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ESTIMATION OF HETEROSIS AND COMBINING ABILITY FOR YIELD AND OTHER AGRONOMIC TRAITS IN MAIZE HYBRIDS (*ZEA MAYS* L.)

Abd El-Aty, M.S. and Y.S. Katta
Agronomy Department, Fac. of Agric., Tanta University Egypt.

ABSTRACT

This investigation aimed to study the type of gene action and heterotic effects in maize. Seven parental single crosses and their resulted 21 diallel double crosses (derived in 2000 season) were tested on a field experiment in the Experimental Farm, Faculty of Agriculture, Kafr El-Sheikh, Tanta University during the season 2001 in a randomized complete blocks design with three replications. The studied traits were silking date, plant and ear heights, ear length, ear diameter, number of rows/ear, number of kernels/row, 100-grain weight and grain yield ardab/fed. The results showed that:

1- Highly significant differences were obtained among the studied genotypes (parental crosses and single vs. double crosses). General and specific combining ability mean squares were highly significant for all studied traits, except plant height for specific combining ability.
2- Non-additive gene effects played a major role in the inheritance of all studied characters except for ear length and ear diameter where the additive gene effects played the important role.
3- Single crosses 10 and 129 showed the best general combining ability effect for grain yield and most agronomic traits, while those for days to 50% silking with short plants were obtained by single crosses 120 and 124.
4- Highest values of specific combing ability effects for grain yield were obtained from the double cross (9 x 10). While nine double crosses exhibited negative and significant specific combining ability effects toward earliness.
5- Heterosis values as a percentage relative to the mid and high parent ranged from negative to positive significant values for all studied traits. The highest heterosis value for grain yield ard./fed. was obtained from the double cross (9 x 10) only.

INTRODUCTION

Many high yielding single, three-way and double cross were developed and released during the last few years.

These hybrids produce high grain yield under different environmental conditions.

Several designs were used for studying the type of gene actions. Partitioning and magnitude of genetic variances in maize are of value to plant breeders as a guide in choosing germplasm for population improvement (Griffing, 1956). Matzinger *et al.* (1959) reported that the general combining ability (G.C.A.) variance is a function of additive genetic variance and additive x additive type of epistasis, while, specific combining ability (S.C.A.) variance is a function of the non additive variance including dominance. Diallel crosses designs are widely and extensively used for estimating the combining ability and type of gene actions, which is considered as a main object for any plant breeding scheme for developing the materials which give superior environmental conditions and the release of new high yielding commercial hybrids. In this respect, Katta *et al.* (1975), Nawar and El-Hosary (1985), Abd El-Aty (1987), Back *et al.* (1991), El-Hosary *et al.* (1999) reported that general combining ability was more important in determining yield and other characters. Meanwhile, Mostafa *et al.* (1996), El-Zeir (1998)and El-Shamarka (1999) reported that specific combining ability effects were much more important in the inheritance of grain yield and its components. On the other hand Hallauer and Miranda (1981) stated that both general and specific combining ability effects should be taken in consideration when planning for maize breeding program to produce and release new inbreds or crosses.

The main objectives of this investigation were;

1- To estimate the type of gene action for a group of single hybrids of maize and their double crosses.
2- To estimate general and specific combining abilities for certain quantitative in a diallel set of maize.
3- To estimate the heterotic effects of the genotypes.
4. To estimate the best combination between any two single crosses to recombine other double or three way-crosses from their inbred lines.

MATERIALS AND METHODS

The present study was carried out at the Experimental Farm, Faculty of Agriculture, Kafr El-Sheikh, Tanta University, Egypt, during the two successive seasons 2000 and 2001. Seven recommended perental single crosses; namely, single cross 9, 10, 120, 122, 123, 124 and 129 were crossed in all possible combinations excluding the reciprocals in 2000. During 2001, all the 21 double crosses and their seven parents were grown in a randomized complete block design, with three replications. Plot size was two rows, 6 m. Long, 70 cm apart and 25 cm between hills. All recommended cultural practices were applied at the proper time. The data were recorded on silking date, plant height (cm), ear height (cm), ear length (cm), ear diameter (cm), number of rows/ear, number of kernels/row, weight of 100 kernels (g) and grain yield ardab per fad, which was adjusted on 15.5% moisture.

