row, number of grains per ear. Grain yield per plantand these results are in line with that of [1], [9]and [15] It is noted from these results that there is a wide variation in the performance of the genotypes for both sites, which gives the opportunity to select some genotypes, namely (Reserave), for the location of Mosul, and the genotype (215472) for Al-Erbil location in order to be included in future experiments.

Table (4) The mean performance of genotypes for thirteen phenotypes in maize for Mosul location

traits genotype	date to tasseling	date to silking	plant height (cm)	number of leaves per plant	Area of the main ear leaf (cm2)	Number of ears per plant	Ear length (cm)	Number of rows per ear	Number of grains per row	Number of grains per ear	Weight 300 grains (gm)	Grain yield per plant(g/plant)	Oil percent %.
AGN 720	53.777 أب جـ	54.333 هـ	171.733 جـ	12.233 أ ب	506.758 و	1.711 أ ب	23.866 أ ب	13.256 د	33.335 د	442.690 و	116.444 ب جـ	179.489 د هـ	2.039 د
Jameson	53.555 أ-د	55.888 جـ د	170.622 جـ د	11.666 ب	506.592 و	1.733 أ ب	21.366 د	14.231 أب جـ	32.610 د هـ	467.140 هـ	116.889 ب جـ	206.289 ب	2.043 جـ د
Reserave	52.777 جـ د	55.111 د هـ	171.778 جـ	12.700 أ ب	553.286 أ ب	1.822 أ	22.600 جـ	14.977 أ	36.717 أ	551.030 أ	111.778 جـ د	227.422 أ	2.072 أ
Konsens	52.666 جـ د	55.111 د هـ	168.133 د هـ	12.722 أ ب	529.278 د هـ	1.844 أ	22.800 ب جـ	14.631 أ ب	36.757 أ	533.680 أ ب	126.556 أ	209.933 ب	2.045 ب جـ د
215479	54.444 أ ب	57.444 أ ب	160.003 و	11.833 أ ب	527.308 د هـ	1.555 أ ب	22.222 جـ د	13.268 د	31.911 هـ	439.810 و	116.111 ب جـ	207.378 ب	2.061 أب جـ
215475	52.444 د	55.222 د هـ	165.822 هـ	12.855 أ	545.308 ب جـ	1.466 ب	23.755 أ ب	13.451 جـ د	35.066 ب جـ	479.800 د هـ	110.222 د	184.000 جـ د	2.055 أ-د
215480	54.555 أ	56.555 ب جـ	177.011 ب	12.077 أ ب	562.261 أ	1.777 أ ب	23.755 أ ب	14.364 أ ب	36.033 أ ب	519.320 ب جـ	108.778 د	174.222 هـ	2.058 أ-د
215481	53.333 أ-د	56.777 أب جـ	176.333 ب	11.811 أ ب	536.067 جـ د	1.688 أ ب	24.266 أ	14.064 ب جـ د	35.961 أ ب	503.510 جـ د	116.333 ب جـ	187.644 جـ	2.065 أ
215482	53.222 ب جـ د	55.777 جـ د	181.689 أ	12.733 أ ب	549.089 أب جـ	1.622 أ ب	23.022 ب جـ	13.917 ب جـ د	34.606 جـ	484.760 د هـ	129.000 أ	209.378 ب	2.059 أ-د
215472	53.000 جـ د	57.666 أ	180.044 أ	12.411 أ ب	519.392 هـ و	1.777 أ ب	23.266 أب جـ	14.072 ب جـ د	36.568 أ	496.490 جـ د	121.000 ب	189.822 جـ	2.065 أ ب

Table (5) The mean performance of genotypes for thirteen phenotypes in maize for the Erbil location

