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COMBINING ABILITY IN LINE × TESTER CROSSES OF MAIZE (*ZEA MAYS* L.)

BY

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ABSTRACT

Thirteen selected S_5 white maize inbred lines developed at Giza Agric. Res. Station of ARC, were topcrossed to each of the three white maize inbred testers, i.e. Sd62, Sd63 and Gz629. The 39 topcrosses were evaluated in 2007 growing season at Sakha, Gemmeiza and Sids Agric. Res. Stations for grain yield, resistance to late wilt disease, silking date, plant height, and ear height. Data combined over locations indicated that highly significant differences were deleted among lines, testers and their crosses for all studied traits. Parental females L2, L7 and L5 were found to be the best general combiners for high yielding ability these lines in addition to L1 produced the highest average grain yield in their testcrosses. Parental lines L1, L2, L6 and L9 were good donors for genes of resistance to late wilt disease to their crosses. L2 and L5 were significantly the best general combiners for earliness. Testcrosses of inbred tester Sd62 manifested the highest average performance of grain yield as compared to testcrosses of Sd63 and Gz629. Results showed that 4 crosses of Sd62 with inbreds L1, L2, L5 and L7 as well as 2 crosses of Gz629 with inbreds L-2 and L-7 significantly outyielded the white commercial check hybrid SC10 (39.97 ardabs/feddan) with a minimum of 3.6 ardabs/feddan (8.9%) and maximum of 7.11 ardabs/feddan (17.8%). Furthermore, these outstanding 6 crosses showed positively SCA effects for grain yield. The magnitude of the ratio of general to specific combining ability variances (σ^2 g.c.a and σ^2 s.c.a) indicated that the non-additive was more important than additive gene action in the inheritance of the studied traits. Furthermore, the magnitude of σ^2 g.c.a x locations was higher than that of σ^2 s.c.a x locations interactions for all traits.

INTRODUCTION

The mating design (Line x Tester) suggested by Kempthorne (1957) has been extensively used to estimate general (GCA) and specific (SCA) combining ability variances and effects. Also, it is used in understanding the nature of gene action involved in the expression of economically important quantitative traits. Successful development of improved maize hybrids is dependent upon the accurate evaluation of inbred lines performance in cross combinations. Combining ability analysis is an important tool for the selection of desirable parents together with the information regarding nature and magnitude of gene effects controlling quantitative traits (Basbag *et al.*, 2007). GCA and SCA are the most important criteria in breeding programs (Ceyhan, 2003). Inbreds of high general combining ability are crossed to detect particular combinations that result in a superior single cross for commercial use.

The choice of suitable testers for testing the developed inbred lines is an important decision. Matzinger (1953) revealed that narrow genetic-base tester contributes more to line x tester interaction than does a heterogeneous one. Moreover, desirable tester was defined as one that combines the greatest simplicity in use with the maximum information on performance to be expected from tested lines when used in other combinations. In addition, Zambezi *et al.* (1986) provided further evidence that inbred testers could be used successfully for estimating GCA, as well as, SCA in maize and also stated that using inbred lines as testers may permit quicker utilization of new lines in commercial hybrids, especially if the tester is already in commercial use.

Several results concerning the genetic analysis of grain yield, as well as other agronomic traits reported by Singh *et al.* (1971), El-Itriby *et al.* (1990), Diab *et al.* (1994), Sultan (1998) and Gado *et al.* (2000) indicated that the relative importance of different components of genetic variance may maximize with homozygous base populations indicated the importance of over-dominance in grain yield performance (Robinson *et al.*. 1949; Gardner *et al.*, 1953; Gardner and Lonquest 1959; Gamble 1962; Findly *et al.*, 1972; Vedeneev 1988 and El-Zeir *et al.*, 2000). In addition, Matzinger *et al.* (1959), Russell *et al.* (1973), El-Hosary (1985), Salama *et al.* (1995), Sultan (1998), Sadek *et al.* (2001 and 2202) and Afaf A.I. Gabr (2003), reported that the variance component due to SCA for grain yield and other agronomic traits was relatively larger than that of GCA. This indicated that non-additive type of gene action appeared to be more important. The objectives of this study were to: a) estimate both GCA and SCA variances and effects of 13 inbred lines top-crossed with 3 inbred tester lines and, b) determine the important type of gene action controlling yield, days to 50 % silking, plant and ear heights, and resistance to late wilt disease, and c) identify the most promising high yielding single crosses with resistance to late wilt disease for possible commercial release.

