J. Agric. Sci. Mansoura Univ., 28(1): 55 - 67, 2003

ESTIMATES OF COMBINING ABILITY AND HETEROSIS EFFECTS FOR GROWTH, EARLINESS AND YIELD IN MAIZE (*Zea mays*-L)

Shafey, S. A.*; H. E. Yassien*; I. E. M. A. El-Beially* and O. A. M. Gad-Alla**

*Dept. of Agronomy, Fac. of Agric., Al-Azhar University, Cairo, Egypt.
** HYTECH Co. station, Kaha, Kalyubia, Egypt.

ABSTRACT

A half diallel cross analysis among eight inbred lines were evaluated for tassling date, silking date, plant height, ear height, ear length, ear diameter, no. of rows/ear, no. of kernels/row, weight of 100 kernel and grain yield/plant. The eight parents and their 28 F_1, (36 entries) were evaluated in a randomized complete blocks design with three replications in 2001 season. Results indicated to significant variances due to general and specific combining abilities for all the studied traits, except for plant height, which were insignificant for general combining ability. P^6 was a good general combiner for grain yield/plant and P^8 was a good general combiner for earliness Hybrid combination P^4xP^8, P^4xP^6, P^1xP^8 and P^5xP^7 exhibited desirable S.C.A. effects. High rations which largely exceed the unity were obtained in ear length, no. of rows/ear and weight of 100 kernel. While the rations were less than unity for all of the other traits indicating that the largest part of the genetic variability associated with those traits was a result of non-additive gene action. Results obtained the obtained results indicated that heterosis (parent. vs. crosses) was generally pronounced for all studied traits except 100 kernel weight. Compared to mid and better parent, the highest heterotic effect was registered by hybrid P^4xP^8 for grain yield/plant and most of yield components, while P^3xP^6 was the best heterotic effect for earliness. It could be concluded that these crosses would be efficient and prospective in maize breeding programs for improving the grain yield/plant.

INTRODUCTION

Combining ability analysis is a useful technique for classifing parental lines in terms of their hybrid performance. Thus it helps in selecting the parents for hybridization which-when crossed would give rise to more desirable segregations.

Differences in GCA effects have been attributed to additive, additive x additive and higher-order interactions of additive genetic effects in the base population, while differences in SCA have been attributed to non-additive genetic variance (Falconer, 1981). Hallauer and Miranda (1981) stated that both GCA and SCA effects should be taken in consideration when planing the maize breeding program to produce and release new inbreds and crosses. Morshed *et al.*, (1989) and Dehghanpour *et al.*, (1997) reported that GCA and SCA effects were significant for all studied traits. Shafey (1993) and Alika (1994) concluded that variation due to GCA was highly significant for plant height, ear height, ear length, ear diameter and 100 kernel weight. Pole and Prodhan (1994) reported that non-additive gene effects were more important for grain yield, number of rows/ear, number of grain/row and ear length. Whereas for ear diameter and 100 grain weight, the additive gene effects exhibited predominant role. El- Hosary (1988) revealed that the additive and additive by additive types of gene action were the more important expression for 100 kernel weight, No. of rows/ear, plant height and silking date. While, non additive gene effects were important for grain yield/plant and No. of kernels/row.

Hybrid vigor resulting from F_1 crosses of maize genotypes was reported by Amer (1991), Mourad *et al.*, (1992), Sadek *et al.*, (1992) and Gama *et al.*, (1995) who reported significant useful heterosis for number of kernels/row, weight of 100 kernels and grain yield/plant.

The objective of this investigation was to evaluate the combining abilities and heterosis effects from diallel crosses among newly eight white maize lines regarding growth, earliness and yield in attempt to produce high yielding white single cross hybrids better than the commercial ones.

MATERIALS AND METHODS

The experiments were carried out at the HYTECH Co. station in Kaha, Kalyubia Governorate during two successive seasons 2000 and 2001. Eight inbred lines of (*Zea mays*, L) wide divergent origins were used as parental lines in the present investigation. These inbred lines were chosen to represent a wide range of variability in most of the studied traits. Parental no., code no. and origin of these inbred lines are presented in Table 1.

Table 1: The parental number, code number and origin of lines used in this recearch

Parent no.	Code no.	Origin
P^1	M.H.T.C-1	Egypt
P^2	M.H.T.C-2	South America
P^3	M.H.T.C-3	South Africa
P^4	M.H.T.C-4	South America
P^5	M.H.T.C-5	India
P^6	M.H.T.C-6	South Africa
P^7	M.H.T.C-7	Egypt
P^8	M.H.T.C-8	South Africa

A half diallel cross set involving eight parents was made during 1999 season by hand method. In 2000 season, the experiments were conducted at Kaha, Kalyobia. Eight inbred parents and their 28 F_1 hybrids were grown in a randomized complete blocks design with three replications. Each plot consisted of two ridges of 5m. length and 70cm. width. Hills were spaced by 25cm. with two kernels per hill and latter thinned to one plant per hill. Cultural practices were followed as usual for ordinary maize field in the area. Random sample of 10 plants in each plot were taken to evaluate, tasseling date, silking date, plant height (cm), ear height, ear length, ear diameter, No. of rows/ear, No. of kenels/row, weight of 100-kernel and grain yield/plant (gm) were recorded. Analysis of variance was done according to Steel and Torrie (1980).

