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HETEROSIS AND COMBINING ABILITY FOR SOME IMPORTANT TRAITS IN MAIZE

BY

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ABSTRACT

A half diallel cross was made among eight white inbred lines of corn, the resulted crosses and check hybrid (S.C. G.10) were tested in both locations (Sakha farm, Kafr EL Sheikh Governorate and Somosta farm, Beni Suif Governorate).

The aim of this study was carried out to estimate the heterotic effects, general and specific combining ability (GCA and SCA) and their interaction with locations. The studied traits were silking and tasseling dates, plant and ear heights, leaf area of ear, no. of row/ ear, no. of kernels/ row, 100-kernel weight, shilling percentage and grain yield/ plant. The obtained results could be summarized as follows:

Location mean squares were significant for all traits except for ear height and number of rows/ ear. Genotypes mean squares were significant for all traits. Significant genotypes × location mean squares were obtained for all traits except shelling percentage. Significant parents mean squares were obtained for all traits. Significant interaction mean squares between parental inbred lines and location were detected for all traits except plant height and shelling percentage. For grain yield/plant, the parental inbred lines P_5, P_2 and P_7 had the highest grain yield/plant. With the exception of inbred lines P_1 and P_6, all inbred lines gave the same grain yield/plant. These inbred lines exhibited high mean values for two or more of the traits contributing to grain yield. However, the parental inbred lines P_1 and P_6 gave the lowest ones for this trait. For grain yield/plant, fifteen parental combinations had significant superiority over check hybrid S.C. G.10. Fifteen hybrids surpassed the check variety by 16.39 to 75.35 % over the two locations. Also, the best heterotic effects were obtained for the crosses $P_5 \times P_7$(75.35), $P_1 \times P_3$(42.21), $P_1 \times P_5$(38.05), $P_1 \times P_8$(28.76), $P_3 \times P_4$(32.23), $P_3 \times P_6$(35.75), $P_3 \times P_7$(31.05), $P_4 \times P_7$(30.44) and $P_7 \times P_8$(33.42). The mean squares associated with general combining ability (GCA) and specific combining ability (SCA) were significant for all the studied traits. GCA/SCA ratio was estimated, it was found that all traits except ear height, number of rows/ear, shelling percentage and 100-kernel weight exhibited low GCA/SCA ratios of less than unity. On the other hand, high GCA/SCA ratio, which exceeded the unity, was obtained for the exceptional traits. The mean squares of interaction between location and both types of combining ability were significant for all traits except shelling percentage. The parental inbred line P_1 exhibited significant negative $\hat{g}_i$ effects for tasseling. The inbred line P_2 showed significant negative $\hat{g}_i$ effects for plant height. The parental inbred line P_3 showed significant negative $\hat{g}_i$ effects for silking date and plant height and ranked the third best-inbred line for both traits.

The parental inbred line P_5 seemed to be the best combiner for plant height and 100-kernel weight. Also, it showed significant desirable $\hat{g}_i$ effects for ear height and grain yield/plant and ranked the second best inbred line for both traits. The parental inbred line P_6 expressed significant desirable $\hat{g}_i$ effects for, silking date, 100-kernel weight and tasseling date. The parental inbred line P_7 behaved as the best combiner for, plant height, ear height, number of kernels/row, grain yield/plant and harvest index. The parental inbred line P_8 exhibited significant desirable $\hat{g}_i$ effects for tasseling date, silking date, leaf area, no. of kernels/row, 100-kernel weight, grain yield/plant and shelling percentage. The most desirable inter and intra allelic interactions were presented by P1x P4 and P5 x P7 for silking and tasseling date and P5xP7, P1xP3, P1xP5 and P3xP6 for grain yield/ plant.

INTRODUCTION

Successful development of improved maize (*Zea mays* L.) hybrids is sepended upon accurate evaluation of inbred lines under different environments.

The diallel analysis procedure suggested by Griffing (1956) is the most common procedure to evaluate the combining ability of lines and to determine the usefulness of lines in hybrids development showing the superior performance of those hybrids under different environmental conditions. The environmental factors are usually daily changed; hence, the studying of genotype environment interaction for plant breeders is of prime importance for devoting these effects which help in selecting the elite materials. However, location effect is one important factor which plays an important role in maize production.

The objectives of this investigation were to study:

1) The evaluation of eight inbred lines of maize and their crosses in order to choose the best hybrids of them.
2) The general and specific combining ability effects were estimated of the eight lines and their interactions with locations, as the useful heterosis.

MATERIALS AND METHODS

Eight (*Zea mays* L.) white inbred lines were developed by Prof. Dr. Ali Abd El-Maksoud El-Hosary Prof. of Agronomy, Fac. of Agric., Moshtohor, Benha Univ. and were used to establish the experiment materials for several characters among inbred lines under study. These lines were selected on bases of yielding ability and other desirable plant aspects. The plant materials were selected with a wide range of diversity for several traits. These inbred lines were Moshtohor 27 (P_1), 1004 (P_2), 21 (P_3), 101B (P_4), 101 (P_5), 212D (P_6), 107 (P_7) and 313D (P_8).