Griffing (1956) method 2 model 1, was used to estimate (G.C.A.) and (S.C.A.) effects. The single crosses were considered fixed. The relative importance of G.C.A. to S.C.A. were expressed as follows:

$$\frac{K^2GCA}{K^2SCA} = \frac{MS\ G.C.A. - MSE/(P+2)}{MS\ S.C.A - MSE}$$

Where:

K^2 = is the average squares of the effects
MS = Mean squares
e = Error Term
P = No. of Parents.

Heterotic effects were calculated relative to mid and better parent as suggested by Mather and Jinks (1971).

RESULTS AND DISCUSSION

1. Analysis of variance:

Data presented in Table 1 show the significant differences among genotypes for all studied traits.

Table 1: Mean squares of diallel analysis for all studied characters.

S.O.V.	D.F	Silking date	Plant height	Ear height	Ear length	Ear diameter	No. of rows/ear	No. of kernels/ row	100-kernels /weight	Grain yield ard./fed
Replication	2	1.73**	53.29	116.39**	0.966**	0.028*	0.174*	1.55*	4.49**	0.376
Genotypes	27	9.08**	464.67**	236.80**	1.83**	0.061**	0.510**	10.51**	62.28**	5.49**
Parent	6	25.62**	1229.44**	364.42**	7.01**	0.073**	0.939**	9.05**	29.77**	16.55**
Crosses	20	9.71**	255.99 ns	2631.75**	3.36**	0.079**	0.877**	6.49**	280.25**	3.04**
Pvs. C	1	8.68**	535.62**	187.05**	1.46**	0.034**	0.395**	10.99**	82.09**	6.04**
g.c.a.	6	13.35**	297.93 ns	1262.24**	0.211*	0.490**	0.600**	24.82**	4.75**	9.46**
s.c.a	21	4.34**	246.17 ns	200.34**	0.358**	0.058*	0.387**	1.92**	71.57**	2.34**
Error	54	0.201	117.06	19.75	0.050	0.007	0.043	0.320	0.186**	0.276
K^2G.C.A./ K^2S.C.A.	-	0.803	0.638	0.205	2.16	1.28	0.278	0.398	0.546	0.814

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

Sum of squares due to genotypes were further partitioned into parental crosses and single vs. double crosses sum of squares (and subsequently to mean of squares) as shown in Table 1. Significant differences of mean squares were obtained among parents with respect to all traits except plant height. Highly significant differences among crosses were obtained in all traits. For parents vs crosses mean squares, significant differences were obtained for all traits except plant height indicating that the average mean performances of the single cross parents outyield those of the double crosses performances derived from them.

General combining ability (G.C.A.) mean squares were highly significant for all studied traits. Specific combining ability mean squares (S.C.A.) were significant for all studied traits except plant height. This would indicate that G.C.A. (additive effects) and S.C.A. (non-additive effects) (non-additive effects) would play an important role in the inheritance of these traits.

These results are in harmony with those of Odemah (1973), Katta *et al.* (1975), Mosa (1996), Abd El-Maksoud (1997), Amer *et al.* (1998), El-Zeir and Amer (1999).

The G.C.A./S.C.A. ratio was less than unity for most studied traits except for ear length and ear diameter. This would indicate that non-additive gene effects were more important in the inheritance of all studied traits except that of ear length and ear diameter in which the additive gene effect were more important in their inheritance.

2. Mean performance:

The mean performance of seven single crosses and their resulted 21 double crosses are presented in Table 2. Single cross 122 was the earliest cross (about 61.40 days for silking), while single cross 10 was the latest one (65.77 day). Single cross 10 gave the highest grain yield (36.12 ard./fed.), followed by S.C. 129 (35.85 ard/fed.), while S.C. 9 and S.C. 123 were inferior in grain yield ard./fed. (33.51 and 33.69, ard./fed. respectively).

Table 2: Mean performance of diallel crosses of seven single crosses and their 21 double crosses for all studied character.