General and specific combining ability estimates were obtained by employing Griffing (1956) diallel cross analysis designated as method II model I.

Heterosis percentage relative to mid-parents (M.P) and better parents (B.P) performance was calculated as follows:

Mid-parent heterosis (M.P) = $\frac{F_1 - M.P}{M.P} \times 100$

Mid-parent heterosis (L.S.D) = $t\sqrt{3MSE/2r}$

Better-parent heterosis (B.P) = $\frac{F_1 - B.P}{B.P} \times 100$

Better-parent heterosis (L.S.D) = $t\sqrt{2MSE/r}$

Where (t) is the tabular value at the stated level of probability for the degrees of freedom of the experimental error, MSE is the mean square for error, and (r) is the number of replicates.

RESULTS AND DISCUSSION

Analysis of variance for traits of the eight parents and their crosses are shown in Table 2. Results indicated that highly significant differences for all the studied traits were found.

Results in Table 2 show the means of squares of the studied traits for parents and their F_1 crosses used in the half diallel.

Mean performance of parents and F_1 crosses:-

Mean performance for the parents and their crosses ranged from 68 (P^6xP^8) to 78 (P^5) for tasseling date. 68.3 (P^3xP^6) to 79 (P^2) for silking date, 190 (P^8) to 310 (P^2xP^5) for plant height, 88.3 (P^6) to 156.7 (P^2xP^4, P^2xP^5 and P^5xP^8) for ear height, 12.2 (P^5) to 21.6 (P^6xP^7) for ear length, 3.5 (P^6) to 5.8 (P^3xP^5) for ear diameter, 10.7 (P^4) to 17.3 (P^5xP^8) for number of rows/ear, 21.7 (P^4) to 50.7 (P^2xP^6) for number of kernels/row, 26 (P^5) to 42.3 (P^3xP^6) for weight of 100 kernel. In addition, grain yield/ plant recorded values ranging from 41.67 (P^4) to 211.34 (P^4xP^8)gm.

General and specific combining ability:-

Analysis of variance Table 4 indicated to significant general and specific combining abilities for all the studied traits, except variance due to plant height which were insignificant for general combining ability. Morshed *et al.*, (1989), Alika (1994) and Shafey (1998) found highly significant G.C.A. and S.C.A effects in the studied traits.

The ratio of 6^2 *G.C.A.*/6^2 S.C.A. was less than unity for tasseling date, silking date, plant height, ear height, ear diameter, number of kernels/row and grain yield/plant indicating the prevalence of non-additive gene action in the genetic control of these traits.

Table 2: Ordinary analysis of variance: -

Traits / S.O.V.	d.f	Tasseling Date	Silking date	Plant height (cm)	Ear height (cm)	Ear Length (cm)	Ear diameter (cm)	No. of rows/ ear	No. of kernel /row	Weight of 100 kernel	Grain yield/plant (gm)
Rep.	2	13.9	15.36	1867.5	558.3	3.62	0.16	2.26	22.34	0.11	431.46
Genotypes	35	23.7**	27.44**	3438.39**	1277.14**	14.53**	0.67**	7.81**	177.61**	43.40**	6841.51**
P	7	1.66	1.47	95.24	161.90	13.56**	0.19*	3.71	67.71**	27.69*	519.55**
F1	27	4.15**	6.13**	605.07	659.79**	6.92**	0.16**	6.52**	39.10**	47.74**	2460.34**
P. vs. F1	1	705.75**	784.34**	103339.95**	25752.39**	226.96**	17.68**	71.15**	4686.67**	36.21	16938.71**
Error	70	1.2	1.62	560.93	222.86	1.30	0.06	1.69	15.11	11.40	76.40

*, ** Significant at 5% and 1% respectively.

Table (3): Mean performance for the eight parents and their F_1 crosses in maize.

