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GENETIC ANALYSIS OF GRAIN YIELD AND OTHER ATTRIBUTES IN DIALLEL CROSSES AMONG YELLOW ENDOSPERM MAIZE INBRED LINES

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ABSTRACT

All possible diallel F_1 crosses excluding reciprocals were made in 2003 season among eight yellow maize inbred lines: L-2. L-6. L-7. Gz 638, Gz 649, Gz 650 and Gm1021. In 2004 growing season, parents, F_1 crosses and two commercial yellow check single cross hybrids (SC155 and SC 3080) were evaluated at three locations (Sakha, Gemmeiza and Sids Research Stations). The results demonstrated that both general (GCA) and specific (SCA) combining ability mean squares were highly significant for all studied traits. However, variance due to SCA (non-additive) plays the major role in the inheritance of grain yield, days to 50 % silking, plant and ear heights. While, variance due to GCA (additive) was more important in the inheritance of number of ears/100 plants and resistance to late wilt disease. Parental inbred line Gm 1021 was found to be the best general combiner for high yielding ability, prolificacy and earliness. Parents L-2, L-7 and L-10 were good donors for resistance to late wilt disease. Parents, Gz 638 and Gz 649 were significantly better general combiners for shortness and lower ear placement. Five crosses, i.e. Gz 638 x Gm 1021, Gz 649 x Gm 1021, L-6 x Gm 1021, Gz 650 x Gm 1021 and L-2 x Gz 650 (30.41, 30.35, 29.19, 28.80 and 28.38 ard/fed., respectively) significantly outyielded the commercial yellow check hybrid SC 155 (25.88 ard/fed.) by 4.53, 4.47, 3.31, 2.92 and 2.50 ard/fed., respectively and showed significant positive SCA effects for grain yield. Therefore, these crosses might be released as new yellow single cross hybrids.

Key words: *Yellow maize, Genetic parameters, Diallel, Combining ability, Additive.*

INTRODUCTION

Providing raw materials for the food industry and animal feed, maize (*Zea mays* L.) is one of the major cereal crops. The production area of maize is gradually increasing in Egypt. Thus, new maize hybrids with high yield capacity need to be developed to meet the demands of maize producers.

Several breeding procedures have been established to increase the grain yields of the maize populations and their hybrids. In order to choose the best hybrid combinations, a large number of subjectively chosen inbred lines need to be crossed. It would be a considerable advantage to be able to estimate the combining ability of parents, gene effects and heterotic effects of crosses before making commercial crosses among inbred lines. Diallel crossing programs have been applied to achieve this goal by providing a systematic approach for the detection of suitable parents and crosses for the investigated characters. In addition, diallel analysis gives plants breeders the opportunity to choose the most efficient selection method by allowing them to estimate several genetic parameters (Unay *et al* 2004).

Combining ability describes the breeding values of parental lines to produce hybrids. Sprague and Tatum (1942) used the term general combining ability (GCA) to designate the average performance of a line in hybrid combinations, and used the term specific combining ability (SCA) to define those cases in which certain combinations do relatively better or worse than would be expected on the basis of the average performance of the lines involved. Hallauer and Miranda (1981) stated that both GCA and SCA effects should be taken into consideration when planning maize breeding programs to produce and release new inbred lines and crosses. El-Hosary (1989), Gado (2000) and Soliman *et al* (2005) found that additive gene action was more important in determining grain yield, days to mid silking, plant and ear heights. On the contrary, Dawood *et al* (1994), Mostafa *et al* (1996), Amer *et al* (1998), El-Zeir and Amer (1999), Soliman (2000) and Sadek *et al* (2001) reported that non-additive gene action played the major role in the inheritance of grain yield and other agronomic traits. In many studies, GCA effects for parents and SCA effects for crosses were estimated in maize (Dehghanpour *et al* 1996, San-Vicente *et al* 1998, Konak *et al* 1999, Gado, 2000, Araujo and Miranda 2001, Kalla *et al* 2001, Unay *et al* 2004 and Soliman *et al* 2005). Non-additive gene effects for grain yield were found to be significant in maize (Dehghanpour *et al* 1996, San-Vicente *et al* 1998, Kalla *et al* 2001). In addition, Paterniani and Lonnquist (1963), Hallauer and Eberhart (1966), El-Rouby and Galal (1972), Shehata and Dhawan (1975), Beck *et al* (1991), Vasal *et al* (1992) and Soliman *et al* (2005) confirmed the importance of dominance gene effects in the expression of yield, days to 50 % silking, plant height and ear position in case of advanced generations of selfing. Moreover, heritability degrees varied from low to moderate for grain yield (Dehghanpour *et al* 1996 and Kalla *et al* 2001).