Characters / Genotypes	Silking date	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of Row /ear	No. of kernels/ row	100 kernels/ weight (g)	Grayin yield ard/fed.
S.C. 9	64.33	208.7	100.7	18.18	4.47	12.53	39.86	41.97	33.51
S.C. 10	65.77	223.7	117.0	20.73	4.93	14.10	43.60	44.70	36.12
S.C. 120	63.37	205.7	100.7	19.07	4.87	13.63	39.97	42.73	34.27
S.C. 122	61.40	225.7	123.3	18.77	4.80	13.33	40.73	41.90	34.34
S.C. 123	60.67	228.7	112.0	18.03	4.80	13.67	39.67	44.93	33.69
S.C. 124	61.60	209.7	102.3	18.60	4.90	14.07	42.23	41.40	34.75
S.C. 129	62.80	219.3	111.0	20.40	4.93	13.87	41.77	43.37	35.85
Mean of S.C.	62.84	217.3	109.8	19.10	4.81	13.60	41.11	43.0	34.65
D.C. (9 x 10)	65.20	225.7	116.0	19.60	5.13	13.67	39.23	41.76	35.83
D.C. (9 x 120)	64.10	204.7	132.3	18.63	5.23	13.43	42.13	42.60	33.92
D.C. (9 x 122)	63.73	232.0	119.7	18.40	4.90	13.77	41.77	43.20	34.11
D.C. (9 x 123)	61.40	201.3	100.7	19.53	4.93	13.67	38.37	46.83	32.00
D.C. (9 x 124)	60.07	200.7	104.7	18.50	5.00	13.73	40.53	45.76	33.81
D.C. (9 x 129)	63.10	217.0	119.0	19.60	5.03	13.20	39.50	50.17	34.12
D.C. (10 x 120)	63.00	233.3	121.7	19.73	5.06	14.03	40.07	47.63	35.06
D.C. (10 x 122)	62.10	238.0	126.0	19.67	5.06	14.10	38.13	47.06	35.07
D.C. (10 x 123)	63.00	239.7	129.7	19.47	4.87	13.80	37.03	51.99	31.93
D.C. (10 x 124)	64.53	226.3	116.0	19.37	5.10	14.17	35.03	43.17	35.10
D.C. (10 x 129)	62.70	232.0	126.3	20.39	5.06	14.03	40.87	38.10	35.80
D.C. (120 x 122)	62.37	234.7	118.7	18.50	5.06	13.90	42.47	41.50	34.08
D.C. (120 x 123)	59.80	235.7	115.0	19.13	4.90	13.33	39.47	38.90	31.20
D.C. (120 x 124)	59.70	198.0	105.3	18.67	5.06	13.73	42.27	43.00	33.88
D.C. (120 x 129)	60.10	204.0	116.7	19.77	5.03	14.13	41.10	38.23	34.67
D.C. (122 x 123)	62.33	224.7	115.0	18.90	4.87	13.67	37.40	33.86	31.23
D.C. (122 x 124)	61.50	220.3	116.7	18.27	4.87	14.00	39.40	43.07	34.22
D.C. (122 x 129)	62.33	233.3	125.0	19.30	4.93	14.00	40.5	48.43	35.26
D.C. (123 x 124)	59.33	219.3	123.3	18.07	4.83	12.67	39.47	51.76	31.88
D.C. (123 x 129)	61.40	217.7	120.3	20.00	4.93	14.07	42.0	45.76	33.85
D.C. (124 x 129)	60.67	217.0	121.0	19.70	4.90	14.03	40.40	32.90	34.27
Mean of D.C.	61.93	221.7	118.52	19.23	4.99	13.80	39.86	43.55	33.87
L.S.D. 0.05	1.03	17.6	7.22	0.36	0.14	0.34	0.92	0.704	0.85
0.01	1.37	23.3	9.58	0.48	0.18	0.44	1.22	0.937	1.13
Overall mean	62.15	220.6	116.3	19.19	4.94	13.74	40.18	43.41	34.2

With regard to the superiority of the double crosses for different traits it could be summarized as follows: Double crosses numbers; (123 x 124), (120 x 124) and (120 x 123) for earliness, (120 x 124) for shortness of plant and ear height, (10 x 129) for ear length, (9 x 120) for ear diameter, (10 x 122) for number of rows/ear, (120 x 122) for number of kernels/row, (10 x 123) for 100-kernel weight, (9 x 10) and (10 x 129) for grain yield ard./fed.

