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COMBINING ABILITY AND HETEROSIS FOR MAIZE GRAIN YIELD AND SOME AGRONOMIC CHARACTERS

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ABSTRACT

The present study was carried out at the Experimental Station Farm, Faculty of Agriculture, Mansoura University, Dakahlya Governorate, during the two successive seasons of 2011 and 2012 to determine general, specific combining abilities and heterosis for grain yield and yield associated traits by crossing 6 inbred lines of maize in a half diallel mating design. Fifteen F_1 single crosses with their parents were planted in a randomized complete block design with three replicates.

Results showed that mean squares of crosses were significant for all studied traits i.e. number of days to 50% tasseling and silking, plant height, number of rows/ear, number of grains/row, 100-grain weight, grain yield/plant and shelling percentage. The analysis of variance revealed highly significant mean squares of general combining ability (GCA) and specific combing ability (SCA) for all studied traits, indicating the importance of both additive and non additive genetic effects for these traits. GCA/SCA variances ratios were found to be greater than unity for number of days to 50% tasseling and silking, plant height and 100-grain weight, indicating that the additive and additive×additive types of gene action were greater importance in the inheritance of these 4 traits. Best GCA effects for earliness traits (number of days to 50% tasseling and silking) achieved inbred lines P4 (Inb.173) and P5 (Inb.174), for plant height were P1 (Sd63), P3 (Inb.19), P4 (Inb.173) and P5 (Inb.174), for number of rows/ear were P1 (Sd63), P3 (Inb.19) and P4 (Inb.173), for 100-grain weight was P1 (Sd63). Inbred lines P1 (Sd63) and P2 (Sd7) showed best GCA effects for grain yield. Also P2 (Sd7) and P6 (Inb.170) showed best GCA effects for shelling percentage.

Hybrid combinations P2×P5 and P3×P6 showed largest SCA effects for number of days to 50% tasseling, for number of days to 50% silking were P1×P2, P1×P6, P2×P5 and P3×P4, for plant height were P1×P3, P1×P5, P2×P3, P2×P6, P4×P5 and P4×P6, for number of rows/ear were P1×P2, P1×P4, P2×P3, P3×P4, P4×P5 and P5×P6 and for shelling percentage were P1×P3, P1×P4, P2×P3, P2×P4, P3×P4 and P5×P6. Concerning number of grains/row, grain yield/plant and100-grain weight, most of crosses recorded positive significant or highly significant SCA effects. Results showed significant or highly significant heterosis for all studied traits. Cross P3×P6 was the best, with highly significant negative heterosis over mid and better parents for number of days to 50% tasseling. Cross P2×P3 recorded the highest negative heterosis over mid and better parents for number of days to 50% silking. Regarding to plant height, none of the cross combinations showed negative heterosis over mid and better parents. The best cross over mid and better parents for number of grains/row, grain yield and 100-grain weight was P1×P2. Crosses P1×P4 and P5×P6 recorded the highest positive heterosis over mid and better parents for number of rows/ear and shelling percentage, respectively.

Therefore, it could be stated that parents with good positive GCA for grain yield (P1 and P2), negative GCA for tasseling, silking date (P4 and P5) and dwarf plant height (P1, P3, P4 and P5) may be extensively used in hybridization program as a donor. The better performing four crosses (P1×P2, P1×P4, P1×P6 and P2×P3) can

be utilized for developing high yielding hybrid varieties as well as for exploiting hybrid vigor.