The objectives of this study were to estimate the relative importance of GCA and SCA and their interaction with locations for grain yield, resistance to late wilt disease and other agronomic traits in a diallel set of maize, to determine superior parental lines and their prospective crosses for further use in the breeding program, and to develop higher yielding yellow single cross hybrid(s) than the commercial ones.

MATERIALS AND METHODS

Eight yellow maize inbred lines with different genetic backgrounds were crossed in a 8 x 8 diallel mating scheme, excluding reciprocals, in 2003 growing season at Sids Agricultural Research Station. These lines were four new developed lines; L-2, L-6, L-7 and L-10 (derived from the wide genetic base populations, Pop. 45 from CIMMYT, Mexico) and four elite inbred lines; Gz 638, Gz 649, Gz 650 and Gm 1021. The parents, their 28 F_1 crosses and two commercial yellow check single cross hybrids SC 155 and SC Pioneer 3080, (making 38 entries in total) were evaluated in replicated yield trials conducted at three locations; Sakha, Gemmeiza and Sids Agricultural Research Stations in 2004 growing season. The experimental design was a randomized complete block design with four replications. Plot size was one ridge, 6 m long and 0.8 m apart and hills were spaced 25 cm along the ridge. Two kernels were planted per hill and thinned later to one plant per hill to provide a population density of approximately 22,000 plants/feddan (feddan = 4200 m^2). All cultural practices for maize production were applied as recommended. Data were recorded for number of days to 50 % silking, plant height, ear height, resistance to late wilt disease, number of ears/100 plants and grain yield/plot adjusted to 15.5 % grain moisture and converted to ardab/feddan (ardab = 140 kg).

Data obtained from the 28 F_1 progenies and the 8 parents were subjected to the statistical analysis for each location according to Steel and Torrie (1980). Error mean squares were homogeneous, therefore, combined analysis of variance over the three locations was performed. Griffing's Method 2 Model 1 (fixed model) was then used to analyze combining ability (Griffing 1956).

RESULTS AND DISCUSSION

Analysis of variance

The analysis of variance combined over the three locations for grain yield, number of ears/100 plants, number of days to mid silking, resistance to late wilt disease, plant and ear heights is presented in Table (1). Highly significant mean squares were detected among locations for all studied traits, indicating that the three locations differed in their environmental conditions. Highly significant differences were detected among genotypes for the six studied traits. Partitioning the sum of squares due to genotypes into its components showed highly significant mean squares due to parental inbred lines, F_1 crosses and parents *vs* crosses for all studied traits, revealing

Table 1. Analysis of variance of 8 inbred lines and their F_1 diallel crosses for grain yield and other studied traits (combined data over three locations in 2004 growing season).

SOV	df	Grain yield (ard/fed.)	Number of ears/100 plants	Days to 50 % silking	Plant height, cm	Ear height, cm	Late wilt resistance %
Locations (L)	2	734.22**	27044.58**	1956.06**	175880.88**	75315.25**	726.52**
Reps/L	9	28.42	426.21	9.72	231.10	819.82	52.15
Genotypes (G)	35	824.91**	1151.10**	176.91**	15320.57**	6570.58**	181.78**
Parents (P)	7	64.29**	2497.98**	128.65**	4384.46**	1323.24**	273.74**
Crosses (C)	27	322.41**	770.69**	35.63**	3515.76**	1913.33**	151.75**
P vs C	1	19716.75**	1994.10**	4329.31**	410603.16**	169047.72**	349.12**
GCA	7	160.51**	3455.18**	111.26**	11127.07**	5540.21**	639.66**
SCA	28	991.01**	575.08**	193.32**	16368.94**	6828.18**	67.32**
G x L	70	28.97**	561.61**	7.37**	269.67**	166.19**	77.62**
P x L	14	21.65**	710.26**	9.07**	318.73**	115.08*	105.79**
C x L	54	29.43**	332.24*	3.87**	138.32	141.49**	72.56**
P vs C x L	2	67.75**	5714.06**	90.18**	3472.86**	1191.23**	32.68
GCA x L	14	32.57**	1158.98**	14.71**	359.52**	226.93**	237.28**
SCA x L	56	28.07**	412.27**	5.54**	247.21**	151.01**	37.70*
Pooled error	315	9.26	221.67	1.80	129.59	70.75	25.76
GCA/SCA		0.16	6.01	0.58	0.68	0.81	9.50
GCA x L/SCA x L		1.16	2.81	2.66	1.45	1.50	6.29
C.V. %		14.31	13.67	2.08	4.93	6.64	5.21