In the first summer season 2006, seeds of the eight inbred lines were split sown on 18th May, 28th May and 8th June to avoid differences in flowering time and to secure enough hybrid seed. All possible cross combinations without reciprocals were made between the eight inbred lines by hand method giving a total of 28 crosses.

In the second summer season 2007, parents and their 28 hybrids were planted at two locations (Sakha farm, Kafr EL Sheikh Governorate and Somosta farm, Beni Suif Governorate). In each experiment, the 8 inbred lines and their 28 hybrids as well as a check hybrid (S.C. 10) were grown in a randomized complete block design with three replications. Each plot consisted of two ridges of 5 m length and 70 cm width. Each hill was spaced 25 cm apart with two kernels planted per hill and later thinned to one plant per hill. The plots were irrigated after sowing. The second irrigation was given after 21 days from sowing. The plants were then irrigated at intervals of 10-15 days. The plots were informally fertilized at the rate of 120 kg of nitrogen per faddan given before the first and second irrigations. The other cultural practices of maize growing were properly practiced.

Random sample of ten guarded plants in each plot were taken to evaluate silking and tasseling dates (dayes) in 50% of plant selked or tasseled, plant and ear heights (cm.), leaf area of ear, no. of rows/ ear, no. of kernels/ row, 100-kernel weight, shelling percentage and grain yield/ plant which was adjusted for 15.5% moisture.

The obtained data were statistically analyzed for analysis of variance by using computer statistical program MSTAT-C. General and specific combining ability were estimated according to Griffin's (1956) diallel cross analysis designated as method 2 model I for each location. The combined analysis of the two locations was carried out whenever homogeneity of variance was detected (Gomez and Gomez 1984). Heterosis expressed as the percentage deviation of the F1 mean performance from S.C.10 was determined.

RESULTS AND DISCUSSION

Location mean squares were significant for all traits under study except for ear height, and no. of rows/ear, with mean values in sakha location being higher than those in Somosta location for all traits except, number of kernels/row and seed index (Table 1). The increase in these traits at sakha location may be due to the prevailing of favorable temperature, day length and soil fertility of soil leading to greater vegetative growth, yield and its components of corn plants. Therefore, Sakha location seemed to be non-stress environment. The decrease in the other traits i.e. number of kernels/row and 100-kernel weight along with high grain yield/plant in Sakha location may be due to the higher no. of ears/plant and shelling percentage. These results are in harmony with those obtained by Amer (2005), El-Hosary and El-Badawy (2005), El-Hosary *et al.* (2006) and Sedhom *et al.* (2007).

Genotypes mean squares were significant for all traits in the combined analysis (Table 1). This indicates the wide diversity between the parental materials used in the present study. Significant genotypes × location mean squares were obtained for all traits except shelling percentage, revealing that the performance of genotypes differed from location to another.

Significant parents mean squares were obtained for all traits (Table 1). Significant interaction mean squares between parental inbred lines and location were detected for all traits except plant height and shelling percentage (Table 1), revealing that the parental inbred lines varied in their response to locations.

For the exceptional traits on the contrary, insignificant interaction obtained revealing that higher repeatability of performance of the parental inbred lines under different locations.

For silking and tasseling dates the inbred line P_6 exhibited significant earliness for both traits. Also, the parental inbred lines P_5 and P_7 recorded the lowest mean values for plant and ear heights.

As for leaf area of ear, the inbred line P_7 gave the highest mean values but without superiority than those inbred lines P_8 and P_4.

The parental inbred line P_2 gave the highest number of rows/ear. The parental inbred line P_7 gave the highest number of kernels/row. However, the parental inbred line P_4 had the lowest ones. The parental inbred line P_1 gave the lowest mean value for shelling percentage and 100-kernel weight. However, the parental inbred line P_8 had the highest mean values for shelling percentage and 100-Kernel weight.

As for grain yield/plant, the parental inbred lines P_5, P_2 and P_7 had the highest grain yield/plant. With the exception of inbred lines P_1 and P_6, all inbred lines gave the same grain yield/plant. These inbred lines exhibited high mean values for two or more of the traits contributing to grain yield. However, the parental inbred lines P_1 and P_6 gave the lowest ones for this trait.

The mean performances of the twenty eight hybrids and the check hybrid S.C.10 (Giza 10) are presented in (Table 2). The earliness of silking date was manifested by all crosses except crosses $P_4 \times P_5$, $P_3 \times P_5$ and $P_4 \times P_8$ compared with S.C.10. Also, the earliness of tasseling date was exhibited by all crosses except crosses $P_4 \times P_5$ and $P_2 \times P_6$ compared with S.C. 10.