INTRODUCTION

In Egypt, maize (*Zea mays* L.) is an important cereal crop and it ranks third position after wheat and rice. Maize plays a significant role in human and livestock nutrition world-wide. Moreover, it confirms the basis of several industries such as; starch, cooking oil and main of animal food. The five main producers in the world are: the United States of America (USA), China, Brazil, India and Mexico. The USA is the major producer of maize in the world, with just below a quarter of the world's production. In Egypt, the annual production of maize is 41.825 million ardab from 1.75 million feddan, viz. a mean yield of only 23.9 ard/fad. (FAO, 2010). There is a critical need to increase the production of maize to face the gab between production and consumption. Exploitation of hybrid vigor and selection of parents based on combining ability has been used as an important breeding approach in crop improvement (Uddin *et.al.* 2006). Developing of high yielding F_1s along with other favorable traits is receiving considerable attention. For developing desirable hybrids, information about combining ability of the parents and the resulting crosses is essential. The variances of general and specific combining ability are related to the type of gene action involved. Variance for GCA includes additive portion while that of SCA includes non-additive portion of total variance arising largely from dominance and epistatic deviations (Rojas and Sprague, 1952). Diallel crosses have been widely used in genetic research to investigate the inheritance of important traits among a set of genotypes. These were devised, specifically, to investigate the combining ability of the parental lines for the purpose of identification of superior parents for use in hybrid development programs. Heterosis can be defined as the increased performance of offspring compared with their respective parents. That is, progeny resulting from hybridization are superior to either of their two parents. (Shull 1908) first described this phenomenon after observing the stimulation of heterozygosity upon cell division, growth, and other physiological characters in maize. Therefore, the objective of this study is meant to estimate general, specific combining abilities and heterosis among six inbred lines and their F_1s crosses.

MATERIALS AND METHODS

Plant materials and field experiments: Six inbred lines of maize viz. P1 (Sd.63), P2 (Sd.7), P3 (Inb.19), P4 (Inb.173), P5 (Inb.174) and P6 (Inb.170) obtained from Field Crop Research Institute (FCRI), Agriculture Research Center (ARC), Ministry of Agriculture and Land Reclamation, Egypt were crossed according to a half diallel crosses mating design during summer season of 2011 in Farm of the Agronomy Department, Faculty of Agriculture, Mansoura University. During summer season 2012, the 15 F_1s and along with their six parents were grown following Randomized Complete Block Design with three replications in the same farm. Each plot area was 6.3 m^2, which consisted of 3 ridges, each of 3 m in length and 70 cm in width. The distance between hills was 25 cm. Calcium super phosphate (15.5 % P_2O_5) was incorporated in the soil during the tillage operation at a rate of 150 kg/fed. Nitrogen fertilizer in the form of Urea (46 % N) was added at the rate of 120 kg N/fed in two equal doses, the first was after thinning and before the first irrigation, and the second before the second irrigation. The first irrigation was applied after 21 days from planting and then at 15 days intervals during the growing seasons. Weeds were controlled by using manual method before irrigation. Other agricultural practices were carried out as recommended by Ministry of Agriculture and Land Reclamation. Samples of ten guarded plants were taken at random from middle ridge of each plot to determine the quantitative and qualitative characters.

Studied traits: Number of days to 50% tasseling and silking (days), plant height (cm), number of rows/ear, number of grains/row, 100-grain weight (g), grain yield/plant (g) and shelling percentage (%).

Statistical analysis: The obtained data were statistically analyzed for analysis of variance by using computer statistical program MSTAT-C. The 15 single crosses comprise a half diallel between 6 inbred lines. Data of all 21 genotype were statistically analyzed, as the technique of analysis of variance (ANOVA) procedures of the used (randomized complete block) design, as mentioned by Gomez and Gomez (1984). The sum of squares of crosses was partitioned to general and specific combining ability following method 4 model 1 (fixed effects) of (Griffing 1956). Heterosis as proposed by Mather and Jinks (1982) was determined for individual crosses as the percentage deviation of F_1 means from mid-parents means (MP) and better parent (BP).

RESULTS AND DISCUSSION

1. Analysis of variance: As shown in Table 1 analysis of variance for combining ability reveled that mean squares of crosses were highly significant for all studied traits, indicating wide range of genetic variability among the studied crosses and this is primary requirement for further computation. Both GCA and SCA variances were highly significant for all the studied characters, indicating the importance of additive as well as non-additive type of gene action in controlling the traits. General combining ability/specific combining ability (GCA/SCA) variance ratios were found to be greater than unity for 4 traits i.e. number of days to 50% tasseling and silking, plant height and 100-grain weight, indicating that the additive and additive×additive types of gene action were greater importance in the inheritance of these 4 traits. It is therefore could be conducted that the presence of large amounts of additive effects suggests the potentiality for obtaining further to improve these 4 traits. On the other hand, GCA/SCA variances ratios were found to be lower than unity for other remaining traits, indicating the performance of non-additive genetic variance in the inheritance of these traits, therefore selection procedure in late or advanced generations will be very important to improve these traits. Similar results were reported by Alam *et al.* (2008), Barakat and Osman (2008) and Sultan *et al*. (2011).

