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Estimated Analysis of Heterosis, Combining Ability and Correlation for some Agronomic Traits of Ten Double-Crosses in White Maize

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Abstract

The experiment was in the Experimental farm, Faculty of Technology and Development, Zagazig University, Egypt, the study was undertaken to evaluate the analysis of variance, mean performance, heterobeltosis, combining ability, correlation and identify superior double-cross hybrid for some agronomic traits. The results showed the analysis of variance of five single hybrids crosses white corn and their F1 crosses. The analysis deference of variance between genotypes showed a significant for all studies traits. Suggesting the presence of genetic variability genetic structures, the parent P_1 (145.3 g) and the crosses $P_3×P_5$ (167.7 g) $P_2×P_3$ (167.0 g), $P_1×P_4$ (164.7 g), and $P_3×P_4$ (163 g), were the better-performing reveled values for grain yield of plant. While grain yield of plant the highest significantly and positive of heterobilitosis was recorded by the crosses $P_3×P_5$, $P_2×P_3$, $P_3×P_4$, $P_1×P_4$, $P_1×P_5$, $P_1×P_3$, $P_2×P_5$, $P_4×P_5$ and $P_2×P_4$. The cross ($P_3×P_5$) showed positive and highly significant SCA effects for height of ear, grains number/row, the shelling and grain yield/plant, the cross recorded high specific combining ability involving good combiner. The correlation recorded that stem diameter demonstrated positive and highly significant association with rows number of ear, grains number of row, hundred grain weight, shelling percentage and grain yield/plant.

Keywords: Combining ability, correlation, Double-crosses in maize Introduction

Full length article *Corresponding Author, e-mail: ragabnada@zu.edu.eg

1. Introduction

The maize (*Zea mays* L.) occupies a high status in the agriculture and is widely used for food and non-food products worldwide [1]. It is the third most consumed cereal crop after wheat and rice [2]. It is used as a staple food in several parts of the world due to its high nutritive value therefore it makes maize more demanding globally not only as food and feed source [3] but also as raw material. It is helping to achieve food security and the economic development in a country [4]. Moreover, maize grain is rich in several nutrients such as protein, vitamins, starch and fibers. The oil extracted of maize has a high calorific value and contains high oleic, linoleic acid and low cholesterol contents which makes maize suitable for cardiovascular patients [5]. The higher genetic variability of maize germplasm allows the possibility for developing the superior cultivar both in yield and quality. The reason for the low productivity of maize in our country is improper genotype selection and plant density [6, 7]. [8] concluded that hybrid vigor by Better-parent is interest from agronomic and breeding point of view, because its amount relative to performance of it, and is crucial for the decision of whether or not to embark on hybrid breeding programs. Testing the single crosses hybrid expansion requires suitable test cross method. The diallel is the most importance hybridization method to find out the extent of single crosses combining ability that is beneficial in hybrid expansion. The [9] reported that the correlation among plant traits is importance to plant breeders for a successful maize breeding program. Substantial additive genetic associate among quantitative traits is essential for the efficient breeding program to development maize crop. In the view of above facts, the present study was to evaluate of analysis of variance, mean performance, heterobiltosis, combining ability and identify superior double-cross hybrid for grain yield and associated traits.

2. Materials and Methods

The experimental field was created by making crosses between 5 hybrids single cross of white maize used half dialile crosses design. Parents and their 10 F_1 crosses. The field experiment was conducted during the two summer successive growing seasons 2022 and 2023 evaluate of analysis of variance, mean performance, heterobiltosis, combining ability and identify superior double-cross hybrid for grain yield and associated traits, at the Experimental farm, Faculty of Technology and Development, Zagazig University, Egypt. The five single crosses hybrids of white Maize, single cross hybrid -10, single cross hybrid -128, single cross hybrid -130, single cross hybrid-131 and single cross hybrid-132 were obtained from Agricultural Research Center, Giza, Egypt. For used in the present study. Name, important traits of genotypes are shown in Table 1.