MATERIALS AND METHODS

The materials used in this investtigation were 13 promising inbred lines of white maize in the S_5 generation developed at Giza Agricultural Research Station. These lines were crossed with three genetically diverse inbred testers *i.e.*, Sd62, Sd63 and Gz629 in 2006. In 2007 growing season, the 39 resultant testcrosses with three commercial check white hybrids *i.e.*, SC10, SC122 and SC129, were evaluated in replicated yield trials conducted at three locations *i.e.*; Sakha, Gemmeiza and Sids Agric. Res. Stations.

A randomized complete block design with four replications was used in each location. Plot size was one row, 6 m long 0.8 m apart and 0.25 m between hills. Three seeds were sown per hill and further thinned to one plant per hill after 21 days from sowing. All cultural practices were applied as recommended at the proper time. Data were recorded for number of days to 50% silking, plant height (cm), ear height (cm), resistance to late wilt disease (%), and grain yield adjusted to 15.5% grain moisture and converted to ardabs/feddam (ardab = 140 kg). Analysis of variance was performed for the combined data over locations after testing homogeneity of error mean squares, according to Steel and Torrie (1980). Combining ability analysis was done as outlined by Kempthorne (1957).

RESULTS AND DISCUSSION

I. Analysis of variance:

The combined analysis of variance for the five studied traits is presented in Table (1). Highly significant differences were detected between locations for all studied traits, indicating that all locations differed in their environmental conditions. Mean squares due to crosses were highly significant for all traits. Partitioning the sum of squares due to crosses into its components showed that mean squares due to lines and testers were highly significant for all traits, revealing that greater diversity existed among testers and among lines. Meanwhile, mean squares due to the lines x testers interaction were highly significant for all traits, indicating that female lines differed in their performance in crosses with each of the male testers. Mean squares due to the interaction of either lines or testers with locations were highly significant for all studied traits, except grain yield and days to 50% silking for testers x locations interactions. These interactions with locations were indicative of different rankings of genotypes (lines and testers) from one location to another. Highly significant lines x testers x locations mean squares were detected for all studied traits, revealing that the hybrids between lines and testers behaved some what differently from location to another. These results are in agreement with those obtained by Shehata *et al.* (1997), Gado *et al.* (2000), Soliman *et al.* (2001), Sadek *et al.* (2002), and Afaf A.I. Gabr (2003) The magnitude of the variances due to testers was higher than variances due to lines for all studied traits. This indicates that the testers contributed much more to the total variation and, less affected by the environmental conditions than the lines for all traits except for plant height and late wilt percentage. Similar findings were obtained by El-Itriby *et al.* (1990), Gado *et al.* (2000), Soliman *et al.* (2001), Sadek *et al.* (2002), and Gabr (2003)

II. Mean performance and combining ability effects:

1. Grain yield:

Grain yield of the 13 lines across the three testers (Table 2) ranged from 37.31 to 44.06 ard/fad for testcrosses with lines L 13 and L 2, respectively. The most preferable lines were L 2, L 5 and L 7. These lines produced the highest average grain yield (44.06, 40.85 and 41.06 ard/fad, respectively) across the three testers. Six topcrosses (L1, L2, L5, L7 with Sd 62 and L2, L7 with Gz 629) significantly out-yielded the commercial hybrid SC 10. More-over, six topcrosses (L8, L9, L10 with Sd 62 and L1, L11 with Sd 63 and L4 x Gz 629) outyielded SC 10 but not significantly. Considering the inbred testers, tester line "Sd62" produced the highest grain yield crosses (40.83 ardabs/feddan) across all parental lines followed by the tester line Sd63 (38.49 ardabs/feddan) and Gz629 (39.22 ardabs/feddan). The highly significant and positive GCA effects were obtained for lines L2, L5, and L7 (Table 3). It is obviously clear that these lines also had the highest yield in their corresponding crosses with the three testers. The inbred tester Sd62 had also highly significant and positive GCA effect, whereas, the inbred tester Sd63 had highly significant negative GCA for grain yield. The above mentioned three inbred lines along with the inbred tester Sd62 had accumulated favorable alleles for grain yield and contributed to upgrading grain yield of all crosses involving these lines.

Table (1): Analysis of variance for grain yield, days to 50% silking, plant height, ear height and late wilt resistance of 13 inbred lines topcrossed with three inbred testers (data are combined across three locations in 2007 season).