Table 1: Mean squares from the analysis of variance, for general and specific combining abilities (SCA&GCA) for all studied traits.

S.V	D.f	No. of days to 50% tasseling	No. of days to 50% silking	Plant height	No. of rows/ear
Crosses	14	15.371**	13.486**	802.870**	3.924**
GCA	5	12.767**	10.867**	548.306**	2.027**
SCA	9	0.878*	0.956**	111.688**	0.908**
Error	28	0.238	0.238	0.407	0.003
GCA/SCA		4.896	3.703	1.231	0.559
S.V	**D.f**	**No. of grains/row**	**100-grain weight**	**Grain yield/ plant**	**Shelling percentage**
Crosses	14	100.440**	58.619**	5393.759**	22.291**
GCA	5	64.378**	45.340**	2993.122**	9.001**
SCA	9	16.315**	5.206**	1133.933**	6.558**
Error	28	0.015	0.00003	0.0003	0.0003
GCA/SCA		0.987	2.177	0.660	0.343

*,** significant at 0.05 and 0.01 level of probability, respectively.

2. General combining ability effects (g_i): As shown in Table 2 estimates of GCA effects showed that, the parents P4 (Inb.173) and P5 (Inb.174) were found to be good general combiners for earliness traits (number of days to 50% tasseling and silking), where they showed negative and highly significant GCA effects for these traits. With respect to plant height, inbred parents P1 (Sd63), P3 (Inb.19), P4 (Inb.173) and P5 (Inb.174) showed negative and highly significant GCA effects, indicating that these inbred parents were good general combiners for short stature. Concerning number of rows/ear, the inbred parents P1 (Sd63), P3 (Inb.19) and P4 (Inb.173) showed positive highly significant GCA effects, indicating that these inbred parents are the best general combiners for increasing number of rows/ear. With respect to number of grains/row, the inbred parents P1 (Sd63), P2 (Sd7) and P5 (Inb.174) showed positive highly significant GCA effects, indicating that these inbred parents are the best general combiners for increasing number of grains/row. In connection with 100-grain weight, P1 (Sd63) was found to be good general combiner for this trait. The best general combiners for grain yield/plant were P1 (Sd63) and P2 (Sd7), indicating that these inbred parents could be considered as good combiners for improving this trait. P2 (Sd7) and P6 (Inb.170) recorded positive highly significant GCA effects for shelling percentage, indicating that these inbred parents are the best general combiners for increasing this trait. The obtained results completely agreed with the points of view which were reported by **Choukan (1999)**, **Alam *et al*.** (2008), Abdel-Moneam *et al*. (2009) and Haddadi *et al*. (2012).

Table 2: Means and general combining ability (GCA) effects (g_i) for inbred parents for all studied traits.

	No. of days to 50% tasseling		No. of days to 50% silking		Plant height		No. of rows/ear	
	Mean	g_i	Mean	g_i	Mean	g_i	Mean	g_i
P1	58.00	1.667**	61.00	1.667**	135.50	-9.000**	10.00	0.472**
P2	57.00	1.167**	62.00	0.917**	185.00	17.375**	11.33	-1.276**
P3	56.00	-0.083	60.00	-0.333	180.75	-2.875**	12.00	0.139**
P4	51.00	-1.333**	55.00	-1.083**	131.50	-14.063**	11.33	0.807**
P5	47.00	-2.833**	50.00	-2.583**	186.50	-1.188**	14.00	-0.113**
P6	57.00	1.417**	61.00	1.417**	157.25	9.750**	12.67	-0.028
S.E (g_i)	--	0.223	--	0.223	--	0.291	--	0.026
S.E (g_i-g_j)	--	0.345	--	0.345	--	0.451	--	0.041

	No. of grains/row		100-grain weight		Grain yield/plant		Shelling percentage	
	Mean	g_i	Mean	g_i	Mean	g_i	Mean	g_i
P1	14.33	0.944**	21.53	6.072**	57.123	45.514**	80.95	-1.958**
P2	15.83	6.697**	22.10	-0.306**	62.140	22.079**	82.22	1.927**
P3	12.33	-4.096**	22.57	-0.113**	70.050	-19.661**	84.00	-0.071**
P4	17.67	-0.806**	16.83	-4.256**	68.149	-11.894**	83.67	-1.168**
P5	30.50	1.234**	22.70	-0.143**	63.104	-16.437**	82.42	-0.238**
P6	22.67	-3.973**	21.80	-1.253**	62.123	-19.602**	82.22	1.509**
S.E (g_i)	--	0.057	--	0.003	--	0.008	--	0.008
S.E (g_i-g_j)	--	0.088	--	0.004	--	0.013	--	0.013

***,** significant at 0.05 and 0.01 level of probability, respectively.**
S.E (gi) Standard error for an GCA effect.
S.E (gi-gj) Standard error for the difference between estimates of GCA effects.