Table (1): Observed mean squares from ordinary and combining ability analysis for the studied traits in the combined analysis.

S.O.V.	d.f.	Silking date	Tasseling date	Plant height	Ear height	Leaf area Of ear	Number of Rows/Ear	Number of Kernels/ Row	100-Kernel Weight	Shelling %	Grain Yield/Plant
Location	1	2571.63**	3432.04**	11068.21**	138.56	8721.98**	0.63	692.66**	85.38**	912.26**	5401.00**
Rep/L	4	8.52**	20.09**	28.12	36.82	7622.00**	3.43*	4.40	5.07	0.32	165.28
Genotypes	35	65.97**	75.28**	6727.07**	1690.51**	85445.65**	7.48**	227.47**	183.77**	75.84**	14615.41**
parent	7	28.07**	10.26**	4154.03**	1062.08**	21219.71**	9.02**	104.02**	199.50**	213.29**	1075.05**
Cross	27	28.28**	41.17**	1171.31**	998.37**	63742.93**	5.36**	69.11**	186.16**	37.43**	3999.90***
Par.vs.cr.	1	1348.94**	1451.40**	174743.77**	24777.23**	1121000.69**	54.11**	5367.47**	9.12	150.63**	396016.69**
G/L	35	15.07**	18.48**	750.95**	578.58**	5739.75**	4.65**	53.99**	37.05**	0.05	2481.73**
par./L	7	26.00**	53.35**	41.55	746.85**	1262.44	11.48**	27.76**	42.67**	0.14	665.89**
Cr./L	27	12.79**	9.86**	378.00**	357.67**	5050.41**	2.95**	60.36**	36.92**	0.03	2909.10**
Par.vs.cr.*Vs*.L	1	0.01	7.15	15786.52**	5365.34**	55692.96**	2.73	65.78**	1.12	0.15	3653.54**
Error	140	1.85	1.87	44.93	78.07	916.38	1.01	6.36	3.78	7.67	143.22
GCA	7	12.23**	12.22**	1088.67**	972.31**	13333.55**	5.14**	40.87**	250.00**	50.16**	1614.66**
SCA	28	24.43**	28.31**	2530.78**	461.30**	32268.97**	1.83**	84.56**	14.07**	19.06**	5686.09**
Ent.xL.	35	15.07**	18.48**	750.95**	578.58**	5739.75**	4.65**	53.99**	37.05**	0.05	2481.73**
GCA x L	7	4.04**	8.58**	78.17**	146.44**	1503.09**	1.81**	17.60**	14.82**	0.03	633.35**
SCA x L	28	5.27**	5.56**	293.35**	204.47**	2015.79**	1.48**	18.10**	11.73**	0.01	875.71**
Error	140	0.62	0.62	14.98	26.02	305.46	0.34	2.12	1.26	2.56	47.74
GCA/SCA		0.50	0.43	0.43	2.11	0.41	2.81	0.48	17.77	2.63	0.28
GCA x L/GCA		0.33	0.70	0.07	0.15	0.11	0.35	0.43	0.06	0.00	0.39
SCA x L/SCA		0.22	0.20	0.12	0.44	0.06	0.81	0.21	0.83	0.00	0.15

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

Table (2): Mean Performance of all genotypes for all the studied traits over the two locations and heterosis relative to check variety S.C. 10 for grain yield/plant.