S.O.V	df	Mean Squares				
		Grain Yield	Days to 50% silking	Plant height	Ear height	Late wilt resistance
Locations (Loc)	2	15350.88**	1945.47**	351578.44**	133083.35**	218.78**
Rep (Loc)	9	19.79	6.71	613.64	454.96	5.53
Crosses (C)	(38)	68.62**	9.39**	701.62**	2460.49**	6.86**
Lines (L)	12	45.67**	8.77**	1783.21**	963.32**	13.05**
Testers (T)	2	233.81**	60.14**	13179.95**	5016.43**	41.52**
L × T	24	66.33**	5.47**	625.61**	211.21**	11.72**
C × Loc	(76)	25.00**	1.56**	267.19**	139.97**	11.07**
L × Loc	24	45.86**	1.92**	356.67**	203.35**	12.20**
T × Loc	4	12.71	0.55	538.01**	139.74**	45.92**
L × T × Loc	48	15.59**	1.47**	199.88**	108.29**	7.60**
Pooled error	342	7.12	0.99	89.82	47.60	2.55
CV %		9.58	1.58	3.44	4.48	1.62

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

Comparison of SCA effects (Table 4) indicated that 2 out of the evaluated 39 testcrosses, *i.e.* (L1 x Sd62 and L2 x Gz629) exhibited significantly positive SCA estimates (2.781and 3.093, respectively) and also gave the highest grain yield (44.57 and 45.57 ardabs/feddan, respectively) (Table 2). It is worth noting that a cross exhibiting high SCA effect may come from two parents possessing good GCA effects or from one parent with good GCA and another with poor GCA effects. For example, the best SCA effects for grain yield were exhibited between parents with poor and good GCA (L1 x Sd62 and L2 x Sd629).

Similar findings were obtained by Nawar *et al.* (1979), Nawar and El-Hosary (1985), Soliman *et al.* (2001), and Sadek *et al.* (2002).

2. Number of days to 50% silking:

Data presented in Tables (2 and 3) confirmed that the inbreds. Sd63 and Gz629 had highly significant GCA effects towards earliness. Average over the three testers, parental lines manifested earlier silking dates in their testcrosses. Parental lines L2 and L5 had negative (favorable) and significant GCA effects for earliness. In other words, top-crosses involving these lines were earlier than these involving the other lines. This indicates that these inbreds possess favorable genes for earliness. Data presented in Table (2) revealed that all testcrosses exhibited significantly earlier silking date than the commercial check hybrid SC 10.

3. Plant height:

With respect of plant height, average performance (Table 2) revealed that tester lines Sd63 and Gz629 resulted in shorter hybrid plants over all parental lines and highly significant negative (desirable) GCA effects (Table 3). These results indicated that Sd63 and Gz629 had favorable genes for shortness. For the parental lines, the best general combiners for plant height were shown by inbred lines L3, L5, L6, L12, and L13, since they had highly significant negative (desirable) GCA effects and exhibited the shortest hybrid plants (Tables 2 and 3).

Plant height of the 39 testcrosses (Table 2) ranged from 265.7 to 337.5 cm for crosses L11 x Gz 629 and L1 x Sd62, respectively. Three topcrosses L4 x Sd62, L12 x Sd62 and L2 x Sd63 exhibited negative and significant SCA effects *i.e.* in the direction of shortness (Table 4). Moreover, crosses between each of inbred lines L3, L5, L6, L7, L9, L10, L11, L12, and L13 with the inbred testers Sd63 and Gz629 were significantly shorter than the check hybrid SC10 (294.0 cm) (Table 2).

4. Ear height:

Data presented in Table (2) showed that ear height average performance revealed that testers lines Sd63 and Gz629 resulted lower ear placement hybrid over all parental inbred lines except for inbred lines L4 and L6. Moreover, these testers had highly significant negative (desirable) GCA effects. Parental lines L2, L3, L5, L12 and L13 had highly significant negative (desirable) GCA effects (Table 3). These results indicated that Sd63 and Gz629 had favorable genes for lower ear placement. For the parental lines, the best general combiners for lower ear placement plants were L2, L3, L5, L12 and L13 since they had highly significant negative (desirable) GCA effect and exhibited the lowest ear placement hybrid plants (Table 2 and 3).Ear height of the 39 testcrosses (Table 2) ranged from 143.0 to 192.4cm for crosses L11 x Sd629 and L8 x Sd62, respectively. Two topcrosses out of the 39 testcrosses (L12 x Sd62 and L11 x Gz629) exhibited negative and significant SCA effect *i.e.* in direction to lowest ear placement (Table 4).Moreover, all parental lines except L4 and L6 x Sd63 and Gz629 were significantly lower ear placement than the check hybrid Sc10 (167.0 cm) (Table 2).