3. Specific combining ability effects (S_{ij}): As shown in Table 3 Significant or highly significant negative SCA effects were found in earliness traits for some crosses. Based on SCA effects, it could be concluded that crosses i.e. P2×P5, P3×P6 showed highly significant or significant negative SCA effects for number of days to 50% tasseling and crosses P1 × P2, P1 × P6, P2 × P5 and P3 × P4 for number of days to 50% silking, indicating that these crosses are the best combinations for improving earliness traits. For plant height, crosses i.e. P1×P3, P1×P5, P2×P3, P2×P6, P4×P5 and P4×P6 showed negative and highly significant SCA effects for this trait, indicating that these crosses are the best combinations for improving shortness stature trait. P1×P2, P1×P4, P2×P3, P3×P4, P4×P5 and P5×P6 showed highly significant and positive SCA effects for number of rows/ear. For number of grains/row, results showed that all crosses recorded positive significant or highly significant SCA effects, except crosses i.e. P1×P3, P1×P5, P2×P6, P3×P6 and P4×P5. Crosses i.e. P1×P2, P1×P4, P1×P5, P2×P3, P2×P6, P4×P5, P4×P6 and P5×P6 showed positive highly significant SCA effects for 100-grain weight, indicating that these crosses are the best combinations for improving the weight of 100-grain. According to grain yield/plant, P1×P2, P1×P4, P2×P3, P2×P5, P3×P5, P3×P6, P4×P5, P4×P6 and P5×P6 recorded positive and highly significant SCA effects, indicating that these crosses are the best combinations for improving grain yield/plant. P1×P3, P1×P4, P2×P3, P2×P4, P3×P4 and P5×P6 showed significant and positive SCA effects for shelling percentage. This means that, all of these crosses could be selected and used in breeding programs for improving all of these traits. These results are in confidence with those of Uddin *et al*. (2006), Alam *et al*. (2008), Barakat and Osman (2008) and Abdel-Moneam *et al*. (2009).

Table 3: Means and specific combining ability (SCA) effects (s_{ij}) for all F_1 crosses for all studied traits.

	No. of days to 50% tasseling		No. of days to 50% silking		Plant height		No. of rows/ear	
	Mean	s_{ij}	Mean	s_{ij}	Mean	s_{ij}	Mean	s_{ij}
P1×P2	53.00	-0.300	55.00	-0.650*	271.75	9.475**	14.00	1.448**
P1×P3	52.00	-0.050	55.00	0.600	225.00	-17.025**	13.67	-0.298**
P1×P4	51.00	0.200	54.00	0.350	233.25	2.413**	15.00	0.365**
P1×P5	50.00	0.700*	53.00	0.850*	242.50	-1.213**	12.33	-1.385**
P1×P6	53.00	-0.550	55.00	-1.150**	261.00	6.350**	13.67	-0.130**
P2×P3	52.00	0.450	54.00	0.350	267.00	-1.400**	12.67	0.450**
P2×P4	51.00	0.700*	53.00	0.100	257.00	-0.213	11.67	-1.218**
P2×P5	47.00	-1.800**	50.00	-1.400**	275.00	4.913**	11.67	-0.298**
P2×P6	54.00	0.950**	57.00	1.600**	268.25	-12.775**	11.67	-0.383**
P3×P4	49.00	-0.050	51.00	-0.650*	250.25	13.288**	14.67	0.368**
P3×P5	48.00	0.450	50.00	-0.150	251.50	1.663**	13.33	-0.053
P3×P6	51.00	-0.800*	54.00	-0.150	264.25	3.475**	13.00	-0.468**
P4×P5	46.00	-0.300	50.00	0.600	226.75	-11.900**	14.67	0.620**
P4×P6	50.00	-0.550	53.00	-0.400	246.00	-3.588**	14.00	-0.135**
P5×P6	50.00	0.950**	52.00	0.100	269.00	6.538**	14.33	1.115**
S.E (S_{ij})	--	0.378	--	0.378	--	0.494	--	0.045
S.E (S_{ij}-S_{ik})	--	0.597	--	0.597	--	0.781	--	0.071
S.E (S_{ij}-S_{kl})	--	0.488	--	0.488	--	0.638	--	0.058