great diversity existed among inbred lines as well as, among their crosses. Moreover, mean squares due to the interaction of parental lines, F_1 crosses and parents *vs* crosses with locations were found to be highly significant for all studied traits, except plant height and resistance to late wilt disease for crosses x locations and parents *vs* crosses x locations interactions, respectively. The result indicated that the genetic behaviour of the parental inbreds and their crosses differed with different environmental conditions. These results are in accordance with those obtained by Singh and Asnani (1979), El-Hosary (1989), Beck *et al* (1991), Dawood *et al* (1994), Mostafa *et al* (1996), El-Zeir *et al* (1997), Sughroue and Hallauer (1997), Soliman (2000) and Soliman *et al* (2005) who suggested that parents and their crosses should be evaluated at different environmental conditions.

Mean squares due to general (GCA) and specific (SCA) combining ability were highly significant for the six studied traits (Table 1). These results indicated that both additive and non-additive types of gene effects were involved in the inheritance of these traits. However, the magnitudes of SCA mean squares were considerably higher than those of GCA for all studied traits, except number of ears/100 plants and resistance to late wilt disease, where the opposite was true (Table 1). These results revealed that non-additive gene effects play the major role in determining the inheritance of grain yield, number of days to mid silking and plant and ear heights. This indicates that the largest part of the total genetic variability associated with these traits was the result of non-additive gene action. This was expected since all genotypes used in this study are in advanced generations of selfing. In this regard, Paterniani and Lonnquist (1963), Hallauer and Eberhart (1966), El-Rouby and Galal (1972), Shehata and Dhawan (1975), Galal *et al* (1978), Paterniani (1980), Beck *et al* (1991), Vasal *et al* (1992) and Sadek *et al* (2001) support the importance of dominance gene effects in the expression of yield, days to 50 % silking, plant and ear heights in case of advanced generations of selfing. However, additive gene action was predominant and played an important role in the inheritance of number of ears/100 plants and resistance to late wilt disease. Results obtained herein are in accordance with those previously reached by Singh and Asnani (1979), Logrono and Lantin (1985), Landi *et al* (1986), Pajic (1986), Soliman (1992), Mostafa *et al* (1996), El-Zeir and Amer (1999) and Sadek *et al* (2001) who reported that SCA or non-additive gene action played an important role in the inheritance of grain yield, silking date, plant and ear heights. For late wilt, Salem *et al* (1992), Sadek *et al* (2001) and Soliman *et al* (2005) found that GCA variance was more important in conditioning resistance than SCA variance.

The interactions of both GCA and SCA with locations (Table 1) were found to be highly significant for all studied traits. However, the magnitude of variance of GCA x locations interaction was higher than that of SCA x locations interaction for all studied traits. This indicates that additive genetic variance controlling these traits was greatly influenced by environment. This conclusion supports the findings of El-Hosary (1989), Dawood *et al* (1994), Mostafa *et al* (1996), Sughroue and Hallauer (1997), Soliman (2000), Gado (2000) and Soliman *et al* (2005) who reported that additive gene effects are more biased by the interaction with the environment than the non-additive ones.

Mean performance

Mean performance of the inbred parents *per se* and their F_1 crosses is given in Table (2). Data obtained showed that parental inbred line Gz 650 gave the highest grain yield (11.30 ard/fed.) followed by Gz 649 and Gm 1021 (11.02 and 10.67 ard/fed., respectively). Meanwhile, the inbred parent Gm 1021 was the earliest in silking (66.0 days) and manifested higher resistance to late wilt disease (98.5 %), and had the highest number of ears/plant (138.5 ears/100 plants) followed by Gz 650. However, the inbred line Gm 1021 was the tallest line and exhibited the highest ear placement. On the other hand; parental line Gz 638 gave the lowest grain yield (5.31 ard/fed.), as well as the lowest number of ears/plant (91.8 ears/100 plants) and the lowest ear placement.

Table 2. Mean performance of eight parental inbred lines and their 28 F_1 crosses for grain yield and other studied traits (combined data over three locations in 2004 growing season).