5. Resistance to late wilt disease:

Data presented in Table (2) show that performance of the 13 lines across testers ranged from 98.0 to 100.0% for lines L5 and L2, respectively. All the tested lines across the three testers exhibited resistance to late wilt disease that were significantly higher than the white check hybrid SC122 (97.2%). General combining ability effects (Table 3) showed that lines L1, L2, L6, and L9 had positive and significant GCA effects for late wilt resistance, suggesting that these parental lines are good donors of genes for resistance to this disease. However, SCA effects (Table 4), towards resistance resulted from the topcrosses L10 x Sd63 and L7 x Gz629 which showed significantly negative SCA estimates. The three testers were significantly different in their reaction to late wilt disease (Table 1).

Table (2): Mean performance of 39 topcrosses among 13 inbred lines and three inbred testers for grain yield, days to 50% silking, plant height, ear height and late wilt resistance (data are combined across three locations in 2007 season).

Line	Grain yield (ardabs/feddan)				Days to mid-silking (days)				Plant height (cm)				Ear height (cm)				Late wilt resistance (%)			
	Sd62	Sd63	Gz629	Mean	Sd62	Sd63	Gz629	Mean	Sd62	Sd63	Gz629	Mean	Sd62	Sd63	Gz629	Mean	Sd62	Sd63	Gz629	Mean
L-1	44.57	40.06	31.76	38.79	64.1	60.3	68.0	64.1	337.5	282.5	289.5	303.2	182.7	157.9	162.2	167.6	100.0	99.3	99.7	99.7
L-2	47.08	39.57	45.52	44.06	62.4	58.7	65.7	62.3	322.9	297.2	295.0	305.0	175.1	157.6	162.5	165.1	100.0	100.0	100.0	100.0
L-3	35.55	39.28	39.83	38.22	63.5	58.8	66.1	62.8	301.6	281.0	274.0	285.5	164.4	157.3	152.7	158.1	100.0	97.7	98.3	98.7
L-4	39.69	37.94	40.31	39.31	64.1	59.6	66.9	63.5	310.0	288.1	292.5	296.6	181.9	167.5	167.0	172.1	98.9	97.4	100.0	98.8
L-5	44.97	38.51	39.06	40.85	63.3	59.0	65.3	62.5	308.5	280.4	272.0	286.9	176.7	154.1	148.7	159.8	97.9	97.8	98.4	98.0
L-6	37.98	39.49	39.22	38.89	63.6	59.1	66.1	62.7	316.7	283.6	281.0	293.8	184.2	166.2	157.0	169.1	99.3	100.0	99.7	99.7
L-7	43.53	37.15	42.51	41.06	64.0	58.5	66.2	62.9	315.8	284.9	273.7	291.5	176.4	160.5	158.0	164.9	99.3	96.7	100.0	98.7
L-8	40.48	37.54	39.67	39.23	64.2	59.2	66.0	63.1	333.9	287.3	287.2	303.0	192.4	160.5	160.7	171.2	99.7	97.7	98.9	98.8
L-9	40.82	39.69	38.73	39.73	64.5	59.7	67.1	63.8	328.7	285.1	272.2	295.3	191.7	163.4	157.2	170.8	100.0	99.3	100.0	99.7
L-10	40.63	39.48	38.85	39.65	64.0	59.1	66.3	63.2	324.2	286.3	281.7	297.4	185.0	161.2	161.2	169.2	99.6	99.7	100.0	99.8
L-11	39.95	40.47	36.20	38.95	63.9	59.7	65.8	63.1	313.2	279.1	265.7	286.0	180.0	158.2	143.0	160.4	100.0	97.8	97.9	98.6
L-12	38.41	36.47	39.11	37.99	63.6	59.8	65.7	63.0	303.7	275.8	281.7	287.1	168.0	150.2	154.7	157.6	100.0	99.3	99.4	99.6
L-13	37.07	35.82	39.03	37.31	63.3	59.3	66.0	62.9	312.4	284.0	280.7	292.4	179.1	155.2	151.7	162.0	100.0	97.3	98.7	98.7
Average	40.83	38.49	39.22		63.7	59.3	66.2		317.6	284.3	280.5		179.8	159.2	156.7		99.6	98.5	99.3	
SC 10	39.97				65.1				294.0				167.0				99.6			
SC 122	37.97				63.0				270.1				150.1				97.2			
SC 129	38.73				61.0				282.2				148.2				99.6			
$LSD_{0.05}$	2.14				0.80				7.58				4..48				0.29			

Table (3): General combining ability effects (g_i) of 13 inbred lines and three testers for grain yield and other studied traits (data are combined across three locations in 2007 season).