	No. of grains/row		100-grain weight		Grain yield/plant		Shelling percentage	
	Mean	s_{ij}	Mean	s_{ij}	Mean	s_{ij}	Mean	s_{ij}
P1×P2	43.50	2.383**	35.94	1.568**	274.077	56.177**	79.98	-0.183**
P1×P3	26.67	-3.655**	34.10	-0.465**	145.117	-31.043**	78.73	0.565**
P1×P4	33.83	0.215*	30.50	0.078**	207.117	23.190**	78.48	1.412**
P1×P5	31.33	-4.325**	35.78	1.245**	138.095	-41.289**	77.57	-0.428**
P1×P6	35.83	5.383**	31.00	-2.425**	169.184	-7.035**	78.38	-1.366**
P2×P3	37.67	1.593**	31.08	2.893**	168.197	15.472**	82.45	0.399**
P2×P4	40.00	0.633**	22.14	-1.905**	123.117	-37.376**	82.58	1.627**
P2×P5	44.00	2.593**	24.45	-3.708**	157.211	1.261**	80.34	-1.543**
P2×P6	29.00	-7.200**	28.20	1.153**	117.250	-35.534**	83.33	-0.301**
P3×P4	29.50	0.925**	23.14	-1.098**	115.240	-3.513**	80.70	1.745**
P3×P5	32.83	2.215**	27.31	-1.040**	121.127	6.918**	78.38	-1.506**
P3×P6	24.33	-1.078**	26.95	-0.290**	123.210	12.166**	80.43	-1.203**
P4×P5	31.33	-2.575**	26.64	2.433**	132.180	10.203**	76.70	-2.088**
P4×P6	29.50	0.803**	23.59	0.493**	126.307	7.496**	77.84	-2.696**
P5×P6	32.83	2.093**	28.28	1.07**	137.176	22.908**	87.03	5.565**
S.E (S_{ij})	--	0.096	--	0.004	--	0.014	--	0.014
S.E (S_{ij}-S_{ik})	--	0.152	--	0.007	--	0.022	--	0.022
S.E (S_{ij}-S_{kl})	--	0.124	--	0.006	--	0.018	--	0.018

***,** significant at 0.05 and 0.01 level of probability, respectively**

S.E (S_{ij}): Standard error for an SCA effect.

S.E (S_{ij}-S_{ik}): Standard error for the difference between two SCA effects for a common parent.

S.E (S_{ij}-S_{kl}): Standard error for the difference between two SCA effects for a non-common parent.

4- Estimates of heterossis: Data presented in table 4 revealed that the most of cross combinations manifested negative highly significant or significant heterosis over mid and better parents for number of days to 50% tasseling and silking. The highest negative heterosis effect for days to tasseling was exhibited by cross P3×P6 (-9.73 and -8.93%) over mid and better parents, respectively and for days to silking were P2×P3 (-11.48%) over mid-parents and P2×P3 or P3×P6 (-10.00%) over better-parent. According to plant height, none of the cross combinations showed negative heterosis over mid and better parents. The highest positive significant heterosis effect was recorded by cross P1×P6 (78.31%) over mid-parents and cross P1×P2 (100.55%) over better-parent. The highest positive heterosis effect for number of rows/ear was P1×P4 (40.65 and 32.39%) over mid and better parents. Results showed that P1×P2 recorded the highest positive significant heterosis in number of grains/row and 100-grain weight over mid and better parents. The corresponding data were (188.46 and 174.79%) and (64.75 and 62.62%), respectively. The highest positive heterosis effect for for grain yield/plant was P1×P2 (359.62 and 341.06%) over mid and better parents and for shelling percentage was P5×P6 (5.72 and 5.59%) over mid and better parents, respectively. These results are in confidence with those of Alvi *et al*. (2003), El-Gazzar (2004), Katta *et al*. (2007), Amiruzzaman *et al*. (2010), Patel *et al*. (2010) and Amanullah *et al*. (2011).