Genotypes	Grain yield (ard/fed.)	Number of ears/100 plants	Days to 50 % silking	Plant height (cm)	Ear height (cm)	Late wilt resistance %
Parents						
L-2	8.23	99.0	72.0	196.8	102.2	98.7
L-6	6.29	111.0	68.8	176.9	97.8	98.0
L-7	6.83	109.9	74.7	162.3	87.5	100.0
L-10	9.40	113.8	74.7	143.3	78.8	99.0
Gz 638	5.31	91.8	70.2	164.5	71.5	93.1
Gz 649	11.02	114.4	70.3	160.5	88.6	91.2
Gz 650	11.30	125.0	66.7	182.2	92.0	86.7
Gm 1021	10.67	138.5	66.0	198.8	99.2	98.5
F_1 Crosses						
L-2 x L-6	19.74	99.3	63.1	261.8	146.1	99.6
L-2 x L-7	21.40	99.1	64.5	262.5	143.0	100.0
L-2 x L-10	21.21	99.6	64.1	249.9	135.6	99.6
L-2 x Gz 638	27.70	106.7	62.0	257.4	136.4	99.3
L-2 x Gz 649	28.06	100.8	63.4	256.4	138.4	99.3
L-2 x Gz 650	28.38	108.5	62.7	260.5	139.3	97.3
L-2 x Gm 1021	26.53	99.0	60.8	265.9	153.0	100.0
L-6 x L-7	22.92	121.3	61.8	251.5	148.1	100.0
L-6 x L-10	18.49	103.7	64.0	252.3	142.8	100.0
L-6 x Gz 638	28.05	106.9	61.8	255.6	143.0	100.0
L-6 x Gz 649	28.17	116.1	62.3	246.9	137.8	99.3
L-6 x Gz 650	28.17	116.8	60.9	251.0	142.8	95.9
L-6 x Gm 1021	29.19	132.1	61.8	272.8	157.7	98.9
L-7 x L-10	22.84	102.8	65.5	241.8	137.2	100.0
L-7 x Gz 638	25.87	102.1	61.5	246.8	138.3	99.3
L-7 x Gz 649	25.87	107.4	62.2	244.8	136.3	96.9
L-7 x Gz 650	27.10	109.4	60.7	251.8	140.3	97.1
L-7 x Gm 1021	27.90	109.5	60.9	254.8	144.8	98.3
L-10 x Gz 638	26.64	99.5	62.3	234.8	125.0	100.0
L-10x Gz 649	27.58	107.3	63.1	234.8	130.9	99.6
L-10 x Gz 650	26.49	103.4	63.1	235.6	132.7	100.0
L-10 x Gm 1021	25.38	110.4	62.3	244.8	135.3	99.5
Gz 638x Gz 649	19.43	103.9	64.5	217.9	111.8	94.0
Gz 638 x Gz 650	18.05	105.9	64.1	222.4	111.0	90.5
Gz 638 x Gm 1021	30.41	112.2	61.7	243.8	129.6	99.7
Gz 649 x Gz 650	5.91	99.8	68.8	187.3	102.8	84.2
Gz 649 x Gm 1021	30.35	120.2	62.9	256.7	149.6	96.8
Gz 650 x Gm 1021	28.80	114.0	61.3	262.4	154.3	93.5
Checks						
SC 155	25.88	99.7	60.4	273.8	141.3	100.0
SC 3080	26.10	104.4	61.1	246.3	124.7	100.0
LSD 0.05	**2.43**	**11.9**	**1.1**	**9.1**	**6.7**	**4.1**
0.01	**3.19**	**15.6**	**1.4**	**11.9**	**8.8**	**5.3**

In general, F_1's were earlier in silking and have greater values for all other attributes (Table 2) than their inbred parents, suggesting the superiority in vigor of the heterozygotes over homozygotes. Grain yield, exhibited the widest difference between means of parents and those of F_1's. It is worth noting that the difference between the two check hybrids; SC 155 (25.88 ard/fed.) and SC 3080 (26.10 ard/fed.) was insignificant. The best five crosses in grain yield (Tables 2 and 3) were Gz 638 x Gm 1021 (30.41 ard/fed.), Gz 649 x Gm 1021 (30.35 ard/fed.), L-6 x Gm 1021 (29.19 ard/fed.), Gz 650 x Gm 1021 (28.80 ard/fed.) and L-2 x Gz 650 (28.38 ard/fed.). These crosses significantly outyielded the commercial yellow check hybrid SC 155 by 4.53, 4.47, 3.31, 2.92 and 2.50 ard/fed (17.5 %, 17.3 %, 12.8 %, 11.3 % and 9.7 %, respectively) (Tables 2 and 3). Hence, the five forementioned outstanding crosses appeared to be promising and should be tested further for commercial use. These crosses might be released as new yellow single cross hybrids.