2.1. Design of experiment

The parents and their hybrids were sown in randomized block design in three replicates with 4 rows/plot, 4 meter length, the spice between plants 60 × 25 cm. Randomization of genotypes was done by Crop Stat v7.2 software. All the recommended agronomy inputs and practices were applied to the crop during the season to raise the successful crop.

2.2. Data Collection

Plant height, ear height, stem diameter, rows number/ear, grains number /row, the shelling percentage, 100-grain weight (g) and grain yield/plant (g).

2.3. Data Analysis

Data were subjected to the analysis of variance in a randomized complete block design using the Software of (SAS) version 9.1 to test, the means were separated by the least significant difference (LSD) for comparing between genotypes at 5% level of significance [10]. Heterobeltiosis were calculated according to the method described by [11].

1- For each trait measured, heterobeltiosis (Hbt) was calculated as increase percentage or decrease exhibited by the F_1s in comparison with the best parent values [12,13,14]:

$$BPH = \frac{F1-BP}{BP} \times 100$$

Where F_1 is the performance of the hybrid, and BP is the best performance of the parent.

2- SCA and GCA effects were calculated as described by [15,16]:

$$gi = \bar{y}_{i.} - \bar{y}_{..}$$
$$s_{ij} = y_{ij} - \bar{y}_{..} - g_i - g_j$$

Where g_i and g_j are the GCA effects for i^{-th} and j^{-th} parents, respectively; sij is the SCA effect for ij^{-th} crosses; y_{ij} is the trait value of ij^{-th} crosses; $\bar{y}_i$.. is the average of the crosses among i^{-th} parent crossed with a series of parents; $\bar{y}_i$.. is the overall mean. The genetic variances of GCA and SCA effects were obtained in a joint linear mixed model analysis of MHP over all tested environments by following [17]:

3- GCA/(GCA + SCA) ratio was calculated using the equation modified from [18,19]:

$$\frac{2\sigma 2\ \mathrm{GCA}}{2\sigma 2\ \mathrm{GCA} + 2\sigma 2SCA}$$

Where; σ^2GCA is the variance of GCA effects derived from the mean square of GCA and σ^2SCA is the variance of SCA effects derived from the mean square of SCA. Since the total genetic variance through F_1 hybrids is equivalent to twice the GCA component plus the SCA component, the closer this ratio is to unity, the greater the proportion of a specific hybrid's performance can be predicted based on GCA unity [18].

4- The genetic correlations between two traits, X1 and X2, were calculated by [20]. Genotypic correlation coefficient was computed according to the equations using computer program (Microsoft Excel).