Table 4: Percentages of heterosis over mid and better parents for the studied maize traits during 2012 summer growing season.

	No. of days to 50% tasseling		No. of days to 50% silking		Plant height		N. of rows/ear	
	M.P	**B.P**	**M.P**	**B.P**	**M.P**	**B.P**	**M.P**	**B.P**
P1×P2	-7.83**	-7.02**	-10.57**	-9.84**	69.58**	100.55**	31.27**	23.57**
P1×P3	-8.77**	-7.14**	-9.09**	-8.33**	42.29**	66.05**	24.27**	13.92**
P1×P4	-6.42*	0.00	-6.90*	-1.82	74.72**	77.38**	40.65**	32.39**
P1×P5	-4.76	6.38**	-4.50	6.00**	50.62**	78.97**	2.75	-11.93**
P1×P6	-7.83**	-7.02**	-9.84**	-9.84**	78.31**	92.62**	20.60**	7.89**
P2×P3	-7.96**	-7.14**	-11.48**	-10.00**	46.00**	47.72**	8.62**	5.58**
P2×P4	-5.56*	0.00	-9.40**	-3.64**	62.40**	95.44**	3.00	3.00**
P2×P5	-9.62**	0.00	-10.71**	0.00	48.05**	48.65**	-7.86**	-16.64**
P2×P6	-5.26*	-5.26**	-7.32**	-6.56**	56.76**	70.59**	-2.75	-7.89**
P3×P4	-8.41**	-3.92**	-11.30**	-7.27**	60.29**	90.30**	25.76**	22.25**
P3×P5	-6.80*	2.13	-9.09**	0.00	36.96**	39.14**	2.54	-4.79**
P3×P6	-9.73**	-8.93**	-10.74**	-10.00**	56.36**	68.04**	5.39**	2.60**
P4×P5	-6.12*	-2.13	-4.76	0.00	42.61**	72.43**	15.83**	4.79**
P4×P6	-7.41*	-1.96	-8.62**	-3.64**	70.39**	87.07**	16.67**	10.50**
P5×P6	-3.85	6.38**	-6.31*	4.00**	56.51**	71.07**	7.46**	2.36**
LSD 5%	2.97	1.14	2.97	1.14	3.83	1.48	0.38	0.14
LSD 1%	4.27	1.64	4.27	1.64	5.52	2.12	0.54	0.21

***,** significant at 0.05 and 0.01 level of probability, respectively**

Table (4): Continue…

	No. of grains/row		100-grain weight		Grain yield/plant		Shelling percentage	
	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P
P1×P2	188.46**	174.79**	64.75**	62.62**	359.62**	341.06**	-1.97**	-2.72**
P1×P3	100.08**	86.11**	54.65**	51.09**	128.22**	107.16**	-4.54**	-6.27**
P1×P4	111.44**	91.45**	59.02**	41.66**	230.67**	203.92**	-4.65**	-6.20**
P1×P5	39.77**	2.72**	61.79**	57.62**	129.72**	118.84**	-5.04**	-5.88**
P1×P6	93.68**	58.05**	43.09**	42.20**	183.76**	172.34**	-3.93**	-4.67**
P2×P3	167.54**	137.97**	39.15**	37.70**	154.48**	140.11**	-0.79**	-1.85**
P2×P4	138.81**	126.37**	13.74**	0.18**	88.99**	80.66**	-0.44**	-1.30**
P2×P5	89.94**	44.26**	9.15**	7.71**	151.05**	149.13**	-2.41**	-2.52**
P2×P6	50.65**	27.92**	28.47**	29.36**	88.71**	88.69**	1.35**	1.35**
P3×P4	96.67**	66.95**	17.46**	2.53**	66.77**	64.51**	-3.74**	-3.93**
P3×P5	53.30**	7.64**	20.65**	20.31**	81.94**	72.92**	-5.80**	-6.69**
P3×P6	39.03**	7.32**	21.48**	19.41**	86.44**	75.89**	-3.22**	-4.25**
P4×P5	30.08**	2.72**	34.78**	17.36**	101.41**	93.96**	-7.64**	-8.33**
P4×P6	46.26**	30.13**	22.13**	8.21**	93.91**	85.34**	-6.15**	-6.97**
P5×P6	23.49**	7.64**	27.10**	24.58**	119.08**	117.38**	5.72**	5.59**
LSD 5%	0.69	0.26	0.04	0.01	0.113	0.043	0.11	0.04
LSD 1%	0.99	0.38	0.05	0.02	0.163	0.063	0.16	0.06