Traits / Genotypes	Silking date	Tasseling date	Plant height	Ear height	Leaf area Of ear	No. of Kernels/ Row	No. of Kernels/ Row	100-Kernel Weight	Shelling %	Grain Yield/ Plant	H% relative S.C.10 for Grain yield / plant
P_1	71.17	72.67	222.88	82.50	483.70	11.48	17.65	16.93	67.38	32.95	
P_2	67.67	70.50	165.43	75.83	462.45	14.58	24.25	28.82	71.65	60.93	
P_3	69.58	72.17	193.03	75.00	498.30	13.17	23.35	32.62	81.72	57.52	
P_4	70.20	71.00	176.52	60.33	578.93	14.15	16.40	28.25	80.75	56.95	
P_5	68.93	71.00	143.83	63.67	494.28	11.37	26.77	33.63	81.07	69.47	
P_6	65.83	68.50	180.75	72.50	550.12	12.60	21.03	32.53	77.85	50.98	
P_7	72.12	71.50	148.33	60.83	621.23	12.53	26.90	32.60	83.30	73.32	
P_8	66.82	72.17	197.83	100.33	600.37	11.53	26.78	34.93	84.23	72.70	
1x2	63.25	66.00	242.18	104.50	805.57	14.33	28.37	23.60	76.13	133.68	-2.78**
1x3	61.40	62.17	240.92	95.00	769.32	14.08	37.57	18.98	79.22	195.53	42.21**
1x4	60.33	62.17	247.47	101.50	769.03	13.12	34.77	26.57	77.63	130.78	-4.88**
1x5	62.78	63.83	264.13	88.33	645.55	13.78	36.18	20.65	76.87	189.82	38.05**
1x6	62.00	64.00	253.12	96.83	745.[illegible]	12.93	39.85	20.53	79.33	151.30	10.04
1x7	65.15	64.67	273.87	81.67	586.[illegible]8	12.23	33.33	23.98	80.68	132.70	-3.49**
1x8	60.35	61.50	246.37	97.50	695.50	14.37	35.73	18.38	82.02	177.05	28.76**
2x3	62.95	66.00	250.80	100.67	837.82	14.52	30.85	36.18	83.37	134.55	-2.15*
2x4	65.30	66.50	257.85	101.83	692.75	13.78	34.43	31.55	83.30	160.85	16.98**
2x5	65.48	67.50	245.97	103.00	889.62	15.62	35.40	38.15	82.95	138.52	0.74
2x6	64.32	68.17	258.83	117.83	848.27	14.22	37.62	34.03	82.35	130.77	-4.90*
2x7	63.02	66.00	221.50	93.33	783.93	14.52	39.82	33.52	81.63	160.03	16.39**
2x8	62.97	64.50	257.03	103.33	771.78	14.22	33.33	31.45	83.05	149.08	8.42**
3x4	61.77	64.50	232.40	113.00	710.65	15.82	34.15	37.12	85.62	181.82	32.23*
3x5	61.83	64.17	239.35	107.17	745.75	14.75	35.05	33.20	77.75	162.57	18.23**
3x6	62.12	66.33	261.03	118.67	687.70	13.98	33.78	30.82	83.20	186.65	35.75**
3x7	62.37	63.17	249.37	93.33	612.22	14.22	36.68	32.78	81.37	180.20	31.05**
3x8	61.48	63.33	237.87	126.33	628.72	13.70	32.82	32.08	78.27	151.20	9.96
4x5	70.28	74.50	216.58	88.33	563.42	14.17	23.10	32.07	79.75	152.27	10.74
4x6	62.67	65.50	261.10	109.17	727.19	14.03	34.05	35.12	81.00	127.35	-7.38**
4x7	63.67	66.[illegible]	219.57	80.83	528.23	13.25	36.38	33.48	83.02	179.35	30.44**
4x8	66.78	65.67	269.42	121.17	762.28	14.30	34.02	31.13	78.02	184.77	34.38**
5x6	64.02	66.67	253.30	103.67	656.35	12.83	33.68	33.63	76.27	146.12	6.27**
5x7	61.95	62.50	247.02	79.17	823.07	14.02	37.85	32.83	78.20	241.10	75.35**
5x8	63.45	64.33	237.65	95.83	739.32	14.97	36.30	33.35	81.08	151.93	10.50*
6x7	59.73	62.00	245.73	78.67	442.02	12.35	37.50	32.30	81.15	164.03	19.30**
6x8	62.38	65.00	238.78	105.83	763.43	12.67	36.48	32.58	78.80	168.20	22.33**
7x8	61.00	61.50	246.58	83.33	632.73	11.90	37.60	34.87	82.05	183.45	7.5
S.C 10	67.18	69.50	271.72	119.17	797.33	13.45	38.05	36.67	86.35	137.50	——
L.S.D 5%	2.18	2.19	10.73	14.14	48.44	1.61	4.04	3.11	4.43	19.15	——
L.S.D 1%	2.86	2.87	14.07	18.54	63.52	2.11	5.29	4.08	5.81	25.11	——

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

Earliness is of great importance and favorable for escaping the destructive injury by the stem corn borer Sesamia cretica led, chilo simplex Bot. and Pyrausta nubilalis Hb.

With the exception of crosses $P_1 \times P_7$, $P_3 \times P_6$ and $P_4 \times P_8$, all crosses exhibited significantly lowest mean values than S.C. 10 for plant height. The short stalks are preferable in corn as much as increase the crop standability and in turn increase the yield potentiality and for intercroping values. For the exceptional cases, the crosses expressed significantly higher mean values compare with S.C. 10. The tallest plants are more important for using corn for forage crop. As for ear height, the cross $P_6 \times P_7$ had the lowest mean values. The low height of ear is preferable in corn to decrease lodging and in turn increase the yield potentiality. However, the highest mean value of ear height was recorded by $P_3 \times P_8$. For leaf area, the hybrid $P_2 \times P_5$ gave the highest mean values. However, the cross $P_6 \times P_7$ had the lowest one for this trait.

Thirteen parental combinations gave significantly the highest mean values for number of rows/ ear. In addition, these crosses were significantly higher than check hybrid S.C. 10 for this trait. Also, the highest value was recorded by cross $P_3 \times P_4$ being (15.82).