traits genotype	date to tasseling	date to silking	plant height (cm)	number of leaves per plant	Area of the main ear leaf (cm2)	Number of ears per plant	ear length (cm)	Number of rows per ear	Number of grains per row	Number of grains per ear	Weight 300 grains (gm)	Grain yield per plant(g/plant)	Oil percent %
AGN 720	55.222 ب جـ	58.333 أ ب	150.088 هـ	13.811 هـ	623.452 جـ	1.955 أ ب	25.577 أ ب جـ	15.177 أ	40.181 أ	598.800 أ	116.778 أ	216.244 أ	2.104 أ ب
Jameson	53.333 و	57.888 أ ب	156.444 د	15.066 أ ب جـ	677.813 أ	1.955 أ ب	26.577 أ	13.382 د	37.249 جـ	495.300 هـ و	110.444 ب	177.822 هـ	2.026 جـ
Reserave	54.888 ب جـ د	58.000 أ ب	172.300 أ	14.666 جـ د	617.643 جـ	1.911 أ ب	26.511 أ	13.544 جـ د	37.091 جـ	497.889 د هـ	105.000 جـ	171.289 و	2.125 أ
Konsens	55.666 ب	57.000 ب	172.777 أ	14.611 جـ د	586.581 د	1.822 أ ب	25.355 ب ج	13.851 ب جـ د	38.378 ب	529.978 جـ	105.667 جـ	183.911 د	2.077 أ ب جـ
215479	57.000 أ	58.777 أ	159.877 جـ	14.366 د هـ	576.967 د	2.044 أ	26.066 أ ب جـ	13.153 د	36.506 جـ د	482.667 ح	111.667 ب	147.022 ح	2.082 أ ب جـ
215475	54.222 جـ-و	57.888 أ ب	171.422 أ	14.533 جـ د	620.645 جـ	1.866 أ ب	26.400 أ ب	13.522 جـ د	36.604 جـ د	487.422 زح	110.444 ب	162.067 ز	2.072 أ ب جـ
215480	54.333 جـ و	58.111 أ ب	157.377 د	15.377 أ	669.947 أ	1.844 أ ب	25.133 جـ	14.191 ب جـ	35.634 د هـ	501.178 د	120.222 أ	203.022 جـ	2.078 أ ب جـ
215481	53.777 هـ و	58.000 أ ب	160.600 جـ	14.688 ب جـ د	588.704 د	1.688 ب	23.755 د	14.417 ب	34.822 هـ	491.533 و ز	119.667 أ	211.578 ب	2.123 أ ب
215482	54.111 د هـ و	57.888 أ ب	166.211 ب	15.133 أ ب جـ	585.220 د	1.622 ب	25.044 جـ	13.591 جـ د	34.599 هـ	472.022 ط	112.889 ب	174.933 هـ	2.082 أ ب جـ
215472	54.555 جـ د هـ	58.555 أ	157.277 د	15.355 أ ب	641.516 ب	1.755 أ ب	26.022 أ ب ج	15.220 أ	40.461 أ	588.400 ب	102.333 جـ	215.556 أ	2.046 ب جـ

It is clear from Table (7) the correlation coefficients of the studied traits for the location of Mosul, where the genetic correlation coefficient was positive significantly between: (1) number of ears per plants per plant, each of the number of grains per ear, the number of grains per row, and the number of rows per ear. (2) The number of rows per ear, each of the number of grains per ear, and the number of grains per row. (3) The number of grains in the row and the number of grains in ear. While the genetic correlation was significantly negative between: (1) ear length and grain yield per plant, and the environmental correlation was positively significant between: (1) number of ears per plant per plant and each of the grain yield per plant, the number of rows in ear and the length of ear. (2) The length of ear and the grain yield per plant. (3) The number of rows per ear and the number of grains per ear While the environmental correlation was significantly negative between: (1) number of ears per plants per plant and the number of grains per ear. (2) The length of the ear and the number of rows in the ear. (3) The number of grains per row and the weight of 300 grains. (4) Weight of 300 grains and grain yield per plant. The phenotypic correlation was significantly positive between: (1) number of ears per plants per plant and each of the grain yield per plant, the number of grains per ear, the number of grains per row, and the number of rows per ear. (2) The length of the ear and the number of grains in a row. (3) The number of rows per ear, each of the grain yield per plant, the number of grains per ear, and the number of grains per row. (4) The number of grains per row and the number of grains per ear. (5) The number of grains per ear and the grain yield per plant. (6) The weight of 300 grains and the grain yield per plant, while the phenotypic correlation was significantly negative between: (1) the length of ear and each of the grain yield per plant, the weight of 300 grains, and the number of rows in ear. This indicates that any increase in one of the two related traits leads to a decrease in the other. We conclude from Table (6) that there is a positive, significant environmental correlation between the grain yield per plant and each of number of ears per plant per plant and the length of ear. While the phenotypic correlation was positive between the grain yield per plant and each of the number of perforations per plant, the number of rows per ear, the number of grains per ear and the weight of 300 grain. Table (7) shows the correlation coefficients for the studied traits for Erbil location, where the genetic correlation coefficient was significant positive between: (1) number of ears per plant per plant and the ear length. (2) The number of rows per ear and each of the grain yield per plant, the number of grains per ear and the number of grains per row. (3) The number of grains per row and the number of grains per ear. (4) The number of grains per ear and the grain yield per plant, while the genetic correlation was significantly negative between: (1) the length of the ear and each of the grain yield per plant and the weight of 300 grains, (2) The number of grains per row and the weight of 300 grains. The environmental correlation was positive and significant between: (1) the number of perforations per plant and each of the number of grains per ear and the number of rows per ear. (2) The ear length and the number of rows in ear. (3) The number of rows per ear and each of the grain yield per plantand the number of grains per ear . While the environmental correlation was significantly negative between: (1) the number of perforations per plant and each of the weight of 300 grains, the number of grains per row and ear length. (2) The number of rows in the ear and each of the weight of 300 grains and the number of grains in a row. (3) The number of grains per row and each of the grain yield per plant and the number of grains per ear. (5) The number of grains per ear and the weight of 300 grains. (6) Weight of 300 grains and grain yield per plant. The phenotypic correlation was significantly positive between: (1) number of ears per plant and each of the number of grains per row and the ear length. (2) The ear length and the number of grains in a row. (3) The number of rows per ear and each of the grain yield per plant, the number of grains per ear and the number of grains per