***,** significant at 0.05 and 0.01 level of probability, respectively**

REFERENCES

Abdel-Moneam, M.A.; A.N.E. Attia; M.I. EL-Emery and E.A. Fayed (2009). combining ability and heterosis for some agronomic traits in Crosses of Maize. Pakistan J. of Biological Sci., 12(5): 433-438.

Alam, A.K.M.M.; S. Ahmed; M. Begum and M.K. Sultan (2008). Heterosis and combining ability of grain yield and its contributing characters in maize. Bangladesh J. Agric. Res. 33(3): 375-379.

Alvi, M.B.; M. Rafique; M.S. Tariq; A. Hussain; T. Mahmood and M. Sarwar (2003). Hybrid viguor of some quantitative characters in maize (*Zea mays* L.). Pakistan J. Bio. Sci., 6(2): 139-141.

Amanullah, S.; M. Mansoor and M. Anwar khan (2011). Heterosis studies in diallel crosses of maize. Sarhad J. Agric., 27, No.2. (C.F. computer search).

Amiruzzaman, M.; M. A. Islam; L. Hassan and M.M. Rohman (2010). Combining ability and heterosis for yield and component characters in Maize. Academic J. of Plant Sci., 3(2): 79-84.

Barakat, A.A. and M.M.A. Osman (2008). Gene action and combining ability estimates for some white promising maize inbred lines by top cross system. J. Agric. Sci., Mansoura Univ., 33(10): 6995-7009.

Choukan, R. (1999). General and specific combining ability often maize inbred lines for different traits in diallel cross. Seed and Plant, 15(13): 280-295.

El-Gazzar, A.I. (2004). Genetic variability in some maize inbred lines. M.Sc. Thesis, Fac. Agric., Mansoura Univ., Egypt.

FAO. Org, Statistical database, FAO Stat Agriculture, Primary crops, Supplied at, 2010.
Gomez, K.A. and A.A. Gomez (1984). Statistical procedures for Agricultural Research. Second ed. Willey Inter. Sci. Publ., pp. 357:423.
Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing systems. Aust. J. of Biol. Sci., 9: 463-493.
Haddadi, M.H.; M. Eesmaeilof; R. Choukan and V. Rameeh (2012). Combining ability analysis of days to silking, plant height, yield components and kernel yield in maize breeding lines. African J. of Agric. Res., 7(33): 4685-4691.
Katta,Y.S; M.S.M. Abd El-Aty; M.A. El-Hity and M.M. Karmara (2007). Estimate of heterosis and combining ability of some white inbred lines of maize (*Zea mays* L.). J. Agric. Sci .Mansoura Univ., 32(9): 7077-7088.
Mather, K. and J. L. Jinks (1982). Biometrical Genetics. 3rd ed. Chapman and Hall, London.
Patel, C. G.; D. B. Patel; N. B. Prajapati; M. D. Patel and K. R. Patel (2010). Heterosis breeding in maize . Res. on Crops. 11(2): 429-431.
Rojas, B.A. and G.F. Sprague (1952). A comparison of variance components in corn yield trials: III. General and specific combining ability and their interaction with locations and years. Agron. J., 44: 462-466.
Shull, G. H. (1908). The Composition of field maize. Report of the American Breeders Association. 4: 296-301.
Sultan, M. S.; A. A. El-Hosary; A. A. Leilah; M. A. Abdel Moneam and M.A. Hamouda (2011). Combining ability for some important traits in red maize using Griffing's method 2 and 4. J. Plant Production, Mansoura Univ., 2(6):811-822.
Uddin, M.S.; F. Khatun; S. Ahmed; M.R. Ali and S.A. Bagum (2006). Heterosis and combining ability in corn (*Zea mays* L.). Bangladesh J. Bot., 35(2): 109-116.