3. Results and discussion

The data in Table (2) showed the f test for five single hybrids crosses white corn and their F1s crosses the analysis of variance between genotypes showed highly significant in all traits. The results were harmony with [21] reported that the highly significant genotypes, evincing the presence of genetic variability. Mean performance in Table (3) it the ranged from (196.7 cm $P_1 \times P_3$) to (294.4 cm $P_1 \times P_2$), the best-performing parents included P_3 (283.7cm) and P_1 (225.7 cm) as well as the crosses $P_1 \times P_2$ (294.4 cm), $P_3 \times P_4$ (249.7 cm), $P_4 \times P_5$ (238.7 cm) and $P_1 \times P_4$ (231 cm) for plant height. The parents P_2 and P_3 and crosses $P_4 \times P_5$ (122.0cm), $P_3 \times P_4$ (114.3cm), $P_2 \times P_3$ (113.7cm), $P_3 \times P_5$ (113.3cm) and $P_1 \times P_3$ (111.3 cm) were the highest performing heights for ear. Were harmony with reported by [22]. Furthermore, the largest stem diameter the crosses $P_1 \times P_3$ (3.6 cm), and $P_3 \times P_4$ (3.5 cm). Were the highest values for rows number/ear the crosses $P_2 \times P_3$ (16.7 row), $P_3 \times P_5$ with (16.0 row) and $P_1 \times P_2$ (15.3 row). The crosses $P_2 \times P_3$ (42.3 grain), $P_1 \times P_4$ (41.7 grain), $P_2 \times P_4$ (42.7 grain), $P_3 \times P_4$ (41.7 grain) and $P_3 \times P_5$ (40.3 grain) were the highest values performing for grains number of row. Furthermore, the crosses $P_2 \times P_3$ (43.3g), $P_1 \times P_4$ (42 g), $P_2 \times P_5$ (41.3g) and $P_1 \times P_3$ (40.3 g) were the entries for 100-grain weight. The crosses $P_3 \times P_4$ (84.9 %), $P_1 \times P_4$ (84.7 %), $P_3 \times P_5$ (84.3 %) and $P_1 \times P_3$ (84 %), were the highest values percentage for the shelling. The parent P1 (145.3 g) and the crosses $P_3 \times P_5$ (167.7 g) $P_2 \times P_3$ (167.0 g), $P_1 \times P_4$ and $P_1 \times P_4$ with mean (164.7 g), and $P_3 \times P_4$ (163 g), were the best-performing reveled values for grain yield of plant. [23] how revealed that the best-performing five highest-yielding crosses were as follows and crosses L6 × T1 (31.87g/plant), L14 × T3 (30.40g/plant), L4 × T1 (29.63g/plant), L5 × T3 (29.43g/plant) and L2 × T2 (29.37g/plant) were recorded maximum performing entries for 100-grain weight. The present data in Table (4) revealed the analysis of variance show the highly significant genotypes for all studies traits as well as highly significant between parents for all studies traits except height of ear and rows number/ear. Meanwhile between F1s crosses showed highly significant for height of plant (cm), ear height, grains number/row, 100-grain weight (g) and grain yield/plant (g), were significant for the shelling percentage but non-significant for stem diameter and number of row/ear. While analysis of variance between P vs. F1 showed highly significant for all studies traits. The results were harmony with recorded by [24] how found that the analysis of variance significant between parents and their crosses for all characters. The present for hetirobilitosis in Table (5) showed negative and highly significant by the crosses $P_1 \times P_3$, $P_1 \times P_5$, $P_2 \times P_3$, $P_3 \times P_5$ and $P_3 \times P_4$ On the basis the best parents for plant height trait, which indicates the possibility of benefiting from it in breeding programs to resistance for lodging and suitable for mechanical harvesting. Meanwhile the crosses P_1 x P_2, P_1 x P_4, P_2 x P_4, P_2 x P_5 and P_4 x P_5 were are showed positive and highly significant hetirobilitosis for plant height. These results are in harmony with those reported by [25] found positive and negative heterosis was against better parent for plant height. The crosses (P_1×P_4), (P_1×P_5), (P_2×P_4) and (P_2×P_5) showed heterosis of best-parents negative and highly significant for ear height. While the crosses (P_1×P_3), (P_2×P_3), (P_3×P_4), (P_3×P_5) and (P_4×P_5) recorded the positive and a highly significant heterobilitosis for height of ear (cm). These results are in agreement with those reported by [26] how showed the highest negative significant heterobeltiosis for height of ear (cm). Meanwhile the crosses (P_1×P_2), (P_1×P_3), (P_1×P_4), (P_1×P_5), (P_3×P_4) and (P_4×P_5), show positive and highly significant heterobilitosis, where the cross (P2×P4) was the negative and highly significant for stem diameter. The highest positive and highly significant best parent heterosis was recorded by the crosses (P_2×P_3), (P_3×P_5), (P_3×P_4), (P_2×P_5), (P_1×P_2). But positive and significant showed by (P_4×P_5) and (P_2×P_3) for number of rows/ear. The height positive and highly significant best-parents heterosis was recorded by P_2×P_5 (38.37%), P_2×P_4 (31.87%), P_4×P_5 (28.57%), P_2×P_3 (27.00%), P_3×P_5 (25.00%), P_3×P_5 (21.00%) and P_1×P_4 (7.76%), while negative and highly significant better parent heterosis was recorded by P_1×P_2 (-14.66%), and P_4×P_5 (-6.03%) for grains number/row. Meanwhile hundred grain weight the all F_1 crosses were showed positive and highly significant except the crosses (P_1×P_2) and (P_2×P_4) were are showed negative and highly significant heterobilitosis. These results are in harmony with those obtained by [25] reported that the hundred grain weight, rows