Genotypes	Tasseling date	Silking date	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernel	Grain yield/plant (gm)
P^1	76.7	78.3	203.3	103.3	13.3	3.8	12	33.7	30.7	81.95
P^2	77.0	79.0	196.7	101.7	18.7	3.8	13.3	35	31	61.12
P^3	76.3	78.0	200	93.3	14.9	3.9	11.3	31	36	45.95
P^4	76.7	78.0	203.3	108.3	14.3	3.8	10.7	21.7	33	41.67
P^5	78.0	78.3	200	105	12.2	3.9	13.3	27.3	26	52.77
P^6	75.7	77.3	190	88.3	16.2	3.5	12.7	27.3	29.3	64.29
P^7	77.3	78	203.3	96.7	16.5	4.4	12.7	30.3	34	68.30
P^8	76.0	76.7	190	90	12.8	3.7	14	23	31.3	51.27
P^1xP^2	70.3	70.3	290	153.3	18.8	4.8	15.3	50.7	29.3	164.84
P^1xP^3	71.0	71.7	280	133.3	18.6	4.6	13.3	44.3	35	130.85
P^1xP^4	72.0	72.7	280	136.7	16.7	4.6	13.3	43.3	27	93.60
P^1xP^5	71.0	71.3	280	153.3	16.7	4.7	15.3	44.7	26.7	123.09
P^1xP^6	70.7	71.7	270	153.3	19.1	4.6	12.7	47.3	34.3	159.48
P^1xP^7	73.0	75	266.7	133.3	16.2	4.3	12.7	43	30	79.48
P^1xP^8	70.0	71.3	270	150	17.3	5	16	44	29	176.18
P^2xP^3	70.3	71.3	276.3	120	19.5	4.8	14	48.7	35.7	167.87
P^2xP^4	70.0	71	273.3	136.7	19.6	5	14	47	38.7	150.79
P^2xP^5	71.3	72.7	310	156.7	18.5	4.8	14	46	29.3	150.40
P^2xP^6	70.7	71	260	126.7	21.3	4.8	14.7	50.7	36	171.37
P^2xP^7	71.0	72.3	230	153.3	19.8	5	13.3	45	32.7	144.82
P^2xP^8	70.3	71.3	263.3	120	17.2	4.9	16	43	31.3	161.91
P^3xP^4	72.0	73.3	270	130	17.2	5	12.7	38	33	111.87
P^3xP^5	70.3	70.3	293.3	133.3	19.7	5.8	15.3	46.3	36.3	169.87
P^3xP^6	67.7	68.3	270	116.7	19.6	4.8	14	41.7	42.3	168.31
P^3xP^7	70.3	71.3	253.3	116.7	18.3	4.7	12.7	41	38.7	141.92
P^3xP^8	69.7	71	270	130	18.9	5.2	16.7	42.3	32	163.54
P^4xP^5	70.7	72	280	133.3	17	5	15.3	40.3	31.3	151.80
P^4xP^6	70.0	70.3	270	136.7	19.5	4.8	14	45.3	39	186.93
P^4xP^7	73.0	74.7	263.3	106.7	18.1	4.5	12	40.3	34	136.77
P^4xP^8	71.0	71.7	273.3	133.3	17.5	5.2	16.7	44.3	31	211.34
P^5xP^6	70.0	72	280	133.3	19.8	4.6	16.7	50	30.7	178.16
P^5xP^7	71.0	72	166.7	143.3	18.9	4.7	14	47	30	177.61
P^5xP^8	69.0	69.7	273.3	156.7	15.8	5	17.3	41.3	28.7	176.31
P^6xP^7	70.7	71.3	276.7	150	21.6	4.5	12.7	50	37	180.24
P^6xP^8	68	69	230	103.3	15.8	4.7	15.3	37.3	29	130.29
P^7xP^8	70.7	70.7	270	143.3	18.7	4.7	14.7	43.3	30.6	143.20
L. S. D. at										
5%	1.78	2.07	38.48	24.26	1.85	0.4	2.11	6.32	5.49	14.20
1%	2.37	2.75	51.25	32.30	2.47	0.53	2.81	8.41	7.3	18.91

Table (4): Analysis of variance for the general (G.C.A.) and specific (S.C.A.) combining ability.

S.O.V Traits	D.F	Tasseling date	Silking date	Plant height (cm)	Ear height (cm)	Ear lenght (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernel/row	Weight of 100 kernel (gm)	Grain yield/plant (gm)
G.C.A	7	3.09**	3.45**	280.87	305.71**	8.74**	0.08**	6.38**	40.5**	41.16**	576.86**
S.C.A	28	9.1**	10.57**	1382.44**	455.71**	3.87**	0.26**	1.66**	63.88**	7.79**	2706.42**
Error	70	0.4	0.54	186.98	74.29	0.43	0.02	0.56	5.04	3.80	25.47
G.C.A/ S.C.A. ratio		0.34	0.33	0.21	0.67	2.26	0.31	3.85	0.63	5.82	0.21

** Significant at 1% level of probability.

But 6^2 S./6^2 S.C.A. was more than unity for ear length, number of rows/ear and weight of 100 kernel revealing the importance of additive gene action in the genetic control of these traits.

These results are in agreement with those reported by Daniel, (1969), Abo- El-Fadhl, (1978) and El-Hosary *et al.*, (1990) for plant height, Shafey (1998) for ear length and ear height, Mostafa *et al.*, (1996) for grain yield, Soliman *et al.*, (1995) for number of rows/ear and weight of 100 kernels. Nevado and Cross (1990) for grain yield/ plant, silking date and number of kernels/row; El-Hosary (1988) for number of rows/ear, number of kernels/row and weight of 100 kernels, El-Zeir *et al.*, (1997) for grain yield/plant, 100 kernel weight, ear diameter, number of rows/ear and number of kernels/row.

Estimates of G.C.A effects for the parents Table 5 indicated that P^3 was the best combiner for ear height, ear diameter and weight of 100 kernel, P^6, for ear length and grain yield/plant, P^2, for number of kernels/row, P^8, for number of rows/ear plant height, tassling date and silking date.

Estimates of S.C.A effects in F_1 crosses for each traits are presented in Table 6. Results show highly significant S.C.A. effects values for all the studied traits.