Twelve parental combinations and check S.C. 10 gave the highest number of kernels/row. The cross $P_1 \times P_6$ gave the highest number of kernels/row for this trait. The cross $P_2 \times P_5$ and S.C. 10 had significantly higher 100-kernel weight. For shelling percentage seven parental combinations had the highest mean values. However, the cross $P_1 \times P_2$ had the lowest one for this trait.

For grain yield/plant, fifteen parental combinations had significant superiority over check hybrid S.C. G.10. These hybrids exhibitted significant increase of one or more of traits contributing to grain yield. The cross $P_5 \times P_7$ gave significantly higher mean value of grain yield/plant. The fluctuation of hybrids from location to another was detected for most traits. These results would be due to significant interaction between hybrids and location (Table 1).

Significant mean squares for parents vs. crosses as an indication to average heterosis over all crosses was detected for all traits except 100-kernel weight (Table 1). Significant interaction between parents vs.crosses and locations were obtained for all traits except silking and tasseling dates, number of rows/ear, 100-kernel weight and shelling percentage, indicating the unstability of heterotic effects from location to another. The results reported herein are in accordance with those of Nawar *et al.* (2002), Singh *et al.* (2004), El-Hosary *et al.* (2006) and Sedhom *et al.* (2007), where heterosis was recorded. For the exceptianal traits, insignificant interaction between mean squares due to parents vs.crosses and locations were obtained, revealing that grand mean of parental inbred lines and their F1 hybrids did not differ from location to another.

Concerning grain yield/plant fifteen hybrids exhibited significantly heterobeltosis. Fifteen hybrids surpassed the check variety by 16.39 to 75.35 % over the two locations. Also, the best heterotic effects were obtained for the crosses $P_5 \times P_7$(75.35), $P_1 \times P_3$(42.21), $P_1 \times P_5$ (38.05), $P_1 \times P_8$(28.76), $P_3 \times P_4$(32.23), $P_3 \times P_6$ (35.75), $P_3 \times P_7$(31.05), $P_4 \times P_7$(30.44) and $P_7 \times P_8$ (33.42). It is clear that the nine particular crosses had the best heterotic values for grain yield/plant and earliness (silking and tasseling dates) relative to check hybrid S.C. 10. Hence, it could be concluded that these crosses offer possibility for improving grain yield and earliness in maize. Also, these findings revealed that a hybrid program based on these materials would be useful. The most considerable heterosis were generally detected from combinations involving parental inbred lines that are very diverse in origin and widely different in their performances. Several investigators reported high heterosis for yield of maize; i.e. Nawar *et al.* (2002), El-Hosary *et al.* (2006) and Sedhom *et al.* (2007).

From the foregoing results, appreciable heterosis was detected for grain yield over the two locations. In addition, heterosis behaved somewhat differently from location to another.

Combining Ability

Analysis of variance for combining ability as outlined by Griffing (1956) Method-2 model-1 at the combined data for all the studied traits is shown in Table (1). The mean squares associated with general combining ability (GCA) and specific combining ability (SCA) were significant for all the studied traits. It is evident that both additive and non-additive gene effects were involved in determining the performance of the single cross progeny. Also, when GCA/SCA ratio was estimated, it was found that all traits except ear height, number of rows/ear, shelling percentage and 100-kernel weight exhibited low GCA/SCA ratios of less than unity indicating the predominance of non additive gene effects for these traits. On the other hand, high GCA/SCA ratio, which exceeded the unity, was obtained for the exceptional traits, revealing the predominance of additive and additive by additive gene effects for these traits.

The mean squares of interaction between location and both types of combining ability were significant for all traits except shelling percentage. Such results showed that the magnitude of all types of gene action varied from location to another. It is fairly evident that the ratio for SCA×L/SCA was higher than ratio of GCA×L/GCA for plant height, ear height, number of rows/ear and 100-kernel weight. This result indicated that non-additive genetic effects were more influenced by the environmental conditions than additive genetic effects of these traits. These conclusions are in well agreement with those reported by Gelbert (1958). However, the ratio for GCA×L/GCA was higher than ratio of SCA×L/SCA for silking and tasseling date leaf area of ear, no. of kernels/row and grain yield per plant, indicating that additive effects were more influenced by the environmental conditions than non-additive genetic effects.

For the exceptional shelling percentage, insignificant mean squares of interaction between location and both combining ability were obtained, revealing that all types of gene action did not appreciably fluctuate in magnitude from location to another. These findings confirm with those obtained above from the ordinary analysis of variance.

Estimates of GCA effects ($\hat{g}_i$) for individual parental inbred lines for each trait are presented in Table (3). General combining ability effects estimated herein were found to differ significantly from zero. The obtained high positive values for all traits in question except silking and tasseling dates as well as plant and ear heights would be useful from the breeder's point of view.