number of ear and grains number of row heterosis was unanimously obtained against all these measurements for heterosis. The shelling percentage the all F_1 crosses were showed positive and highly significant except the crosses (P_1×P_2) and (P_2×P_3) were are showed negative and non-significant heterobilitosis. Grain yield of plant the crosses P_3×P_5 (22.38%), P_2×P_3 (21.90%), P_3×P_4 (18.98%), P_1×P_4 (13.30%), P_1×P_5 (13.30%), P_1×P_3 (7.80%), P_2×P_5 (6.11%), P_4×P_5 (2.96%) and P_2×P_4 (2.69%) were the highest positive and highly significant better-parents heterosis. while negative and highly significant better parent heterosis was recorded by P1×P2 (-1.38%) grain yield of plant. [23] reported that the increase heterobeltiosis by significant positive heterosis for the grain yield (g). [26] found that the positive significant heterobeltiosis of rows number of ear, grains number of /row, 100-grain weight and grain yield. The present data in Table (6) showed that the general combining ability (GCA) was highly significant ($P < 0.01$) for all traits, which indicates that the Parents contributed differently in the crosses in which they were involved. The specific combining ability (SCA) was highly significant for all traits under this study, which allows us to infer that there were hybrid combinations that had a performance different from that expected only on the GCA effects for all traits, the additive and non-additive effects are relevant. GCA/SCA ratio was computed. With the exception of all traits, low values which less the unity were detected, indicating that the largest part of the total genetic variability associated with these traits was a result of dominance and over dominance type of gene action. Some researcher found similar results [27,28,29]. On the other hand, [30,31] reported that both additive and non-additive were important in genetic expression of the yield and its components traits in maize. The results were harmony with reported by [32,33] reported that the additive and dominance effects for grain yield had similar magnitudes. The predominance of GCA verified in this study for all traits can be explained by the fact that the parents make use of were selected for both per se and testcross performance, which is directly associated with additive effects. In addition, [34] indicated that GCA and SCA were significant for all observed traits. Estimates of general combining ability effects (GCA) and specific combining ability (SCA) are given in Table (7). The results reveal the all parents were positive and highly significant GCA effects for all traits except the parent P5 for stem diameter and the parent P4 for 100-grain weight from the previous result, it could be concluded that the three parental P_3, P_2 and P_1 seemed to be the best general combiners for grain yield/plant and some of its components in the combined analysis. [29] found that the parents M9 and M120 were good general combiner for yield and its components. These single crosses parents may be attained if they are used in hybridization program for production the double-crosses because they contain favorable genes to improvement of yield. Meanwhile the SCA effects indicated the cross P3xP4 reveled positive and highly significant for height of plant (cm), height of ear (cm), rows number of ear, grains number of row, 100-grain weight (g), the shilling and grain yield/plant (g) and significant for other traits. As well as the cross (P_4×P_5) recorded positive and highly significant SCA for height of plant, height of ear, stem diameter, grains number of row, 100-grain weight and grain yield of plant but positive non-significant for rows number of ear. The cross (P_3×P_5) showed positive and highly significant SCA effects for height of ear, grains number of row, the shelling and grain yield of plant (g). Meanwhile the cross (P_1×P_4) recorded positive significant and highly significant SCA for height of plant (cm), grains number of row, 100-grain weight (g), grain yield of plant (g) and stem diameter. While the cross (P_2 x P_3) reveled positive and significant and highly significant SCA for height of ear, number of rows, grains number of row, 100-grain weight and grain yield of plant. Whereas the cross (P_1×P_5) recorded positive significant and highly significant SCA for stem diameter, 100-grain weight, the shelling, grain yield and plant height. These crosses recorded high specific combining ability involving good combiner such combinations would reveled desirable transgressive-segregation, system present in the good combiner as well as the complementary and epistatic effects present in the cross, appear in the same direction to reduce unwanted plant and maximize the traits. Therefore, the previous crosses may be of prime importance in breeding program for traditional breeding procedures. The results were harmony with reported by [35]. Association among plant traits in Table (8) revealed that the correlation between plant height and with other traits it were positive and non- significant except grain yield of plant, it was negative and non-significant it is concluded that improving plant height leads to a decrease in grain yield as a result of plant loading or the plant's tendency toward vegetative growth at the expense of the yield.