3. Combining ability effects:

a. General combining ability effects:

Estimates of G.C.A. effects of the seven parental single crosses are shown in Table 3. Parents with negative estimates for silking date, plant and ear height are considered better since they are earlier, shorter and would be more resistant to stalk breakage. Data in the Table 3 showed that the parental single crosses 120 and 124 exhibited negative and highly significant GCA effects toward earliness for days to 50% silking and plant height, indicating that those single crosses possess favorable genes for developing improved hybrids with short plants and early maturity. However, the single cross 10 and single cross 129 had the highest positive and highly significant GCA effects for ear length ear diameter, number of rows/ear and grain yield ard./fed. This is of a practical interest in breeding programs for developing high yielding genotypes because of their superiority in ear length, number of rows/ear, grain yield ard./fed. and one or more of the remaining traits).

These results are in agreement with those reported by El-Zeir (1990), Ragheb *et al.* (1995), El-Zeir *et al.* (1994) and El-Absawy (2000).

Table 3: Estimates of general combining ability of seven single crosses of maize for all studied characters.

Characters / Parents	Silking date	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of row/ear	No. of kernels/ row	100 kernels weight (g)	Grain yield ard./ fed.
S.C. 9	1.00**	-7.34**	-4.07**	-0.330**	-0.045**	-0.326**	-0.017	0.571**	-0.189*
S.C. 10	1.65**	8.62**	4.38**	0.740**	.066**	0.225**	-0.428**	1.331**	0.945**
S.C. 120	-0.384**	-4.79*	-2.14**	-0.112*	0.059**	0.040	0.668**	-1.084**	-0.130
S.C. 122	-0.232**	7.732**	4.15**	-0.334**	-0.030*	0.022	-0.032	-0.684**	0.014
S.C. 123	-0.962**	3.43	-0.25	-0.267**	-0.071**	-0.160**	-0.928**	1.338**	-1.449**
S.C. 124	-0.917**	-7.09**	-4.29**	-.423*	-0.001	-0.055	0.016	-0.740**	0.016
S.C. 129	-0.151	-0.566	2.23**	0.725**	0.023*	0.144**	0.720**	-0.732**	0.794**
S.E.g_i 0.05	0.16	3.84	1.58	0.08	0.03	0.08	0.20	0.153	0.19
0.01	0.21	5.09	2.09	0.11	0.04	0.10	0.27	0.203	0.25
LSD g_i-g_j 0.05	0.24	5.86	2.41	0.12	0.04	0.11	0.31	0.234	0.28
0.01	0.32	7.77	3.19	0.16	0.06	0.15	0.41	0.310	0.38

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

b. Specific combining ability effects:

Specific combining ability effects of the 21 double crosses for all studied traits are presented in Table 4. For days to 50% silking, nine crosses exhibited negative and significant specific combining ability effects for earliness, indicating that one of these combinations could be helpful for selecting early maturing maize lines and subsequently early hybrids. For plant and ear height, two crosses showed negative and significant desirable S.C.A. effects, which indicate that these crosses possess favorable genes for producing improved hybrids with short plants and low ear position placement. Five crosses had the highest desirable estimates of S.C.A. effects for ear length. For ear diameter, seven crosses exhibited positive and significant S.C.A. effects. Regarding to the number of rows/ear, five crosses exhibited positive and significant S.C.A. effects. Relative to 100 kernels weight ten of the 21 crosses exhibited positive and significant S.C.A. effects. The highest desirable and positive S.C.A. effects relative to grain yield ard./fed. were obtained from one (4 x 10) out of 21 double crosses.

Table 4: Estimates of specific combining ability effects of 21 double crosses among seven single crosses of maize for all studied characters.