The parental inbred line P_1 exhibited significant negative $\hat{g}_i$ effects for tasseling, indicating that this of inbred line could be considered as a good combiner for developing early genotypes. In addition, it gave significant (undesirable) or insignificant $\hat{g}_i$ effects for other traits.

The inbred line P_2 showed significant negative $\hat{g}_i$ effects for plant height. In addition, it gave significant positive $\hat{g}_i$ effects for leaf area of ear and no. of rows/ear and 100-kernel weight. However, it is undesirable significant or insignificant $\hat{g}_i$ effects for other traits.

The parental inbred line P_3 showed significant negative $\hat{g}_i$ effects for silking date and plant height and ranked the third best-inbred line for both traits. While, it gave significant positive $\hat{g}_i$ effects for number of rows per ear, shelling percentage and 100-kernel weight and ranked the second best combiner for these traits. Also, it gave significant positive $\hat{g}_i$ effects for grain yield/plant and ranked the fourth best inbred line for this trait. However, it exhibited either significant undesirable or insignificant $\hat{g}_i$ effects for other traits.

The parental inbred line P_4 expressed significant negative $\hat{g}_i$ effects for plant height. However, it exhibited significant positive $\hat{g}_i$ effects for number of rows/ear, 100-kernel weight and shelling percentage and ranked the third best inbred line in the first two traits.

The parental inbred line P_5 seemed to be the best combiner for plant height and 100-kernel weight. Also, it showed significant desirable $\hat{g}_i$ effects for ear height and grain yield/plant and ranked the second best inbred line for both traits. On the contrary, it expressed significant undesirable or insignificant $\hat{g}_i$ effects for the other traits.

The parental inbred line P_6 expressed significant desirable $\hat{g}_i$ effects for, silking date, 100-kernel weight and tasseling date. However, it is exhibited either significant undesirable or insignificant $\hat{g}_i$ effects for the other traits.

The parental inbred line P_7 behaved as the best combiner for; plant height, ear height, number of kernels/row, grain yield/ plant and harvest index. In addition, inbred line P_7 exhibited significant desirable $\hat{g}_i$ effects for tasseling date and 100-kernel weight. On the contrary, it exhibited either significant undesirable or insignificant $\hat{g}_i$ effects for the other traits.

The parental inbred line P_8 exhibited significant desirable $\hat{g}_i$ effects for tasseling date, silking date, leaf area, no. of kernels/row, 100-kernel weight, grain yield/plant and shelling percentage. On the other hand, significant undesirable or insignificant $\hat{g}_i$ effects for the other traits. It is worth noting that the inbred line which possessed high $\hat{g}_i$ effects for grain yield per plant showed the same effect for one or more of the traits contributing to grain yield.

From the previous result, it could be concluded that the parental inbred lines P_7, P_5 and P_8 seemed to be the best general combiners for grain yield/plant and some of its components and earliness traits.

Estimates of SCA effects in 28 hybrids for the studied traits over the two locations are presented in Table (4). The most desirable inter and intra allelic-interactions were presented by P1x P4 and P5 x P7 for silking and tasseling date, P2xP5 and P2xP3 for leaf area of ear, P5xP8, P3xP4 and P2xP5 for no. of rows/ ear, P1xP3, P1xP4 and P1xP6 for no. of kernels/ row, PxP5 and P3xP4 for 100-kernel weight, P1xP8, P2xP5 and P3xP4 for 100-kernel weight, P1xP8 and P2xP5 for shelling percentage and P5xP7, P1xP3, P1xP5 and P3xP6 for grain yield/ plant. These crosses may be prime importance in breeding programmes either towards hybrid maize production or synthetic varieties composed of hybrids which involved the good combiners for the traits in view.

Table (3): General combining ability effects for all the studied traits in the combined analysis.

Traits / Parent	Silking date	Tasseling date	Plant height	Ear height	Leaf area Of ear	Number of Rows/Ear	Number of Kernels/ Row	100-Kernel Weight	Shelling %	Grain Yield/Plant
P_1	-0.17	-0.74**	12.77**	-1.49	-5.37	-0.47**	-0.89**	-8.73**	-3.39**	-7.84**
P_2	0.33*	0.86**	-2.11**	3.10**	51.61**	0.78**	-0.16	1.23**	-0.44	-12.58**
P_3	-0.62**	-0.30	1.17	5.90**	-4.98	0.49**	-0.24	1.26**	1.17**	5.24**
P_4	1.19**	1.03**	-2.87**	-0.87	-12.71**	0.42**	-2.63**	0.97**	0.93**	-2.40
P_5	0.84**	0.85**	-9.44**	-5.24**	1.31	0.03	0.11	1.73**	-0.55	6.61**
P_6	-1.04**	-0.24	4.73**	3.05**	-6.78	-0.43**	0.51	1.03**	-0.27	-7.87**
P_7	0.18	-0.77**	-8.58**	-13.32**	-38.69**	-0.50**	2.30**	1.51**	1.42**	13.24**
P_8	-0.72**	-0.69**	4.33**	8.88**	15.60**	-0.33**	0.99**	0.99**	1.12**	5.60**
L.S.D (0.05)gi	0.32	0.32	1.59	2.09	7.17	0.24	0.60	0.46	0.66	2.83
L.S.D (0.01)gi	0.42	0.42	2.08	2.74	9.40	0.31	0.78	0.60	0.86	3.71
L.S.D (0.05)gi-gj	0.49	0.49	2.40	3.16	10.83	0.36	0.90	0.70	0.99	4.28
L.S.D (0.01)gi-gj	0.64	0.64	3.15	4.15	14.20	0.47	1.18	0.91	1.30	5.62