row. (4) The number of grains per row and each of the grain yield per plant and the number of grains per ear. (5) The number of grains per ear and the grain yield per plant. (6) The weight of 300 grains and the grain yield per plant, while the phenotypic correlation was significantly negative between: (1) number of ears per plants per plant and each of the grain yield per plant and the number of rows per ear. (2) The ear length, each of the grain yield per plant, the weight of 300 grains, and the number of rows per ear. (3) The number of grains per row and the weight of 300 grains. (4) The number of grains per ear and the weight of 300 grains. In general, the positive significantly correlation indicates that the genetic systems cooperate synergistically by affecting each of the two linked traits, and that selection for any of them will affect the other in the same direction. Whereas, the phenotypic positive correlation indicates that any increase in one of the two traits leads to an increase in the other trait. These results are in line with what was reported by [17], [8]and [11]. It is clear from Table No. (7) that there is a positive significant genetic correlation between the grain yield per plant and each of the number of rows per ear and the number of grains per ear. While the environmental correlation was significant and positive between the grain yield per plant and the number of rows in ear. The phenotypic correlation was significant and positive between the grain yield per plant and each of the number of rows per ear, number of grains per ear, number of grains per row and weight of 300 grains.

Table (6) the genetic, environmental and phenotypic correlation of the studied traits for Mosul location

traits	correlation	traits					
		grain yield per plant (g/plant)	Weight 300 grain(g)	Number of grains per ear	Number of grains per row	The number of rows per ear	ear length (cm)
Number of ears per plant in plants	Rg	0.066	0.060	*0.225	*0.175	*0.245	-0.066
	Re	**0.378	-0.083	**-0.368	0.000	*0.229	**0.293
	Rp	*0.212	0.127	**0.504	**0.448	**0.678	-0.052
ear length (cm)	Rg	*-0.240	-0.062	0.040	0.147	-0.064	
	Re	**0.313	-0.126	-0.061	0.063	*-0.246	
	Rp	**-0.633	*-0.193	0.101	**0.409	*-0.230	
The number of rows per ear	Rg	0.160	0.015	**0.298	*0.230		
	Re	0.076	0.090	*0.221	-0.057		
	Rp	**0.457	0.058	**0.856	**0.628		
Number of grains per row	Rg	0.001	0.019	**0.297			
	Re	0.001	**-0.329	0.048			
	Rp	0.002	0.014	**0.857			
Number of grains per ear	Rg	0.103	-0.005				
	Re	0.089	-0.136				
	Rp	**0.305	-0.030				
Weight 300 grain(g)	Rg	0.127					
	Re	**-0.521					
	Rp	**0.328					

Table (7) The genetic, environmental and phenotypic correlation of the studied traits for Erbil location

traits	correlation	traits					
		The grain yield per plant (g/plant)	Weight 300 grain(g)	Number of grains per ear	Number of grains per row	The number of rows per ear	ear length (cm)
Number of ears per plant in plants	Rg	-0.131	-0.016	0.030	0.131	-0.103	*0.247
	Re	0.125	*-0.183	**0.342	**-0.344	*0.176	**-0.277
	Rp	**-0.299	-0.090	0.087	*0.228	*-0.167	**0.429
ear length (cm)	Rg	*-0.170	*-0.208	0.026	0.142	-0.130	
	Re	0.130	-0.079	0.123	0.029	**0.440	
	Rp	**-0.464	**-0.574	0.074	**0.391	*-0.246	
The number of rows per ear	Rg	**0.306	0.045	**0.286	*0.206		
	Re	**0.358	**-0.335	**0.346	**-0.360		
	Rp	**0.890	0.079	**0.830	**0.551		
Number of grains per row	Rg	0.129	*-0.170	**0.305			
	Re	**-0.312	-0.008	**-0.400			
	Rp	**0.376	**-0.489	**0.897			
Number of grains per ear	Rg	*0.230	-0.072				
	Re	-0.101	**-0.384				
	Rp	**0.689	*-0.216				
Weight 300 grain(g)	Rg	0.093					
	Re	*-0.243					
	Rp	**0.265					

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