Characters / Genotypes	Silking date (days)	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of row/ear	No. of kernels /row	100 kernels weight (g)	Grain yield (ard. /fed)
D.C. (9 x 10)	0.39	3.80	-0.59	-0.01	0.17**	0.02	-.50	-3.53**	1.01**
D.C. (9 x 120)	1.32**	-3.79	22.26**	-0.21	0.27**	0.47**	1.31**	-0.28	0.17
D.C. (9 x 122)	0.81**	11.02	3.30	-0.13	0.03	0.33**	1.64**	-0.08	0.22
D.C. (9 x 123)	-0.80**	-15.35**	-11.30**	0.93**	0.10*	0.41**	-0.87*	-1.53**	-.42
D.C. (9 x 124)	-2.17**	-5.50	-3.26	0.06	0.10*	0.26*	0.36	0.54*	-0.08
D.C. (9 x 129)	0.09	4.32	4.56	0.01	0.11*	-0.36**	-1.38**	6.94**	-0.55
D.C. (10 x 120)	-0.42	8.91	3.15	-0.09	-0.01	0.02	-0.35	3.99**	0.18
D.C. (10 x 122)	-1.47**	1.06	1.19	0..06	0.08	0.11	-1.58**	3.03**	0.04
D.C. (10 x 123)	0.16	7.02	9.26**	-0.20	-0.08	-0.01	-1.79**	5.91**	-1.63**
D.C. (10 x 124)	1.65**	4.20	-0.37	-0.15	0.09*	0.14	-4.73**	-0.08	0.07
D.C. (10 x 129)	-0.95**	3.35	3.44	0.27*	0.03	-0.08	0.40	-5.89**	-0.01
D.C. (120 x 122)	-1.17**	11.13*	0.37	-.25*	0.09*	0.09	1.65**	-.09	0.13
D.C. (120 x 123)	-1.01**	16.43**	1.11	0.32**	-0.03	-0.29**	-0.45	-4.74**	-1.29**
D.C. (120 x 124)	-1.16**	-10.72	-4.52	0.01	0.06	-0.11	1.41**	1.73**	-0.07
D.C. (120 x 129)	-1.52**	-11.24*	0.30	-0.04	0.01	0.20	-0.47	-3.34**	-0.06
D.C. (122 x 123)	1.37**	-7.09	-5.16*	0.31**	0.02	0.06	-1.82**	-10.18**	-1.40**
D.C. (122 x 124)	0.49*	-0.91	0.52	-0.17	-0.05	0.18	-0.76*	1.10**	.0.12
D.C. (122 x 129)	0.56*	5.57	2.33	-0.29*	-0.01	0.16	-.37	6.45**	0.38
D.C. (123 x 124)	-0.94**	2.39	11.59**	-0.44**	-0.04	-0.98**	0.20	7.78**	-0.75*
D.C. (123 x 129)	0.36	-5.80	2.07	0.35**	0.04	0.34**	2.03**	1.97**	0.44
D.C. (124 x 129)	-0.42	4.06	6.78**	0.20	-0.07	0.09	-0.51	-0.02	-0.61
S.E.. Sij 0.05	0.46	11.16	4.58	0.23	0.09	0.21	0.58	0.45	0.64
0.01	0.61	14.80	6.08	0.31	0.21	0.28	0.78	0.59	0.84
L.S.D. Sij-Skl 0.05	0.64	15.50	6.37	0.32	0.12	0.30	0.81	0.62	0.75
0.01	0.85	20.57	8.45	0.42	0.16	0.39	1.08	0.83	0.99

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

On the other hand, when a cross ranks highest for S.C.A. effect in a certain trait and at the same time ranks best for its mean performance per se in the same trait, such cross would be considered as a good breeding material to improve this specific traits. According to this and relative to the results obtained herein, the crosses (9 x 10), (10 x 120), (10 x 122), (10 x 124) and (122 x 129) might be a good material for improving grain yield and other studied traits, as shown in Tables 2 and 4.

Out of 21 double crosses obtained herein, the \number of the double crosses having positive S.C.A. were more than those of negative S.C.A., in all trits.

4. Effect of heterosis:

Heterotic effects were computed relative to mid and better parent and are presented in Table 5. Positive heterosis relative to mid-parents, was highly significant for ear length, ear diameter, number of rows/ear and grain yield ard./fed. in double cross (9 x 10). Highly significant positive heterosis values were also observed for double cross (120 x 124) for ear diameter, number of kernels/row, and 100 kernels weight relative to mid and better parents.

Table 5: Estimates of heterosis relative to mid parents and height parent from 21 double crosses for all studied traits.