Table 3. Grain yield percentage of 28 F_1 crosses relative to the yellow check hybrids (combined data over three locations in 2004 growing season).

Crosses	% of SC 155	% of SC 3080
L-2 x L-6	76.3	75.6
L-2 x L-7	82.7	82.0
L-2 x L-10	82.0	81.3
L-2 x Gz 638	107.0	106.1
L-2 x Gz 649	108.4	107.5
L-2 x Gz 650	109.7	108.7
L-2 x Gm 1021	102.5	101.6
L-6 x L-7	88.6	87.8
L-6 x L-10	71.4	70.8
L-6 x Gz 638	108.4	107.5
L-6 x Gz 649	108.8	107.9
L-6 x Gz 650	108.8	107.9
L-6 x Gm 1021	112.8	111.8
L-7 x L-10	88.3	87.5
L-7 x Gz 638	100.0	99.1
L-7 x Gz 649	100.0	99.1
L-7 x Gz 650	104.7	103.8
L-7 x Gm 1021	107.8	106.9
L-10 x Gz 638	102.9	102.1
L-10x Gz 649	106.6	105.7
L-10 x Gz 650	102.4	101.5
L-10 x Gm 1021	98.1	97.2
Gz 638x Gz 649	75.1	74.4
Gz 638 x Gz 650	69.7	69.2
Gz 638 x Gm 1021	117.5	116.5
Gz 649 x Gz 650	22.8	22.6
Gz 649 x Gm 1021	117.3	116.3
Gz 650 x Gm 1021	111.3	110.3

Concerning number of ears per 100 plants, Table (2) showed that the four top most outyielding crosses L-6 x Gm 1021, Gz 638 x Gm 1021, Gz 649 x Gm 1021 and Gz 650 x Gm 1021 had significantly more ears/plant than SC155. With respect to number of days to 50 % silking, (Table 2) showed that 7 out of the 28 crosses, *i.e.* L-2 x Gm 1021, L-6 x Gz 650, L-7 x Gz 638, L-7 x Gz 650, L-7 x Gm 1021, Gz 638 x Gm 1021 and Gz 650 x Gm 1021 did not significantly differ from the check hybrid SC 155. On the contrary, the cross Gz 649 x Gz 650 was the latest one in silk appearance. For plant and ear heights, the presented data in Table (2) revealed that all the crosses were significantly shorter than the check hybrid SC 155, however, only seven crosses had significantly lower ear placement than SC 155. In respect of resistance to late wilt disease (Table 2) all the studied crosses manifested high resistance ranging from 90.5 % to 100.0 %, except the cross Gz 649 x Gz 650 (84.2 %),. Moreover, 24 out of the 28 crosses did not significantly differ from the .commercial check hybrids (100.0 %) for resistance to late wilt.

Combining ability effects

Average performance of each parental line through its crosses and the estimates of general (g_i) combining ability effects for the six studied traits are presented in Tables (4 and 5), respectively. It is worthy to mention that parent(s) with significantly positive GCA effects for grain yield, number of ears/plant and resistance to late wilt disease are considered to be useful in breeding for high yielding ability, prolificacy and more resistance to late wilt. However, parents with negative values for number of days to 50 % silking, plant and ear heights are considered to be earlier, shorter and had lower ear placement.

The most preferable line was Gm 1021. This line produced the highest average of grain yield across its crosses (28.37 ard/fed.) and exhibited also the best significant positive GCA effect (Table 5). In other words, this line had accumulated favorable alleles for grain yield and contributed to high grain yield of all crosses involving this line. Furthermore, this inbred line (Gm 1021) gave the highest average of ears/100 plants followed by the inbred parent L-6 (113.9 and 113.7 ears/100 plants, respectively) and had highly significant positive GCA effects (Tables 4 and 5). Meanwhile, the inbred parent Gm 1021 was the most desirable line for number of days to 50 % silking, since it had highly significant negative GCA effect towards earliness (Tables 4 and 5). In other words, crosses involving this line were earlier. This indicates that this inbred line possesses favorable genes for

Table 4. Average performance of the eight parental inbred lines across their crosses for grain yield and other studied traits (combined data over three locations in 2004 growing season).