Table 1. Name and origin of parents in white Maize

Number	**Genotypes**	**Origin**
P1	single cross hybrid -10	Egypt
P2	single cross hybrid -128	Egypt
P3	single cross hybrid -130	Egypt
P4	single cross hybrid -131	Egypt
P5	single cross hybrid-132	Egypt

Table 2. Estimation of mean of square for some agronomic in five parents and their f_1 crosses for of white Maize

c.v.	**d.f**	**Height of plant (cm)**	**Height of ear (cm)**	**Stem diameter (cm)**	**Rows number of ear**	**Grains number of row**	**100-grain weight (g)**	**The shelling %**	**Grain yield /plant (g)**
Rep.	2	2.710	3.622	0.044	0.87	0.96	13.38	8.281	4.9
Genotypes	14	2211.2**	92.517**	0.301**	4.09**	69.6**	99.98**	12.921**	507.4**
Error	28	12.167	5.860	0.046	1.3	3.41	3.51	1.859	3.6
Total	44								

* Significant at 0.05 level; **. Significant at 0.01 level

Table 3. Mean performance of some agronomic for five parents and their F1 double-crosses for white Maize

Genotype	Height of plant (cm)	Height of ear (cm)	Stem diameter/ (cm)	Rows number / ear	Grains number of row	100-grain weight (g)	The shelling (%)	Grain yield plant (g)
P1	225.7	105.0	2.8	14.3	38.7	31.0	82.1	145.3
P2	214.0	108.7	3.1	12.7	28.7	32.3	80.6	136.3
P3	283.7b	106.0	3.3	12.7	33.3	31.7	81.1	137.0
P4	214.7	105.7	3.1	13.3	30.3	23.0	78.1	134.7
P5	198.0	106.0	2.4	13.3	28.3	28.8	78.8	135.0
P1 x P2	294.4a	107.7	3.3	15.3	33.0	30.0	81.9	143.3
P1 x P3	196.7	111.0	3.6	14.7	38.0	40.0	84.0	156.7
P1 x P4	231.0	102.7	3.4	14.7	41.7	42.0	84.7	164.7
P1 x P5	221.3	103.7	3.4	14.7	36.3	38.0	84.3	164.7
P2 x P3	228.3	113.7	3.4	16.7	42.3	43.3	80.8	167.0
P2 x P4	222.3	105.0	2.9	14.0	40.0	30.0	83.0	140.0
P2 x P5	222.3	101.0	3.1	15.3	39.7	41.3	81.6	144.7
P3 x P4	249.7	114.3	3.5	15.3	41.7	38.0	84.9	163.0
P3 x P5	227.0	113.3	3.2	16.0	40.3	34.7	83.5	167.7
P4 x P5	238.7	122.0	3.4	14.0	39.0	35.3	83.3	139.0
LSD $_{0.05}$	9.8	3.933	0.349	3.2	5.2	5.2	3.8	5.3