For tasseling date the crosses P^3xP^6 (-3.093) and P^5xP^8 (-2.459) had the lowest values of S.C.A. effect. Regarding silking date, P^3xP^6 (-3.50) and P^1xP^2 (-3.20) gave the lowest values of S.C.A. for these trait. The previous crosses could be considered as the best crosses for earliness. With respect to plant height P^6xP^7 cross gave the best values (-28.630). the cross P^4xP^7 gave the best values for ear height (-18.556). The cross P^3xP^5 gave the highest values for ear length (2.611) and ear diameter (0.571). The crosses P^4xP^8 (1.881) and P^5xP^6 (1.881) gave the best values for number of rows/ear and number of kernels/row (8.759 and 8.059). The crosses P^2xP^4 and P^3xP^6 gave the highest values for weight of 100 kernel (5.167 and 5.133). For grain yield/plant the crosses P^4xP^8 and P^4xP^6gave the highest values of these trait.

Heterosis:-

Different significant parents vs. crosses mean squares were detected for all studied traits except 100 kernel weight Table 2. Heterosis expressed as percentage deviation of F_1 performance from its mid parent and better parent average values for all studied traits are presented in Table 7. For tasseling date all hybrids expressed negative significantly heterotic effects ranged from –5.194 to –10.960 for mid parent and ranged from –5.599 to –11.538 for better parent. For silking date all hybrids expressed negative and desirable direction significantly heterotic effects ranged from –4.049 to .–12.019 relative to mid parent and ranged from –4.251 to –12.397 relative to better parent. This results are in accordance with those obtained by Nagda *et al.*, (1995). For plant height the cross P^6xP^8 gave the best heterosis. For ear height the cross P^4xP^7 gave the best value of heterosis. Effect ear length showed positive and highly significant heterosis over mid and better parent Table 7.

Table (5): General combining ability (G.C.A.) effects for the parents used in half diallel.

Traits / parents	Tasseling date	Silking date	Plant height	Ear height	Ear lenght	Ear diameter	No. of rows/ear	No. of kernel/row	Weight of 100 kernel	Grain yield/plant
P¹	0.400*	0.442*	3.750	7.500**	-0.770**	-0.108*	-0.350	1.575*	-1983**	-10.112**
P²	0.067	0.175	3.750	2.500	-1.333**	0.048	0.183	3.208**	0.250	4.171**
P³	-0.333	-0.292	-0.583	-7.833**	0.280	0.092*	-0.483*	-0.458	3.250**	-4.642**
P⁴	0.467*	0.542*	1.083	-1.500	-0.452*	0.033	-0.683**	**-2.692****	0.750	-6.610**
P⁵	0.200	0.042	7.750	7.500**	-0.799**	0.043	0.850**	**0.142**	-2.750**	4.024**
P⁶	-0.833**	-0.792**	-6.917	-4.833	1.033**	-0.157**	-0.083	**0.808**	1.450*	11.082**
P⁷	0.700**	0.708**	-1.250	-0.500	0.573**	-0.023	-0.883**	**0.142**	0.850	-5.190**
P⁸	-0.667**	-0.825**	-7.853	-2.833	-1.197**	0.072	1.450**	**-2.725****	-1.817**	7.278**
S.E.gi	0.187	0.217	4.045	2.550	0.195	0.042	0.222	**0.664**	0.577	1.493

Table (6): Specific combining ability (S.C.A) effects for crosses produced in the half diallel

characters / crosses	Tasseling date	Silking date	Plant height	Ear height	Ear length	Ear diameter	No. of rows/ear	No. of kernels/row	Weight of 100 kernels	Grain yield/plant
P^1xP^2	-2.059**	-3.200**	26.296*	16.111*	0.630	0.299*	1.481*	4.893*	-1.433	38.278**
P^1xP^3	-0.993	-1.400*	20.630	6.444	1.450*	0.039	00.148	2.226	1.233	13.097**
P^1xP^4	-0.973	-1.233	18.963	3.444	0.281	0.064	0.348	3.459	-4.267*	-22.185**
P^1xP^5	-1.526**	-2.067**	12.296	11.111	0.661	0.204	0.815	1.959	-1.100	-3.329
P^1xP^6	-0.826	0.900	16.963	23.444**	1.130	0.254	-0.919	3.959	2.367	26.006**
P^1xP^7	-0.026	0.933	7.963	-0.889	-1.277*	-0.179	-0.119	0.293	-1.367	-37.722**
P^1xP^8	-1.659**	-1.200	17.630	18.111*	1.660**	0.476**	0.881	4.159*	0.300	46.513**
P^2xP^3	-1.326**	-1.467*	3.963	-1.889	0.213	0.116	0.281	4.926*	-0.333	35.834**
P^2xP^4	-2.459**	-2.633**	12.296	8.444	1.061	0.357**	0.481	5.493**	5.167**	20.726**
P^2xP^5	-0.859	-0.467	42.296**	19.444*	0.325	0.131	-1.052	1.659	-0.667	9.705*
P^2xP^6	-0.493	-1.300	9.963	1.778	1.326*	0.314*	0.548	5.695**	1.800	23.610**
P^2xP^7	-1.693**	-1.467*	31.296*	24.111**	0.303	0.381**	0.015	0.659	-0.933	13.335**
P^2xP^8	-0.993	-0.933	10.963	-6.889	-0.577	0.186	0.348	1.526	0.400	17.954**
P^3xP^4	-0.059	0.167	13.296	12.111	-0.302	0.314*	-0.185	0.159	-3.500	-9.381*
P^3xP^5	-1.459*	-2.333**	29.963*	6.444	2.611**	0.571**	0.948	5.569**	3.333	37.981**
P^3xP^6	-3.093**	-3.500**	21.296	2.111	0.680	0.271*	0.548	0.326	5.133**	29.370**
P^3xP^7	-1.959**	-2.000**	-1.037	-2.222	-0.227	0.004	0.015	0.326	2.067	19.245**
P^3xP^8	-1.259*	-0.800	21.963	13.444	2.176**	0.442**	1.681*	4.526*	-1.933	28.400**
P^4xP^5	-1.926**	-1.500*	14.963	0.111	0.643	0.262*	1.157	1.893	0.833	21.883**
P^4xP^6	-1.559**	-2.333**	19.930	15.778*	1.278*	0.329*	0.748	6.226**	4.300*	49.951**
P^4xP^7	-0.093	-0.500	7.296	-18.556*	0.371	-0.071	-0.452	1.893	-0.100	16.066**
P^4xP^8	-0.726	-0.967	23.630	10.444	1.475*	0.467**	1.881**	8.759**	-0.433	78.172**
P^5xP^6	-1.293*	-0.167	22.963	3.444	1.985**	00.152	1.881**	8.059**	-0.533	30.551**
P^5xP^7	-1.826**	-1.667*	3.963	9.111	1.435*	0.052	0.015	5.726**	-0.600	46.272**
P^5xP^8	-2.459**	-2.467**	16.963	24.778**	0.121	0.257	1.105	2.926	0.733	32.504**
P^6xP^7	-1.126	-1.500*	-28.630*	28.111**	2.320**	0.119	-0.385	8.059**	2.200	41.847**
P^6xP^8	-2.426**	-2.300**	-11.704	-16.222*	-1.677**	0.191	-0.052	-1.741	-3.133	-20.574**
P^7xP^8	-1.293*	-2.133**	22.630	19.444*	1.650**	0.057	0.081	4.926*	-0.867	8.611
S.E.Sij	0.574	0.666	12.399	7.815	0.597	0.129	0.680	2.035	1.767	4.576