Characters	Silking date		Plant height (cm)		Ear height (cm)		Ear length (cm)		Ear diameter (cm)		No. of rows/ear		No. of kernels/row		100-kernels weight (g)		Grain yield ard./fed.	
	Heterosis		Heterosis		Heterosis		Heterosis		Heterosis		Heterosis		Heterosis		Heterosis		Heterosis	
Double crosses	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P
D.C. (9 x 10)	0.23	1.35*	4.39	8.14	6.52	15.19*	0.77**	-5.45**	4.69**	4.05**	2.63**	-3.04**	-5.99**	-10.0**	-3.65**	-6.58**	2.91**	-0.80
D.C. (9 x 120)	0.39	1.15	-1.21	-0.48	31.4**	31.38**	0.05	-2.30**	11.99**	7.39**	6.49**	2.20**	5.54**	5.40**	0.59	-0.30	0.09	-1.02
D.C. (9 x 122)	1.46**	3.79**	6.81	11.10	6.87	18.96**	-0.54*	-1.97**	5.83**	2.08**	6.49**	3.31**	3.65**	2.55**	3.01**	52.93**	0.54	-0.6
D.C. (9 x 123)	-1.76**	1.20	-7.95	3.54	-5.35	0.00	7.90**	7.48**	6.25**	2.70**	4.36**	0.0	-3.53**	-3.73**	7.78**	4.22**	-4.76**	-5.01**
D.C. (9 x 124)	-4.60**	-2.489**	-4.06	-3.83	3.15	3.97	0.54	-2.53	6.61**	2.04**	3.24**	-2.42**	-1.27	-4.02**	7.97**	3.70**	-0.94	-2.70**
D.C. (9 x 129)	-0.73	0.47	1.40	3.97	12.4*	18.17	1.55**	-3.92**	7.02**	2.02**	0.00	-4.83**	-3.23**	-5.43**	18.08**	15.97**	-1.62*	-4.80**
D.C. (10 x 120)	-2.43*	0.58	8.66	13.4	11.8*	20.8**	-0.85**	-4.82**	3.27**	2.63**	1.15**	0-0.49	-4.12*-*	-8.09**	8.95**	6.55**	-0.40	-2.936**
D.C. (10 x 122)	-2.34*	1.14	5.91	6.399	4.82	7.69	-0.065*	-5.11**	3.9**	2.63**	2.76**	0.00	-9.59**	-12.54**	8.69**	5.27**	-0.46	-2.90**
D.C. (10 x 123)	-0.34	3.84**	5.96	7.15	13.3*	15.80*	0.36	-6.08**	0.21*	-14.20**	-0.65*	-2.12**	-11.08**	-15.06**	15.1**	15.7**	-8.54**	-11.6**
D.C. (10 x 124)	1.31*	4.75**	4.43	7.92	5.74	13.39*	-1.52**	-6.56**	3.66**	3.44**	0.57*	0.49	-18.39**	-19.65**	0.28	-3.42**	-0.96	-2.92**
D.C. (10 x 129)	-2.47**	-0.15	4.74	5.79	10.8	13.78*	-0.87**	-1.04**	2.64**	2.63**	0.29	-0.49	-4.27**	-6.26**	-13.5**	-14.7**	-0.53	-0.88
D.C. (120 x 122)	-3.23**	-1.67**	8.80	14.10	5.98	17.87**	-2.21**	-2.98**	4.55**	3.90**	3.11**	1.98**	4.28**	4.27**	-1.94**	-2.87**	-0.68	-0.75
D.C. (120 x 123)	-3.57**	-1.43*	8.51	14.58	8.08	14.2*	3.12**	0.31	1.24**	0.60**	-2.35**	-2.48**	-0.88	-1.25	-11.3**	-13.7**	-8.129**	-8.95**
D.C. (120 x 124)	-4.46**	-3.08**	-4.67	-3.74	3.74	4.56	-090**	-2.09**	3.48**	3.26**	-0.87**	-2.41**	2.85**	0.0945	2.22**	0.63	-1.83**	-2.50**
D.C. (120 x 129)	-4.73**	-4.29**	-4.0	-0.82	10.30	15.88*	0.15	-3.08**	2.65*	2.02**	2.77**	1.87**	0.57	-1.60*	11.20**	-11.85**	-1.12	-3.29**
D.C. (122 x 123)	2.11**	2.70**	-1.10	-0.44	-2.29	2.67	2.71**	0.69*	1.45**	1.45**	1.26**	0.00	-13.87**	-8.17**	-223.3**	-24.69**	-8.29**	-9.05**
D.C. (122 x 124)	0.0	0.16	1.29	5.05	3.45	14.0*	-2.324**	-2.66**	0.41**	-0.60**	2.19**	-0.49	-5.41**	-6.70**	3.41**	2.79**	-0.96	-1.52*
D.C. (122 x 129)	0.37	1.50*	4.85	6.38	6.65	12.60*	-1.48**	-5.39**	1.23**	0.00	2.95**	0.93**	-5.02**	-3.04**	13.60**	11.66**	0.72	-1.64*
D.C. (123 x 124)	-2.96**	-2.20**	0.04	4.57	15.0**	20.5**	-1.36**	-2.84**	-0.41**	-1.4**	-8.65*	-9.95**	-3.62**	-6.53**	19.9**	15.20**	-0.684**	-8.25**
D.C. (123 x 129)	-0.56	1.20	-3.13	-0.73	7.89	-0.73	4.05**	-1.96**	1.23**	0.0	2.18**	1.44**	3.12**	0.55	3.65**	1.84**	-2.65**	-5.57**
D.C. (124 x 129)	-2.45**	-1.51*	1.16	3.66	13.40*	3.66	1.02**	-3.43**	-0.20*	0.60**	0.43	-0.28	-3.81**	-4.33**	-22.4**	-24.14**	-2.92**	-4.40**