Table 4. Mean of square of some agronomic for five parents and their F_1 double-crosses for white Maize

c.v	d.f	Height of plant (cm)	Height of ear (cm)	Stem diameter (cm)	Rows number/ear	Grains number/ row	100-grain weight (g)	The shelling (%)	Grain yield /plant (g)
Rep.	2	2.71	3.62	0.04	0.87	0.96	13.37	8.28	4.87
Genotypes	14	2211.2**	92.52**	0.30**	4.09**	69.64**	99.98**	12.92**	507.49**
Parents	4	3281.1**	5.90	0.38**	1.40	55.10**	43.22**	8.27**	57.83**
Crosses	9	1941.7**	130.15**	0.14	2.13	24.09**	66.80**	5.82*	427.32**
P. Vs. F1	1	356.8**	100.28**	1.47**	32.40**	537.78**	625.58**	95.40**	3027.60**
Error	28	12.17	5.86	0.05	1.30	3.41	3.51	1.86	3.65
Total	44								

* Significant at 0.05 level; **. Significant at 0.01

Table 5. Estimated of heterobeltosis of some agronomic traits for five parents and their F_1 double-crosses for white Maize

Genotype	height of plant (cm)	Height ear (cm)	Stem diameter (cm)	Rows number of /ear	Number of grain/row	100-grain weight (g)	The shelling (%)	Grain yield of /plant (g)
P1 x P2	30.46**	-0.92	6.45**	6.98**	-14.66**	-7.22**	-0.19	-1.38**
P1 x P3	-30.67**	4.72**	7.00**	2.33	-1.72	26.32**	2.40**	7.80**
P1 x P4	2.36**	-2.84**	10.87**	2.33	7.76**	35.48**	3.27**	13.30**
P1 x P5	-1.92**	-2.20**	21.43**	2.33	-6.03**	22.58**	2.69**	13.30**
P2 x P3	-19.51**	4.60**	3.00	31.58**	27.00**	34.02**	-0.39	21.90**
P2 x P4	3.57**	-3.37**	-7.53**	5.00*	31.87**	-7.22**	2.96**	2.69**
P2 x P5	3.89**	-7.06**	1.08	15.00**	38.37**	27.84**	1.18**	6.11**
P3 x P4	-11.99**	7.86**	6.00**	15.00**	25.00**	20.00**	4.69**	18.98**
P3 x P5	-19.98**	6.92**	-5.00**	20.00**	21.00**	9.47**	3.03**	22.38**
P4 x P5	11.18**	15.09**	11.96**	5.00*	28.57**	22.74**	5.80**	2.96**

* Significant at 0.05 level; **. Significant at 0.01 levels

Table 6. Mean of square of combining ability for some agronomic of five parents and their F_1 double-crosses for white Maize

c.v	d.f	Height of plant (cm)	Height ear (cm)	Stem diameter (cm)	Rows number of ear	Grains number of row	100-grain weight (g)	The shelling (%)	Grain yield /plant (g)
GCA	4	151606.5**	33080.9**	29.01**	589.3**	3823.2**	3412.7**	18996**	62938.1**
SCA	9	12409.2**	2220.9**	2.16**	43.4**	339.1**	352.0**	1222.8**	4646.3**
Error	28	12.2	5.9	0.05	1.3	3.4	3.5	1.9	3.7
GCA/ (GCA+SCA)		0.924	0.937	0.930	0.931	0.919	0.906	0.940	0.931

* Significant at 0.05 level; **. Significant at 0.01 levels

Table 7. Estimation of GCA and SCA effects of for some agronomic of five parents and their F_1 double-crosses for white Maize