Table (7): Percentage of heterosis over both mid (M.P.) and better parent (B.P.) values for all traits studied in the F_1 diallel

Genotypes	Tasseling date		Silking date		Plant height		Ear height		Ear length		Ear diameter	
	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.
P^1xP^2	-8.466	-8.662	-10.595	-10.974	45	42.625	49.590	48.338	15.876	0.856	27.105	27.105
P^1xP^3	-7.189	-7.792	-8.309	-8.502	38.844	-37.707	35.594	29.033	29.481	24.832	20	18.461
P^1xP^4	-6.091	-6.091	-7.030	-7.225	37.707	37.707	29.141	26.160	18.607	16.538	20.526	20.526
P^1xP^5	-8.191	-8.974	-8.933	-8.933	38.844	37.712	47.199	46.028	28.692	20.968	23.337	22.22
P^1xP^6	-7.220	-7.825	-7.914	-8.502	37.289	32.789	60.002	48.388	26.739	17.469	25.997	20.526
P^1xP^7	-5.194	-5.599	-4.049	-4.251	31.151	31.151	33.33	29.033	6.627	-2.00	4.773	-2.059
P^1xP^8	-8.298	-8.699	-7.961	-8.936	35.596	32.789	55.175	45.165	30.007	25.307	34.133	32.368
P^2xP^3	-8.263	-8.662	-9.133	-9.708	34.454	31.665	23.076	18.028	15.996	4.284	25.974	24.358
P^2xP^4	-8.895	-9.090	-9.554	-10.126	36.665	34.426	30.161	26.160	18.666	4.874	32.368	32.368
P^2xP^5	-7.961	-8.551	-7.620	-8.012	56.301	55.00	51.613	49.209	19.974	-.910	25.684	24.547
P^2xP^6	-7.421	-8.220	-9.166	-10.126	34.481	32.201	33.336	24.589	22.340	14.247	32.049	26.315
P^2xP^7	-7.989	-8.185	-7.859	-8.443	45.0	42.625	54.613	50.811	12.880	6.320	22.399	14.416
P^2xP^8	-8.065	-8.662	-8.357	-9.708	36.203	33.894	25.215	18.028	9.206	-7.873	30.666	28.947
P^3xP^4	-5.882	-6.091	-5.987	-5.987	33.885	32.789	28.712	20.003	17.482	15.234	30.649	28.974
P^3xP^5	-8.857	-9.833	-10.023	-10.213	46.665	46.665	34.452	26.980	45.77	32.416	36.422	35.897
P^3xP^6	-10.960	-11.345	-12.019	-12.397	38.461	35.00	28.448	25.008	26.237	21.172	30.257	23.076
P^3xP^7	-8.460	-9.052	-8.551	-8.551	25.619	24.590	22.810	20.688	16.369	10.727	12.938	6.864
P^3xP^8	-8.527	-8.725	-8.191	-8.974	38.461	35.00	41.820	39.2902	36.314	26.845	36.842	33.333
P^4xP^5	-8.618	-9.397	-7.887	-8.081	38.844	37.707	24.998	23.077	28.528	18.841	28.552	27.390
P^4xP^6	-8.100	-8.699	-9.444	-9.833	37.289	32.789	38.991	26.160	27.743	29.370	32.049	26.3
P^4xP^7	-5.194	-5.599	-4.269	-4.269	29.508	29.508	4.068	-1.532	17.612	9.878	10.893	3.661
P^4xP^8	-6.988	-7.395	-7.325	-8.115	38.982	34.426	34.452	23.077	28.645	21.912	37.866	36.052
P^5xP^6	-8.895	-10.256	-7.490	-8.081	43.589	40.00	37.929	26.980	39.795	22.407	26.158	19.638
P^5xP^7	-8.581	-8.974	-7.887	-8.081	32.234	31.151	42.143	36.504	31.496	14.242	13.349	6.864
P^5xP^8	-10.389	-11.538	-10.103	-11.055	40.169	36.665	60.687	49.209	26.16	22.915	31.307	28.423
P^6xP^7	-7.620	-8.612	-8.156	-8.551	40.680	36.069	62.162	55.167	31.926	30.727	15.561	3.661
P^6xP^8	-10.331	-10.526	-10.389	-10.772	21.052	21.052	15.886	14.811	8.852	-2.469	31.101	27.027
P^7xP^8	-7.819	-8.612	-8.618	-9.397	37.289	32.789	53.565	48.267	27.209	13.151	16.480	7.551
L. S. D. At 5%	1.541	1.779	1.791	2.068	33.326	38.482	21.006	24.256	1.604	1.852	0.344	0.398
5%	2.044	2.361	2.376	2.743	44.212	51.051	27.867	32.179	2.128	2.457	0.457	0.528