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

Table (4): Specific combining ability effects for all the studied traits over the two locations.

Crosses \ Traits	Silking date	Tasseling date	Plant height	Ear height	Leaf area Of ear	Number of Rows/Ear	Number of Kernels /Row	100-Kernel Weight	Shelling %	Grain Yield/Plan t
1x2	-1.28*	-0.46	-0.27	8.98**	88.38**	0.41	-2.80**	0.67	-0.10	14.64**
1x3	-2.18**	-3.13**	-4.81	-3.32	108.71**	0.45	6.47**	-3.97**	1.37	58.67**
1x4	-5.06**	-4.46**	5.77*	9.95**	116.17**	-0.45	6.06**	3.90**	0.03	1.56
1x5	-2.25**	-2.61**	29.02**	1.15	-21.34	0.61	4.74**	-2.78**	0.75	51.58**
1x6	-1.16*	-1.36**	3.83	1.36	86.69**	0.22	8.01**	-2.19**	2.93**	27.55**
1x7	0.77	-0.16	37.89**	2.56	-39.91**	-0.41	-0.30	0.77	2.59*	-12.16**
1x8	-3.12**	-3.41**	-2.52	-3.80	14.32	1.56**	3.41**	-4.31**	4.22**	39.83**
2x3	-1.13*	-0.90	19.95**	-2.24	120.23**	-0.37	-0.97	3.27**	2.58*	2.43
2x4	-0.59	-1.73**	31.04**	[illegible]70	-17.10	-1.04**	5.01**	-1.08	2.75**	36.37**
2x5	-0.05	-0.55	25.73**	1[illegible].23**	165.75**	1.18**	3.23**	4.76**	3.89**	5.02
2x6	0.66	1.20*	24.42**	17.78**	132.49**	0.25	5.06**	1.35	3.01**	11.76**
2x7	-1.87**	-0.43	0.40	9.65**	100.06**	0.62	5.46**	0.35	0.60	19.91**
2x8	-1.01*	-2.01**	23.02**	-2.55	33.63**	0.15	0.29	-1.19	2.31*	16.61**
3x4	-3.17**	-2.56**	2.31	14.06**	57.39**	1.29**	4.79**	4.46**	3.46**	39.52**
3x5	-2.75**	-2.71**	15.83**	12.60**	78.47**	0.61	2.95**	-0.22	-2.93**	11.25*
3x6	-0.59	0.54	23.34**	15.81**	28.51*	0.31	1.29	-1.89	2.24*	49.82**
3x7	-1.56**	-2.10**	24.99**	6.85*	-15.07	0.61	2.40**	-0.41	-1.28	22.26**
3x8	-1.54**	-2.01**	0.58	17.65**	-52.85**	-0.07	-0.15	-0.59	-4.09**	0.90
4x5	3.89**	6.29**	-2.89	0.53	-96.13**	0.09	-6.61**	-1.06	-0.69	8.60
4x6	-1.85**	-1.63**	27.45**	13.08**	75.73**	0.43	3.95**	2.69**	0.28	-1.83
4x7	-2.07**	-0.10	-0.77	1.11	-91.31**	-0.29	4.49**	0.57	0.61	29.06**
4x8	1.95**	-1.01*	36.17**	19.25**	88.45**	0.60	3.44**	-1.25	-4.10**	42.12**
5x6	-0.15	-0.28	26.22**	11.95**	-9.12	-0.38	0.84	0.45	-2.97**	7.92
5x7	-3.44**	-3.91**	33.25**	3.81	189.50**	0.87*	3.22**	-0.84	-2.73**	81.79**
5x8	-1.03*	-2.16**	10.98**	-1.72	51.46**	1.65**	2.98**	0.20	0.45	0.27
6x7	-3.78**	-3.33**	17.79**	-4.97	-183.46**	-0.34	2.47**	-0.67	-0.06	19.21**
6x8	-0.22	-0.41	-2.06	0.00	83.67**	-0.18	2.77*	0.14	-2.11*	31.02**
7x8	-2.83**	-3.38**	19.05**	-6.14	-15.12	-0.88*	2.09	1.94**	-0.55	25.16**
SD 5% (sij)	0.99	0.99	4.86	6.41	21.96	0.73	1.83	1.41	2.01	8.68
SD 1% (sij)	1.30	1.30	6.38	8.41	28.80	0.96	2.40	1.85	2.63	11.39
SD 5% (sij-sik)	1.46	1.47	7.20	9.49	32.50	1.08	2.71	2.09	2.97	12.85
SD 1% (sij-sik)	1.92	1.93	9.44	12.44	42.61	1.41	3.55	2.74	3.90	16.85
SD 5% (sij-ski)	1.38	1.39	6.78	8.94	30.64	1.02	2.55	1.97	2.80	12.11
SD 1% (sij-ski)	1.81	1.82	8.90	11.73	40.17	1.33	3.35	2.58	3.68	15.88