Genotypes		Grain Yield (ard/fed)	Days to 50% silking	Plant height (cm)	Ear height (cm)	Late wilt resistance (%)
Lines	L1	-1.537**	1.026**	9.438**	1.175	0.626**
	L2	1.817**	-0.835**	7.993**	-2.130*	0.979**
	L3	-1.648**	-0.279	-9.673**	-7.519**	0.386
	L4	-0.208	0.442**	-1.617	3.119**	0.236
	L5	1.075**	-0.558**	-8.312**	-5.019**	-0.999**
	L6	-0.215	-0.169	-2.673*	2.231*	0.603**
	L7	1.727**	-0.197	-0.201	-0.602	0.410
	L8	0.678	0.026	8.855**	6.258**	0.295
	L9	0.402	0.664**	7.243**	8.647**	0.719**
	L10	0.265	0.109	4.743**	5.008**	0.287
	L11	-0.921**	0.053	-2.589	-0.047	0.442
	L12	-0.570	-0.029	-9.895**	-8.519**	-0.494
	L13	-0.865*	-0.252	-3.312*	-2.602**	0.366
Testers	Sd62	1.321**	0.716**	10.201**	6.391**	-0.323**
	Sd63	-1.096**	-0.323**	-7.639**	-4.429**	0.595**
	Gz629	-0.225	-0.393**	-2.562**	-1.961**	-0.272*
SE for						
Lines g_i		0.445	0.166	1.579	1.149	0.266
$g_i - g_j$		0.629	0.235	2.234	1.626	0.376
Testers g_i		0.214	0.079	0.759	0.552	0.128
$g_i - g_j$		0.302	0.113	1.073	0.781	0.181

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

Data presented (Table 2) showed that resistance to late wilt disease ranged from 97.9 to 100.0% for crosses involving Sd62, from 96.7 to 100.0% for crosses involving Sd63 and from 97.9 to 100.0 % for crosses involving Gz629 .Variation in resistance among testcrosses including Sd62 was greater than that of testcrosses including other testers.

III. Type of gene action:

The estimates of general and specific combining ability variances (σ^2 gca and σ^2 sca) and their interactions with locations (σ^2 gca x loc. and σ^2 sca x loc.) for all studied traits (Table 5) showed that SCA variance played the major role in determining the inheritance of all studied traits. This indicates that the largest part of the total genetic variability associated with these traits was the result of non-additive gene action. These results are in the same line with those reported by Dhillon and Singh (1977), Singh and Asnani (1979), Landi *et al.* (1986), Sadek *et al.* (2002) and Gabr (2003) They mentioned that SCA or non-additive gene action was predominant and played an important role in the inheritance of grain yield, silking date, plant and ear height. Shehata (1976), El-Itriby *et al.* (1990), Soliman *et al.* (2001), Sadek *et al.* (2002) and Gabr, (2003) found that SCA variance was more important in conditioning late wilt resistance than GCA variance. Furthermore, the non-additive gene action interacted more with different environ-mental conditions prevailing in the three locations than the additive gene effects for all studied traits (Table 5). This finding indicates that non-additive type of gene action is more affected by environment than additive and additive x additive types of gene action for all traits. This result is in agreement with the findings of several investigators who reported that specific combining ability is more sensitive to environmental changes than general combining ability (Gilbert, 1958). In addition, Shehata and Dhawan (1975), Sadek *et al.* (2001 and 2002) and Gabr A.I. Afaf (2003), also found that the non-additive genetic variation interacted more with the environment than the additive component.

Table (4): Specific combining ability effects (S_{ij}) of 39 top crosses for grain yield and other studied traits (data are combined across three locations in 2007 season).