Genotypes	No. of rows/ear		No. of kernel/row		Weight of 100 kernel		Grain yield/plant	
	M.P.	B.P.	M.P	B.P.	M.P	B.P.	M.P.	B.P.
P^1xP^2	21.042	15.003	47.575	44.771	-4.880	-5.387	130.432	101.147
P^1xP^3	14.273	11.083	37.096	31.660	4.994	-2.777	104.612	59.670
P^1xP^4	12.632	11.083	56.595	28.690	-15.187	-18.181	51.431	14.215
P^1xP^5	21.042	15.003	46.459	32.670	-5.876	-13.042	82.734	50.201
P^1xP^6	2.715	0.00	55.180	40.570	14.433	11.933	118.107	94.606
P^1xP^7	2.715	0.00	34.375	27.710	-7.221	-11.764	5.797	-3.014
P^1xP^8	23.076	14.285	55.284	30.680	-6.451	-7.436	164.494	114.984
P^2xP^3	13.544	5.026	47.484	39.057	6.477	-0.916	212.570	174.656
P^2xP^4	16.666	5.026	65.872	34.285	20.843	17.181	193.42	146.71
P^2xP^5	5.026	5.026	47.601	31.428	2.912	-5.387	164.09	146.07
P^2xP^6	12.846	10.052	62.586	44.771	19.343	16.129	173.295	166.557
P^2xP^7	2.538	0.00	37.762	28.571	0.523	-3.911	123.798	112.035
P^2xP^8	17.072	14.285	48.275	22.857	0.529	0.0	188.121	164.905
P^3xP^4	15.181	11.827	44.294	22.580	-4.347	-8.333	155.35	143.460
P^3xP^5	24.330	15.003	58.854	49.451	17.193	0.916	244.14	221.906
P^3xP^6	16.666	10.497	42.876	34.419	29.588	17.583	205.35	161.798
P^3xP^7	5.583	0.00	33.702	32.258	10.485	7.416	148.437	107.789
P^3xP^8	31.622	19.071	56.777	36.548	-4.945	-11.111	236.432	218.977
P^4xP^5	17.923	15.003	64.612	47.566	6.203	-5.060	221.473	187.663
P^4xP^6	19.965	10.497	85.020	65.861	25.140	18.181	252.831	190.760
P^4xP^7	2.827	-5.288	55.115	32.970	2.985	0.0	148.740	100.248
P^4xP^8	35.143	19.071	85.048	79.695	-3.621	-6.060	354.788	312.209
P^5xP^6	28.230	25.056	82.949	82.949	10.862	4.568	204.390	177.119
P^5xP^7	7.692	5.026	63.024	54.962	0.0	-11.764	193.400	160.043
P^5xP^8	26.820	23.785	64.256	51.225	0.017	-8.490	238.927	234.110
P^6xP^7	0.00	0.00	73.430	64.853	57.903	47.058	171.875	163.894
P^6xP^8	14.960	9.500	48.340	36.589	-4.385	-7.436	125.493	102.659
P^7xP^8	10.011	4.785	62.497	42.861	-6.107	-9.794	139.524	109.663
L. S. D. At 5%	1.829	2.112	5.469	6.315	4.343	5.486	12.299	14.202
5%	2.426	2.802	7.256	8.378	4.751	7.256	16.316	18.841