القدرة على التآلف و قوة الهجين لمحصول الحبوب وبعض الصفات الأخري في الذرة الشامية

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أجري البحث بمزرعة قسم المحاصيل- كلية الزراعة- جامعة المنصورة، خلال الموسمين الزراعيين ٢٠١١ و ٢٠١٢ وذلك لتقدير القدرة على التآلف وقوة الهجين لمحصول الحبوب وبعض الصفات الأخرى في الذرة الشامية. تم التهجين النصف دائري بين ٦ سلالات نقية من الذرة الشامية وذلك للحصول على ١٥ هجين فردي في عام ٢٠١١، ثم تمت زراعة الـ ٢١ تركيب وراثي في تصميم القطاعات الكاملة العشوائية ذو ثلاث مكررات بهدف تقييم كل من السلالات والهجن. تم أخذ بيانات محصول الحبوب، عدد الأيام حتى طرد النورة المذكرة، عدد الأيام حتى ظهور الحريرة، إرتفاع النبات، عدد الصفوف/كوز، عدد الحبوب/صف، وزن الـ ١٠٠ حبة و نسبة التفريط.

ويمكن تلخيص نتائج البحث فيما يلي:

١- كانت متوسطات مربعات الإنحرافات للهجن عالية المعنوية لكل الصفات المدروسة.

٢- أظهرت النتائج أن متوسطات مربعات الإنحرافات لكل من القدرة العامة والخاصة على التآلف عالية المعنوية لكل الصفات المدروسة، وهذا يشير إلى أهمية كل من التأثير الوراثي التجميعي وغير التجميعي في توريث هذه الصفات.

٣- كانت نسب تباين القدرة العامة على التآلف إلى القدرة الخاصة على التآلف أكبر من واحد صحيح لكل من عدد الأيام حتى طرد النورة المذكرة، عدد الأيام حتى ظهور الحريرة، إرتفاع النبات و وزن الـ١٠٠ حبة، مما يشير إلى أن الفعل الجيني المضيف أكثر أهمية من الفعل غير المضيف.

٤- أوضحت النتائج أن أحسن الأباء قدرة عامة على التآلف لصفات التزهير هي السلالة النقية P4، P5؛ والسلالاتP1، P3، P4، P5 لصفة قصر النبات؛ والسلالاتP1، P3، P4 لصفة عدد الصفوف/كوز؛ السلالة P1 لصفة وزن الـ ١٠٠ حبة؛ والسلالتين P1، P2 لصفة محصول الحبوب؛ والسلالتين P2، P6 لصفة زيادة نسبة التفريط.

٥- كانت أحسن الهجن قدرة خاصة على التآلف (P2xP5)، (P3xP6) لصفة عدد الأيام حتى طرد النورة المذكرة؛ (P1xP2)، (P1xP6)، (P2xP5)، (P3xP4) لصفة عدد الأيام حتى ظهور الحريرة؛ (P1xP3)، (P1xP5)، (P2xP3)، (P2xP6)، (P4xP5)، (P4xP6) لصفة قصر النبات؛ (PxP2)، (P1xP4)، (P2xP3)، (P3xP4)، (P4xP5)، (P4xP6) لصفة عدد الصفوف/كوز؛ (P1xP3)، (P1xP4)، (P2xP3)، (P2xP4)، (P3xP4)، (P5xP6) لصفة زيادة نسبة التفريط. أما بالنسبة لصفات عدد الحبوب/صف و وزن الـ١٠٠ حبة فقد أظهرت معظم الهجن معنوية عالية و موجبة لقدرتها الخاصة على التآلف.

٦- أظهرت النتائج قوة هجين بالنسبة لمتوسط و أفضل الآباء عالية المعنوية لكل الصفات المدروسة. حيث حقق الهجين P3xP6 أعلى قوة هجين سالبة بالنسبة لمتوسط و أفضل الآباء في صفة عدد الأيام حتى طرد النورة المذكرة، والهجين P2xP3 في صفة عدد الأيام حتى ظهور الحريرة. أما بالنسبة لصفات عدد الحبوب/صف و محصول الحبوب/نبات و وزن الـ١٠٠ حبة فقد سجل الهجين P1xP2 أعلى قوة هجين موجبة بالنسبة لمتوسط و أفضل الآباء؛ والهجين P1xP4 لصفة عدد الصفوف/كوز؛ والهجين P5xP6 لصفة زيادة نسبة التفريط.

قام بتحكيم البحث

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