Crosses	Grain yield (ard/fed)	Days to 50%-silking (days)	Plant height (cm)	Ear height (cm)	Late wilt resistance (%)
L-1 × Sd 62	2.781**	0.506	-5.284	2.331	-0.03
L-2 × Sd 62	2.325	0.034	16.410**	4.053	0.323
L-3 × Sd 62	-2.426	0.229	-3.589	-4.307	-1.042
L-4 × Sd 62	-1.077	-0.743	-9.562**	-2.946	0.151
L-5 × Sd 62	0.881	0.256	0.549	-2.224	0.445
L-6 × Sd 62	-1.293	-0.049	0.493	3.359	0.743
L-7 × Sd 62	1.013	0.312	0.521	-0.307	-0.288
L-8 × Sd 62	0.477	0.256	-1.284	1.831	-0.604
L-9 × Sd 62	-0.147	0.201	4.577	3.109	0.063
L-10 × Sd 62	-0.665	0.256	3.077	1.664	2.523
L-11 × Sd 62	1.927	0.479	6.410	3.803	-1.099
L-12 × Sd 62	-1.721	-1.521**	-11.201	-8.974**	-0.162
L-13 × Sd 62	-2.076	-0.216	-4.117	-1.391	-1.023
L-1 × Sd 63	2.439	-1.288*	1.722	-2.765	-0.222
L-2 × Sd 63	-5.498**	0.906	-17.000**	-5.793	-0.595
L-3 × Sd 63	0.321	0.100	4.833	4.763	0.413
L-4 × Sd 63	0.783	0.045	1.944	1.207	0.793
L-5 × Sd 63	0.454	-0.122	5.306	1.679	-0.347
L-6 × Sd 63	1.803	-0.094	0.333	-1.820	-0.971
L-7 × Sd 63	-1.031	0.267	1.028	1.513	1.406
L-8 × Sd 63	0.337	-0.455	-1.361	-3.098	0.477
L-9 × Sd 63	0.366	-0.011	-1.083	-0.237	-0.076
L-10 × Sd 63	0.311	-0.288	-0.500	-0.432	-1.528*
L-11 × Sd 63	-0.029	0.100	-0.333	3.541	0.205
L-12 × Sd 63	-0.305	0.517	4.722	4.679	-0.321
L-13 × Sd 63	-0.030	0.323	0.389	-3.237	0.764
L-1 × Gz 629	-5.220**	0.782	3.562	0.434	0.252
L-2 × Gz 629	3.093**	-0.940	0.589	1.739	0.272
L-3 × Gz 629	2.105	-0.329	-1.243	-0.455	0.629
L-4 × Gz 629	0.294	0.699	7.617	1.739	-0.944
L-5 × Gz 629	-1.335	-0.135	-5.855	0.545	-0.098
L-6 × Gz 629	-0.509	0.143	-0.827	-1.538	0.229
L-7 × Gz 629	0.017	-0.579	-4.549	-1.205	-1.118
L-8 × Gz 629	-0.814	0.199	2.645	1.267	0.126
L-9 × Gz 629	-0.219	-0.190	-3.493	-2.872	0.012
L-10 × Gz 629	0.354	0.032	-2.577	-1.233	-0.995
L-11 × Gz 629	-1.898	-0.579	-6.077	-7.344**	0.894
L-12 × Gz 629	2.026	1.004**	6.479	4.295	0.483
L-13 × Gz 629	2.106	-0.107	3.729	4.628	0.259
SE S_{ij}	1.334	0.497	4.739	3.449	0.798
S_{ij}-S_{kl}	1.887	0.704	6.701	4.878	1.129

Table (5): Estimates of general (σ^2gca) and specific (σ^2sca) combining ability variances and their interactions with locations for grain yield and other agronomic traits.

Estimates	Grain yield (ard/fed)	Days to 50% silking (days)	Plant height (cm)	Ear height (cm)	Late wilt resistance (%)
σ^2gca	0.096	0.043	11.233	5.367	0.019
σ^2sca	11.803	0.725	133.947	40.903	2.413
σ^2gca × Loc	0.066	0.002	0.546	0.269	0.026
σ^2sca × Loc	2.118	0.480	27.515	15.173	1.260

REFERENCES

Basbag S.; Ekinci R, and Gencer, O. (2007): Combining ability and heterosis for earliness characters in line × tester population of *Gossypium hirsutum* L. - Hereditas 144: 185-190.

Ceyhan, E. (2003): Determination of some agricultural characters and their heredity through line x tester method in pea parents and crosses. Selcuk Univ., Graduate School Nat. Appl. Sci. p. 103.

Dhillon, B.S. and Singh, J. (1977): Combining ability and heterosis in diallel crosses of maize. Theor. Appl. Genet., 49: 117-122.