The average heterosis of all crosses was –6.627 to 45.77 comparing with mid parent and ranged from – 7.873 to 32.416 comparing with better parent. In this connection, positive heterosis for ear length of maize was also reported by Shafey (1998). For ear diameter results showed that heterosis percentage over mid and better parent ranged from 4.773 to 37.866 as percent of mid

parent and ranged from –2.059 to 36.052 as percent of better parent. The heterosis as percent of mid and better parent appeared significant different for all single crosses of ear diameter trait. Also, Shafey (1998) and Yassien (1993 and 1999) supported the obtained results. Heterosis effect could be observed in Table 7 for number of rows/ear. The heterosis as percent of mid parent ranged from Zero to 35.143 and ranged from Zero to 23.785 for better parent. In this connection- El-Shamarka (1999) and Yassien (1999) reported that the majority of hybrids showed significant degree of heterosis for this trait. For number of kernels/row the heterosis as percent of mid parent ranged from 33.702 to 85.048 and ranged from 22.580 to 82.949 for better parent. These results are agreement with those obtained by Shafey (1998) and Yassien 1999. As weight of 100 kernel it ranged from 15.187 to 57.903. for mid parent and ranged from –18.181 to 47.058 for better parent. These results agreed with those obtained by Yassien (1993 and 1999) and Shafey (1998). Values of heterosis for grain yield/plant are given in Table 7. Heterosis as percent of mid parent ranged from 5.797 to 354.788 and ranged from 3.014 to 312.209 as percent of better parent. These results are agreement with those obtained by El-Shamarka (1999). The present results indicated that the inbred line P^2 and P^6 were the best parents for most of the studied traits. The crosses (P^4xP^8), (P^4xP^6) and (P^3xP^5) gave the highest heterosis values for grain yield/plant.

REFERENCES

Abo-El-Fadhl, M. A. (1978). Heritability estimates of some characteristics in maize (*Zea mays* L.). Ph.D. Thesis, Fac. of Agric., Ain-Shams Univ., Egypt.

Alika, J. E. (1994). Diallel analysis for ear morphological characters in maize (*Zea mays* L.). Indian J. Genet, 54 (1): 22-26.

Amer, E. E. (1991). Genetic studies on some crosses of maize. Ph.D. Thesis, Fac. of Agric., Al-Azhar Univ., Egypt.

Daniel (1969). Heterosis and mean degree of dominance in the inheritance of plant height in maize (*Zea mays* L.). Z. Pflanzenz . 61. 366-380 (C.F./ P Breed. Abst., 40: 2911, 372, (1970)).

Dehghanpour, Z.; Ehdaie, B; Moghaddam, M.; Griffing, B. and Hayman, B. I. (1997). Diallel analysis of agronomic characters in white endosperm cornt. of. Genet and Breeding, 50(4): 357-365.

El-Hosary A. A. (1988). Heterosis and combining ability of ten maize inbred lines as determined by diallel crossing over two planting dates. Egypt. J. Agron., 13 (1-2): 13-25.

El-Hosary A. A.; G. A. Sary and A. A. Abd El-Sattar (1990): Studies on combining ability and beterosis in maize (*Zea mays* L.) . Growth Attributes. Egypt. J. Agron.,15 (1-2): 23-34.

EL- Shamarka. S. A. (1999). Estimation of genetic effects of some quantitative attributes of maize (*Zea mays* L.) Egypt. J. Plant Breed. 3:101-113.

El-Zeir, F. A.; Soliman, F. H. and Shahata, A. M. (1997). Combining ability estimates from diallel crosses amonge new yellow maize inbreds. Egypt. J. Appl. Sci., 12 (9): 200-213.

Falconer, D. S. (1981). Introduction to quantitative genetics. 2nd ed., Longman, New York.

Gama, E. E. G.; Hallauer, A. R.; Ferrao, and Barbose, D. M. (1995). Heterosis in maize single crosses derived from a yellow Tuxpeno variety in Brazil. Revista Brasileira-de-Genetica. 1995, 18:1, 81-85.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing systems. Australia J. Biol., Sci, 9: 463-493.

Hallauer, A. R. and J. B. Miranda (1981). Quantitative Genetics In Maize Breeding. Snd Ed. the lowa State Univ. press. Ames. U.S.A.

Morshed, G. A., A. F. Abdalla and S. A. Mohamed (1989). Diallel analysis of some agronomic characters in maize. Egypt. J. Appl., Sci., 4 (3): 601-611.

Mostafa, M. A., A. A. Abdel-Aziz; G. M. A. Mahgoub and H. S. El-Sherbiney (1996). Diallel analysis of grain yield and natural resistance to late wilt disease in newly developed inbred lines of maize. Bull., Fac. Agric. Cairo Univ., 47:393-404.

Mourad, S. B.; S. E. Sadek; A. I. El-Agamy and F. H. S. Soliman (1992). Genetic variances in two maize estimated by reciprocal half-sib selection method. Egypt. J. Appl., Sci., 7: 585-598.

Nagda, A. K.; Vyas, M. C., Dubey, R. B. and Pandiya, N. K. (1995). *Heterosis* and combining ability analysis for grain yield and its components in *maize* crop . Res, Hisar. 10 (3): 297-301.

Nevado, M. E.; H. Z. Cross (1990). Diallel analysis of relative growth rates in maize synthetics, crop Sci., 30:549-552.

Pole, A. K. and H. S. Prodhan (1994). combining ability analysis of grain yield and oil content along with some other attributes in maize (*Zea mays* L.). Indian J. Genet, 54 (4): 376-380.