Parents	Grain yield (ard/fed.)	Number of ears/100 plants	Days to 50 % silking	Plant height (cm)	Ear height (cm)	Late wilt resistance %
L-2	24.72	101.9	62.9	259.2	141.7	99.3
L-6	24.96	113.7	62.2	256.0	145.5	99.1
L-7	24.84	107.4	62.4	250.6	141.1	98.8
L-10	24.09	103.8	63.5	242.0	134.2	99.8
Gz 638	25.16	105.3	62.6	239.8	127.9	97.5
Gz 649	23.62	107.9	63.9	235.0	129.7	95.7
Gz 650	23.27	108.3	63.1	238.7	131.9	94.1
Gm 1021	28.37	113.9	61.7	257.3	146.3	98.1

Table 5. General combining ability effects, (g_i) of the eight parental inbred lines for grain yield and other studied traits (combined data over three locations in 2004 growing season).

Parents	Grain yield (ard/fed.)	Number of ears/100 plants	Days to 50 % silking	Plant height (cm)	Ear height (cm)	Late wilt resistance %
L-2	-0.195	-6.924**	0.423	13.058**	5.573*	1.662*
L-6	-0.412	3.774	-0.710	6.817*	7.365**	1.374
L-7	-0.387	-0.888	0.606	0.092	2.265	1.569*
L-10	-0.399	-2.595	1.340**	-9.700*	-4.319	2.064**
Gz 638	-0.465	-5.950**	-0.219	-6.975*	-10.227**	-0.700
Gz 649	-0.400	0.409	0.756	-11.175**	-5.552*	-2.338**
Gz 650	-0.593	2.758	-0.544	-4.225	-3.327	-4.403**
Gm 1021	2.850**	9.417**	-1.652**	12.108**	8.223**	0.772
S.E. for g_i	**0.900**	**2.202**	**0.397**	**3.367**	**2.488**	**0.751**
g_i-g_j	**1.361**	**3.329**	**0.600**	**5.091**	**3.762**	**1.135**

earliness. On the contrary, parental line L-10 had for lateness in silk appearance. With respect to plant and ear heights, the best general combiners were L-10, Gz 638 and Gz 649, since they had significant negative (desirable) GCA effects, the shortest plants and the lowest ear placement (Tables 4 and 5). On the other hand, parental lines L-2, L-6 and Gm 1021 had positive and significant or highly significant (undesirable) GCA effects towards tallness and higher ear placement.

In respect of resistance to late wilt disease, average performance of parental lines across their crosses ranged from 94.1 % to 99.8 % for lines Gz 650 and L-10, respectively (Table 4). General combining ability effects (Table 5) showed that inbred lines, L-2, L-7 and L-10 had the best significant GCA effects for late wilt resistance suggesting that these parents are good donors for resistance to this disease.

The estimates of specific (S_{ij}) combining ability effects of the 28 F_1 crosses for the six studied traits are given in Table (6). Positive specific combining ability effects for the F_1 crosses greatly outnumbered those showing negative effects for grain yield, number of ears/plant and resistance to late wilt disease, while the opposite was true for number of days to 50 % silking, plant and ear heights. The highest positive values of S_{ij} effects were exhibited by 16 out of the 28 F_1 crosses for grain yield. However, most of the crosses that involved the inbred line Gm 1021 (4 crosses out of the 16 ones) showed significantly the highest grain yield (Table 2), which corresponded with its highly significant GCA effect (Table 5). It is worthy to mention that a good SCA cross may come from two parents possessing good GCA or from one with good GCA and the other with poor GCA. For example, the best S_{ij} for grain yield was exhibited in the crosses between parents with poor and good GCA, *i.e.* L-6 x Gm 1021, Gz 638 x Gm 1021, Gz 649 x Gm 1021 and Gz 650 x Gm 1021. Similar findings were also obtained by Nawar and El-Hosary (1985), Amer *et al* (1998), Soliman (2000) and Soliman *et al* (2005).

Considering number of ears/100 plants, Table (6) showed that 12 out of the 28 F_1 crosses manifested positive SCA effects but did not reach the level of significance. With respect to number of days to 50 % silking, results in Table (6) showed negative estimates of SCA effects for all crosses, except Gz 649 x Gz 650. However, significantly negative S_{ij} values towards earliness were manifested by 14 out of the 28 crosses. Concerning plant and ear heights, 18 and 10 crosses out of the 28, respectively exhibited significantly positive SCA effects, while the cross Gz 649 x Gz 650 manifested significant negative SCA effects for both plant and ear heights (Table 6). In respect of resistance to late wilt disease (Table 6), the highest desirable SCA effect towards resistance was exhibited by the cross L-10 x Gz 650, which showed significant positive estimate.