El-Hosary, A.A. (1985): Study of combining ability in some topcrosses in maize. Egypt. J. Appl. Sci. 10: 39-47.

El-Itriby, H.A.; Ragheb, M.M.; El-Sherbieny, H.Y. and Shalaby, M.A. (1990): Estimates of combining ability of maize inbred lines in top crosses and it's interaction with environments. Egypt. J. Appl. Sci. 5(8): 354-370.

El-Zeir, F.A.A.; Amor, E.A.; Abdel-Aziz, A.A. and Mahmoud, A.A. (2000): Combining ability of new maize inred lines and type of gene action using topcrosses of maize. Egypt. J. Appl. Sci. 15(2): 116-128.

Findly, W.R.; Dallinger, E.J. and Eberhart, S.A. (1972): Gene action in Oh 45 and Oh 42 B crosses of *Zea mays* L. Crop Sci. 12: 287-290.

Gabr, Afaf A.I. (2003): Combining ability yellow maize (*Zea mays* L.) inbred lines. Egypt. J. Appl. Sci., 18(11): 117-131.

Gado, H.E.; Soliman, M.S.M. and Shalaby, M.A.K. (2000): Combining ability analysis of white maize (*Zea mays* L) inbred lines. J. Agric. Sci., Mansoura Univ., 25: 3719-3729.

Gamble, E.E. (1962): Gene effects in corn (*Zea mays* L) 1. Separation and relative importance of gene effects for yield. Can. J. Plant Sci. 42: 339-348.

Gardner, C.O. and Lonnquist, J.H. (1959): Linkage and the degree of dominance of genes controlling quantitative characters in maize. Agron. J. 51: 524-528.

Gardner, C.O.; Harvey, P.H.; Comstock, R.E. and Robinson, H.F. (1953): Dominance of genes controlling quantitative characters in maize. Agron. J. 45: 186-191.

Gilbert, N.E.G. (1958): Diallel cross in plant breeding. Heredity. 12: 477-492.

Kempthorne, O. (1957): An introduction to genetic statistics. John Wiley and Sons Inc, New York, USA.

Landi, P.; Comussi, A.; Verderio, A. and Lorenzoni, C. (1986): Combining ability of early maize (*Zea mays* L) inbred lines as evaluated under conditions of double cropping . Mydica, 31: 369-377.

Matzinger, D.F. (1953): Comparison of three types of testers for the evaluation of inbred lines of cron. Agron. J. 45: 493-495.

Matzinger, D.F.; Sprague, G.F. and Cackerham, C.C. (1959): Diallel crosses of maize in experiments repeated over locations and years. Agron. J. 51: 346-350.

Nawar, A.A. and El-Hosary, A.A. (1985): A comparison between two experimental diallel crosses design. Minoufiya J. Agric. Res., 10: 2029-2039.

Nawar, A.A.; Gomaa, M.E. and Rody, M.S. (1979): Genetic analysis of maize inbred lines. 1. Genetic analysis of grain yield and some of its components. Bull. Fac. Agric. Ain Shams Univ. No. 1168:11P.

Robinson, H.F.; Comstock, R.E. and Harvey, P.H. (1949): Estimates of heritability and the degree of dominance in Corn. Agron. J. 41: 353-359.

Russell, W.A.; Eberhart, S.A. and Urbano A. Vega O. (1973): Recurrent selection for specific combining ability for yield in two maize populations. Crop Sci. 13: 257-261.

Sadek, S.E.; Soliman, M.S.M. and Barakat, A.A. (2001): Evaluation of new developed maize lines using commercial inbred testers. Egypt. J. Appl. Sci. 16: 406-425.

Sadek, S.E.; Soliman, M.S.M. and Barakat, A.A. and Khalifa, K.I. (2002): Topcrosses analysis for selecting maize lines in the early self generations. Minufiya J. Agric. Res., 27: 197-213.

Salama, F.A.; Aboel-Saad, Sh.F. and Ragheb, M.M. (1995): Evaluation of maize (*Zea mays* L) top crosses for grain yield and other agronomic traits under different environmental conditions. J. Agric. Sci. Mansoura Univ. 20(1): 127-140.

Shehata, A.H. (1976): Gene action involved in the manifestation of late wilt *Cephalosporium maydis* of maize. Egypt J. Genet. Cytol. 5: 42-47.

Shehata, A.H. and Dhawan, N.F. (1975): Genetic analysis of grain yield in maize as manifested in genetically diverse varietal populations and their crosses. Egypt. J. Gent Cytal. 4: 96-116.