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

Many crosses gave desirable and highly significant heterotic effects in different studied traits. Desired heterotic values towards earliness were obtained from the double crosses (9 x 124), (120 x 122), (120 x 123), (120 x 124), (120 x 129), (123 x 124) and (124 x 129) where they gave negative values and highly significant relative to mid and better parent. Our results are in agreement with El-Hosary *et al.* (1999) and El-Absawy (2000). In our result such promising genetic materials which showed desirable values of mean performances, (G.C.A.), (S.C.A.) and heterotic effects, i.e. S.C. 10, 124 and 129 and D.C. (120 x 124) may be used in improving yielding ability and some agronomic traits in maize breeding programmes.

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تقدير قوة الهجين والقدرة على الأئتلاف لمحصول الحبوب والصفـــات الزراعيـــة الأخرى لهجن الذره الشامية

محمد سعد مغازى عبدالعاطى، يوسف صلى محمد قته
قسم المحاصيل ــ كلية الزراعة بكفرالشيخ ــ جامعة طنطا

يهدف هذا البحث لدراسة فعل الجين المؤثر فى الصفة وتقدير قوة الهجين وكذلك القـدرة العامة والخاصة على الأئتلاف لسبعة هجن فردية من محصول الذره الشامية وواحـد وعشـرون هجين زوجى ناتجة عنها باستخدام نظام الهجن التبادلية خلال عامى 2000 ، 2001 فى مزرعـة كلية الزراعة بكفرالشيخ ــ جامعة طنطا. وذلك لصفات: ميعاد التزهير (50% حريره) ، ارتفـاع النبات ، ارتفاع الكوز ، طول الكوز ، قطر الكوز ، عدد صفوف الكوز ، عدد حبـوب الصـف ووزن الـ 100 حيه. بالإضافة إلى محصول الفدان من الحبوب.

ويمكن تلخيص النتائج فيما يلى:

1- وجود اختلافات عالية المعنوية بين التراكيب الوراثية تحت الدراسة (الأباء والجيل الأول) ، وكانت تقديرات القدرة العامة والقدرة الخاصة على الأئتلاف عالية المعنوية لجميع الصفـات المدروسة فيما عدا القدرة الخاصة على الأئتلاف لصفة ارتفاع النبات.
2- أوضحت الدراسة أهمية الفعل الجينى غير المضيف فى وراثة جميع الصفات المدروسة مـا عدا صفتى طول الكوز وقطر الكوز فكان الفعل الجينى المضيف لهم أكثر أهمية.
3- كان أحسن الأباء للقدرة العامة على الأئتلاف بالنسبة لمحصول الحبوب ومعظـم الصفـات الأخرى هو الهجين الفردى 10 ، 129 ، بينما يعتبر الهجينان الفرديان 120 ، 124 مـن أبكر الهجن الفردية وأقصرهم ارتفاعا.
4- أعلى تأثير مرغوب بالنسبة للقدرة الخاصة على الأئتلاف بالنسبة لمحصول الحبـوب تـم الحصول عليها من الهجين الزوجى (9 × 10) ، فى حين كانت هناك تسعة هجن زوجيـة مبكرة عن الأباء الناتجة منها.
5- تراوحت قوة الهجين بالنسبة لمتوسط الأبوين أو بالنسبة للأب الأعلى ما بين قيـم معنويـة سالبة إلى موجبة لجميع الصفات المدروسة ويعتبر الهجين الزوجى (9 × 10) من أفضـل الهجن الناتجة سواء بالنسبة لمحصول الحبوب أو بالنسبة لباقى الصفات الأخرى المدروسة.