The study indicated that, five crosses, i.e. Gz 638 x Gm 1021, Gz 649 x Gm 1021, L-6 x Gm 1021, Gz 650 x Gm 1021 and L-2 x Gz 650 are promising single cross hybrids and should be tested further for commercial use. In addition, the inbred parent commonly included in these crosses, i.e. Gm 1021 had good GCA effects for grain yield, prolificacy and earliness. Another two inbreds, *i.e.* Gz 638 and Gz 650 had good GCA effects for shortness and lower ear placement. In addition, the inbreds L-2 and L-6 are good donors for resistance to late wilt disease. These inbreds may be intermated to develop a new synthetic variety of yellow maize which can be used as a base population for the extraction of more favorable yellow lines for development of high yielding, earlier and disease resistant single cross hybrids of yellow maize.

Table 6. Specific combining ability effects, (S_{ij}) of 28 F_1 crosses for grain yield and other studied traits (combined data over three locations in 2004 growing season).

Crosses	Grain yield (ard/fed.)	Number of ears/100 plants	Days to 50 % silking	Plant height (cm)	Ear height, (cm)	Late wilt resistance %
L-2 x L-6	-0.921	-6.495	-1.113	11.042	6.440	-0.768
L-2 x L-7	0.709	-1.991	-1.013	18.517*	8.457	-0.567
L-2 x L-10	0.538	0.240	-2.163*	15.725	7.623	-1.424
L-2 x Gz 638	7.092**	10.604	-2.688**	20.500*	14.365*	1.022
L-2 x Gz 649	7.381**	-1.580	-2.246*	23.700**	11.690	2.674
L-2 x Gz 650	7.894**	3.754	-1.696	20.833*	10.298	2.712
L-2 x Gm 1021	2.611	-12.371*	-2.421*	9.917	12.498	0.230
L-6 x L-7	2.448	9.461	-2.546*	13.758	11.748	-0.279
L-6 x L-10	-1.973	-6.432	-1.113	24.383**	13.082*	-0.774
L-6 x Gz 638	7.654**	0.114	-1.805	24.908**	19.157**	1.991
L-6 x Gz 649	7.716**	3.006	-2.196*	20.442*	9.315	2.947
L-6 x Gz 650	7.904**	1.382	-2.313*	17.575*	12.090	1.565
L-6 x Gm 1021	5.480*	9.948	-0.288	22.992**	15.373*	-0.573
L-7 x L-10	2.361	-2.612	-0.930	20.525*	12.515	-0.969
L-7 x Gz 638	5.450*	-0.032	-3.371**	22.800*	19.590**	1.115
L-7 x Gz 649	5.389*	-1.041	-3.680**	25.000**	12.915	0.349
L-7 x Gz 650	6.814**	-1.406	-3.880**	25.050**	14.607*	2.641
L-7 x Gm 1021	4.171	-7.941	-2.521*	11.717	7.640	-1.341
L-10 x Gz 638	6.239**	-0.892	-3.271**	20.675*	12.840	1.301
L-10x Gz 649	7.110**	0.558	-3.496**	24.875**	14.082*	2.541
L-10 x Gz 650	6.210**	-5.675	-2.196*	18.675*	13.607*	5.004*
L-10 x Gm 1021	1.660	-5.376	-1.838	11.508	4.723	-0.693
Gz 638x Gz 649	-0.970	0.538	-0.521	5.233	0.823	-0.254
Gz 638 x Gz 650	-2.165	0.205	0.362	2.783	-2.152	-1.733
Gz 638 x Gm 1021	6.760**	-0.146	-0.946	7.867	4.882	2.245
Gz 649 x Gz 650	-14.363**	-12.320*	4.137**	-28.183**	-14.994*	-6.350**
Gz 649 x Gm 1021	6.636**	1.479	-0.671	24.900**	20.207**	1.047
Gz 650 x Gm 1021	5.278*	-7.136	-0.955	23.700**	22.648**	-0.206
S.E. for S_{ii}	**2.400**	**5.872**	**1.058**	**8.979**	**6.635**	**2.002**
S_{ii}-S_{ik}	**4.083**	**9.987**	**1.799**	**15.273**	**11.285**	**3.405**
S_{ii}-S_{kl}	**3.849**	**9.416**	**1.696**	**14.399**	**10.640**	**3.210**