Shehata, A.M.; El-Zeir, F.A. and Amer, E.A. (1997): Influence of tester lines on evaluating combining ability of some new maize inbred lines. J. Agric. Sci. Mansoura Univ. 22: 2159-2176.

Singh, B.; Ramaniam, S. and Dhawan, N.L. (1971): Genetic of yield and yield components in maize composites. Indin Jour. Genet and Plant Breed., 31: 322-332.

Singh, I.S. and Asnani, V.L. (1979): Combining ability analysis for yield and some yield components in maize. Indian J. Genet. Plant Breed., 39: 154-157.

Soliman, M.S.M.; Mahmoud, A.A.; Afaf A.I. Gabr and Soliman, F.H.S. (2001): Utilization of narrow base testers for evaluating combining ability of newly developed yellow maize inbred lines (*Zea mays* L). Egypt. J. Plant Breed., 5: 61-76.

Steel, R.G.D. and Torrie, J.H. (1980): Principles and procedures of statistics: A biometrical approach 2nd (ed). Mc Graw Hill Book Co. Inc., N. Y., USA.

Sultan, M.A. (1998): Estimates of combining ability of yellow maize inbred lines in top crosses. J. Agric. Sci. Mansoura Univ., 23(12): 5837-5851.

Vedeneev, G.L. (1988): Genetic control of quantitative characters in maize IV. Ear length Genetika. USSR, 24(4): 689-697 (C.F. Maize Abstr. 5 (2): 775,1989).

Zambezi, B.T.; Horner, E.S. and Martin, F.G. (1986): Inbred lines as testers for general combining ability in maize. Crop Sci. 26:908-910.

القدرة على الائتلاف للهجن القمية فى الذرة الشامية

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تم انتخاب عدد ثلاث عشر سلالة ذرة شامية بيضاء مستنبطة حديثا فى جيل الإخصاب الذاتى الخامس بمحطة بحوث الجيزة مع ثلاث سلالات كشافة سدس ٦٢ وسدس ٦٣ وجيزة ٦٢٩ وفى موسم ٢٠٠٧ تم تقييم الهجن القمية الناتجة (٣٩ هجينا) بالإضافة إلى هجين المقارنة الفردى ١٠ فى تجربة مكررة تم تنفيذها فى محطات البحوث الزراعية بسخا والجميزة وسدس وذلك لصفات محصول الحبوب (أردب / فدان)، عدد الأيام من الزراعة حتى خروج حراير ٥٠% من النباتات، إرتفاع النبات (سم)، ارتفاع الكوز (سم) والنسبة المئوية للمقاومة لمرض الذبول المتأخر (الشلل). ومن أهم النتائج المتحصل عليها ان متوسطات المربعات كانت عالية المعنوية لكل من السلالات والكشافات والهجن الناتجة بينهم وللتفاعلات مع المواقع لكل الصفات المدروسة فيما عدا الكشافات × المواقع لصفتى محصول الحبوب والتزهير. ووجد ان السلالات الأبوية L2, L7, L5 افضل التأثيرات المعنوية للقدرة العامة للائتلاف لصفة محصول الحبوب ويضاف إليهم السلالة L1 لإعطائهم هجن ذات محصول عالي . السلالات الأبوية L1, L2, L6, L9 كانت أفضل السلالات لإعطاء هجنها جين المقاومة لمرض الذبول التأخر والسلالات L2, L5 كانت أفضل السلالات معنوية لتأثيرات القدرة العامة على الائتلاف لصفة التبكير. وقد أعطت هجن السلالة الكشافة

سدس ٦٢ محصولا أفضل من هجن السلالتين الكشافتين سدس ٦٣وجيزة ٦٢٩. وأظهرت النتائج أن هنـــاك ٤ هجن مع السلالة الكشافة سدس ٦٢ وهجينين مع السلالة الكشافة جيــزة ٦٢٩ كـــانوا عاليــة المعنويـــة للمحصول بالمقارنة بهجين المقارنة هجين فردى ١٠.

أظهر التباين الراجع للفعل الوراثى غير المضيف دوراً أكثر أهمية بالمقارنة بالتباين الراجـــع للفعـــل الوراثى المضيف فى وراثة جميع الصفات محل الدراسة وكذلك كان تباين التفاعل بـــين التـــأثير المضـــيف والبيئة أقل من تباين التفاعل بين التأثير غير المضيف والبيئة لجميع الصفات محل الدراسة.