Genotype	Height of plant (cm)	Height of ear (cm)	Stem diameter(cm)	Rows number of /ear	Grains number of /row	100-grain weight (g)	The shelling (%)	Grain yield /plant (g)
GCA								
P1	29.85**	11.64**	0.411**	2.0**	5.3**	4.9**	11**	21.7**
P2	29.94**	12.84**	0.369*	1.8**	3.6*	4.5**	9.7**	15.2**
P3	39.14**	15.31**	0.549**	1.9**	5.6**	5.8**	10.5**	22.7**
P4	26.89**	14.18**	0.424**	1.5*	4.9**	2.3	10.1**	16.2**
P5	18.68**	13.76**	0.244	1.8**	3.5*	4.2**	9.9**	17.4**
SCA								
P1 x P2	19.5**	5.8**	0.2	1.2*	-2.1	-4.1**	2.5	-0.2
P1 x P3	-37.5**	6.6**	0.3*	0.4	0.8	4.6**	3.8**	5.6*
P1 x P4	9.1**	-0.6	0.3*	0.8	5.2**	10.1**	4.9**	20.1**
P1 x P5	7.7*	0.9	0.5**	0.6	1.2	4.2**	4.6**	18.9**
P2 x P3	-5.9	8.1**	0.2	2.6**	6.8**	8.3**	1.8	22.5**
P2 x P4	0.4	0.6	-0.2	0.3	5.3**	-1.5	4.5**	2.0
P2 x P5	8.6*	-3.0*	0.2	1.4*	6.3**	7.9**	3.3**	5.4*
P3 x P4	18.5**	7.4**	0.3*	1.5*	4.8**	5.2**	5.5**	17.4**
P3 x P5	4.1	6.9**	0.1	1.9*	4.9**	-0.1	4.4**	20.8**
P4 x P5	28**	16.6**	0.5**	0.3	4.3**	4.1**	4.6**	-1.3

* Significant at 0.05 level; **. Significant at 0.01 levels

Table 8. Estimation of correlation for some agronomic traits for five parents and their $f_1$crosses

Traits	Height of plant (cm)	Height of ear (cm)	Stem diameter (cm)	Rows number of ear	Grains number of row	100-grain weight (g)	The shilling %
Height of plant (cm)							
Height of ear (cm)	0.093						
Stem diameter (cm)	0.321	0.393					
Rows number of ear	0.078	0.233	0.404				
Grains number of row	0.043	0.241	0.471*	0.729**			
100-grain weight (g)	0.090	0.145	0.584*	0.636**	0.709**		
The shilling %	0.132	0.213	0.603**	0.432	0.719**	0.610**	
Grain yield /plant (g)	-0.061	0.165	0.564*	0.788**	0.704**	0.736**	0.665**

* Significant at 0.05 level; **. Significant at 0.01 levels

Meanwhile the stem diameter trait recorded positive and significant between grain yield (g), the shelling percentage (%), 100-grain weight (g) and grains number of row, suggesting that the improving of stem diameter leads to increase these traits. Meanwhile, the character rows number of ear demonstrated positive and highly significant association with grains number of row (0.729**), 100-grain weight (g) (0.636**) and with grain yield/plant (g), (0.765**). The results are in agreement with those reported by other researchers, [36,37,38]**.** The character number of grain /row demonstrated positive and highly significant association with the 100-grain weight (g) (0.709**) shilling percentage (0.719**), and grain yield of plant (0.704**). Whereas 100-grain weight showed positive and highly significant correlation between the shelling percentage (0.610**) and with grain yield of plant (0.736**). The results were in harmony with those recorded by [39] showed that 100-grain weight has the most positive correlation with grain yield. The high correlation of grain yield with 1000-grain weight (g) and rows number/ear is reported by other researchers [40]. The shelling % recorded positive and significant association with grain yield of plant (g).

4. Conclusions

Suggesting the presence of genetic variability genetic structures, the parent P_1 (145.3 g) and the crosses $P_3×P_5$ (167.7 g) $P_2×P_3$ (167.0 g), $P_1×P_4$ (164.7 g), and $P_3×P_4$ (163 g), were the better-performing reveled values for grain yield of plant. While grain yield of plant the highest significantly and positive of heterobilitosis was recorded by the crosses $P_3×P_5$, $P_2×P_3$, $P_3×P_4$, $P_1×P_4$, $P_1×P_5$, $P_1×P_3$, $P_2×P_5$, $P_4×P_5$ and $P_2×P_4$. The cross ($P_3×P_5$) showed positive and highly significant SCA effects for height of ear, grains number/row, the shelling and grain yield/plant, the cross recorded high specific combining ability involving good combiner. The correlation recorded that stem diameter demonstrated positive and highly significant association with rows number of ear, grains number of row, hundred grain weight, shelling percentage and grain yield/plant.

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