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التحليل الوراثى لمحصول الحبوب وبعض الصفات الأخرى فى الهجن التبادلية بين بعض سلالات التربية الذاتية من الذرة الشامية صفراء الحبوب

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فى موسم ٢٠٠٣ تم بمحطة البحوث الزراعية بسدس عمل جميع الهجن الممكنة (عدا الهجن العكسية) بين ثمانية سلالات التربية الذاتية من الذرة الشامية صفراء الحبوب هى سلالات ٢، ٦، ٧، ١٠، جيزة ٦٣٨، جيزة ٦٤٩، جيزة ٦٥٠، جميزة ١٠٢١. وفى موسم ٢٠٠٤ تم تقييم الآباء وهجن الجيل الأول وهجينين تجاريين صفراء الحبوب للمقارنة هما هـ.ف ١٥٥، هـ. ف بيونير ٣٠٨٠ بمحطات البحوث الزراعية بسخا والجميزة وسدس فى تصميم القطاعات العشوائية الكاملة فى أربع مكررات وكان الهدف هو تقدير القدرة العامة والخاصة على الائتلاف وتحديد التراكيب الوراثية الأكثر تفوقاً لاستخدامها فى برنامج التربية بالإضافة الى استنباط هجن فردية صفراء جديدة عالية المحصول مقاومة للأمراض تتفوق على الهجن التجارية الأخرى.

أظهرت النتائج المتحصل عليها ان كلا من تباينات القدرة العامة والخاصة على الائتلاف كانت عالية المعنوية لجميع الصفات تحت الدراسة، وقد لعب التباين الراجع للقدرة الخاصة على التآلف (التباين الوراثى غير المضيف) الدور الأكبر فى توريث صفات محصول الحبوب، عدد الأيام حتى ظهور ٥٠ % حريرة وارتفاع كل من النبات والكوز بينما كان التباين الراجع للقدرة العامة على التآلف (التباين الوراثى المضيف) اكثر أهمية بالنسبة لتوريث صفتى المقاومة لمرض الذبول المتأخر (الشلل) وعدد الكيزان/١٠٠ نبات. أوضحت الدراسة أن السلالة جميزة ١٠٢١ كانت احسن السلالات فى القدرات الهجينية بالنسبة للمحصول والتبكير حيث أظهرت تقديرات موجبة ومعنوية للقدرة العامة على التآلف لصفة المحصول وسالبة ومعنوية أي مرغوبة (اتجاه التبكير) لصفة عدد الأيام حتى ظهور ٥٠ % حريرة. كما أظهرت السلالات ٢، ٧، ١٠ تقديرات موجبة ومعنوية للقدرة العامة على التآلف لصفة المقاومة لمرض الذبول المتأخر بينما بالنسبة لصفتى ارتفاع النبات والكوز فان السلالتين الأبوية جيزة ٦٣٨ وجيزة ٦٤٩ قد أظهرتا تأثيرات سالبة ومعنوية أي مرغوبة للقدرة العامة على التآلف (اتجاه قصر النبات وموقع الكوز المنخفض). أظهرت النتائج ان محصول الهجن الفردية جيزة ٦٣٨ x جميزة ١٠٢١، جيزة ٦٤٩ x جميزة ١٠٢١، سلالة ٦ x جميزة ١٠٢١، جيزة ٦٥٠ x جميزة ١٠٢١، سلالة ٢ x جيزة ٦٥٠ قد تفوق معنويا على محصول هجين المقارنة التجارى هـ ف ١٥٥ (٢٥,٨٨ اردب/فدان) بمعدل زيادات قدرها ٤,٥٣، ٤,٤٧، ٣,٣١، ٢,٩٢، ٢,٥٠ اردب/فدان على الترتيب حيث

كان محصولها ٣٠,٤١، ٣٠,٣٥، ٢٩,١٩، ٢٨,٨٠، ٢٨,٣٨ اردب/فدان بنفس الترتيب، كما أظهرت تلك الهجن تأثيرات موجبة عالية المعنوية للقدرة الخاصة على التآلف لصفة المحصول العالى، ومن ثم فان هذه الهجن تعتبر من الهجن المبشرة والتى يجب تكرار اختبارها فى مراحل التقييم تمهيداً لتسجيلها وإطلاقها بالأسواق لزيادة المحصول.