Sadek, S. E.; N. A. Ahmed; S. F. Aboul-Saad and H. E. Gado (1992): Analysis of components of plant yield variation in maize. Egypt. J. Appl. Sci., 7 : 559-569.

Shafey, S. A. (1993). Diallel analysis for some agronomic characters and yield in yellow maize (*Zea mays* L.). Egypt. J. Appl. Sci., 8 (7): 602-616.

Shafey, S. A. (1998). Combining ability and heterosis for yield and yield components in maize (*Zea mays* L.). Al-Azhar J. Agric., Res., 28 PP. 1-12.

Soliman, F. H. S.; A. A. El-Shenawy; F. A. El-Zeir and E. A. Amer (1995). Estimation of combining ability and type of gene action in topcrosses of yellow maize. Egypt. J. Appl. Sci., 10 (8): 321-329.
Steel, R. G. D. and T. H. Torrie (1980). Principles and procedures of statistics. McGraw-Hill. N. Y., USA.
Yassien, H. E. (1993), Genetical study in two maize crosses. Egypt. J. Appl. Sci 8 (8): 473-485.
Yassien, H. E. (1999). Genetic parameters for yield and its components in some Maize crosses. Al-Azhar. J. Agric. Res., 30, 1-15.

تقدير القدرة على التآلف وقوة الهجين للنمو والتبكير والمحصول في الذرة الشامية

شافعي عبد الفتاح شافعي* ، حمزة السيد يسن* ،إبراهيم الوصيف محمد على البيلي* ، عمر عبد الله محمود جاد الله**
*** قسم المحاصيل بكلية الزراعة – جامعة الأزهر– القاهرة.**
**** شركة مصر هاي تك الدولية للبذور – مدينة قها– قليوبية**

أجرى هذا البحث بهدف دراسة القدرة على التآلف وقوة الهجين في مجموعة من الهجن التبادلية بين ثمانية سلالات من الذرة الشامية البيضاء وهي :-
MHTC-1, MHTC-2, MHTC-3, MHTC-4, MHTC-5, MHTC-6, MHTC-7, and MHTC-8.

وقد أجرى هذا البحث بالمزرعة الخاصة بشركة مصر هاي تك الدولية للبذور بمدينة قها- قليوبية خلال موسمين متتاليين حيث تم عمل جميع الهجن الممكنة بين الآباء خلال موسمي ٢٠٠٠ و ٢٠٠١ قيمت الـ ٢٨ هجين الناتجة في الجيل الأول والآباء في تصميم القطاعات الكاملة العشوائية في ثلاث مكررات في موسم ٢٠٠١م ودونت البيانات على صفات : ميعاد ظهور النورة المذكرة والمؤنثة ، ارتفاع النبات ، ارتفاع الكوز ، طول الكوز ، قطر الكوز ، عدد صفوف الكوز ، عدد حبوب الصف ، وزن ١٠٠ حبة ومحصول حبوب النبات . وقد حللت النتائج وراثيا طبقا للموديل الأول. الطريقة الثانية للعالم جرفنج ١٩٥٦.

ويمكن تلخيص النتائج المتحصل عليها كالآتي:-

كان التباين الراجع لكل من القدرة العامة والخاصة على التآلف معنويا لكل الصفات ما عدا طول النبات في القدرة العامة على التآلف وكانت النسبة بين تباين القدرة العامة والقدرة الخاصة على التآلف ذات قيمة عالية تفوق الوحدة لصفات طول الكوز وعدد حبوب الكوز ووزن ١٠٠ حبة بينما كانت النسبة أقل من الوحدة لباقي الصفات مما يدل على أن الجزء الأكبر من الاختلافات الوراثية المرتبط بهذه الصفات كان راجعا إلى فعل الجينات من النوع السيادي.

- أظهرت السلالة P^6 قدرة عامة عالية علي التآلف لكل من محصول حبوب النبات وطول الكوز والسلالة P^8 للتبكير وارتفاع النبات والسلالة P^3 لارتفاع الكوز ، وقطر الكوز ووزن ١٠٠ حبة.
- أشارت نتائج القدرة الخاصة إلى ارتفاع قيم الهجين P^4xP^8 بالنسبة لصفات عدد صفوف الكوز وعدد حبوب الصف وكذلك محصول حبوب النبات والهجين P^3xP^6 لصفات التبكير ووزن ١٠٠ حبة والهجين P^3xP^5 لصفة طول الكوز وقطره مما يدل علي أن التأثير غير المضيف له أهمية في وراثة هذه الصفات.
- أتضح من النتائج أهمية التأثير المضيف وغير المضيف في وراثة صفات المحصول ومكوناته في الذرة الشامية وكذلك في اختيار برامج التربية المناسبة لتحسين المحصول .
- كانت قوة الهجين معنوية لمعظم الصفات المدروسة في معظم الهجن كما أعطى الهجين P^4xP^8 أعلى قوة هجين مقارنة بباقي الهجن بالنسبة لمحصول حبوب النبات ومعظم الصفات المحصولية الأخرى بينما كان الهجين P^3xP^6 هو المفضل لصفات التبكير. لذا توصي هذه النتائج إلى أن هذه الهجن ذات كفاءة مبشرة في برامج تربية الذرة لتحسين المحصول وللتبكير.