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

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قوة الهجين والقدرة على التآلف لبعض الصفات الهامة فى الذرة الشامية

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يهدف البحث الى تقييم ثمانية سلالات جديدة (منتخبة بواسطة د. على عبد المقصود الحصرى) والهجن الناتجة منها بنظام التهجين النصف دائرى بالأضافة الى الهجين الفردى وذلك فى موقعين هما سخا (كفر الشيخ) وسمسطا (بنى سويف) وتقدير القدرة العامة والخاصة على التآلف وقوة الهجين وتفاعلها مع المواقع. وكانت الصفات المدروسة هى ميعاد ظهور ٥٠% من الحراير والنورات المذكرة، ارتفاع الكوز، طول النبات، مساحة ورقة الكوز، عدد صفوف الكوز، عدد حبوب الصف، وزن ١٠٠ حبة، نسبة التصافى ومحصول النبات الفردى وتم التهجين فى موسم ٢٠٠٦ والتقييم فى موسم ٢٠٠٧. ويمكن تلخيص أهم النتائج كما يلى:

كان التباين الراجع الى المواقع معنويا لكل الصفات عدا ارتفاع الكوز وعدد صفوف الكوز. كان التباين الراجع الى التراكيب الوراثية معنويا لكل الصفات. وكان التباين الراجع الى التفاعل بين التراكيب الوراثية والمواقع معنويا لكل الصفات عدا صفة نسبة التصافى. وكان التباين الراجع للاباء معنويا لكل الصفات وكان التباين الراجع للتفاعل بين الاباء والمواقع معنويا لكل الصفات عدا ارتفاع النبات ونسبة التصافى. بأستثناء السلالتين ١ و٦ اعطت كل السلالات قيمة متساوية فى محصول الحبوب/ نبات. اعطت السلالتين ١ و٦ اقل قيمة فى كمية المحصول. اعطت ١٥ هجين تفوقا معنويا مقارنة بالهجين الفردى ١٠ وكان التفوق يتراوح من ١٦,٣٩ الى ٧٥,٣٥% فى التحليل المشترك. كانت احسن الهجن فى المحصول بالنسبة لقوة الهجين مقارنة بالهجين الفردى ١٠ فى محصول الحبوب/ نبات هى ٧x٥ (٧٥,٣٥%)، ٣x١ (٤٢,٢١%)، ٥x١ (٣٨,٠٥)، ٨x١ (٢٨,٧٦%)، ٤x٣ (٣٢,٢٣)، ٦x٣ (٣٥,٧%)، ٧x٣ (٣١,٠٥%)، ٧x٤ (٣٠,٤٤) و٨x٧ (٣٣,٤٢%).

كان التباين الراجع للقدرة العامة على التالف معنويا لكل الصفات. كانت النسبة بين GCA/SCA اقل من الوحدة لكل الصفات عدا صفة ارتفاع الكوز، عدد صفوف الكوز، نسبة التصافى ووزن المائة حبة حيث كانت النسبة اكبر من الوحدة. كان التباين الراجع الى التفاعل بين المواقع وكل من القدرة العامة والخاصة على التالف معنويا لكل الصفات بأستثناء نسبة التصافى.

أظهرت السلالة ١ و٢ قدرة عامة معنوية وسالبة لميعاد ظهور النورة المذكرة وارتفاع النبات. أظهرت السلالة ٣ قدرة عامة معنوية وسالبة لميعاد ظهور النورة المؤنثة وارتفاع النبات وكانت ترتيبها ثالث للصفتين كما اظهرت السلالة رقم ٥ قدرة عالية ومرغوبة لصفة ارتفاع النبات، وزن المائة حبة، ارتفاع الكوز ومحصول النبات. واظهرت السلالة رقم ٦ قدرة عالية ومعنوية ومرغوبة لصفة ميعاد تزهير النورة المؤنثة والمذكرة ووزن المائة حبة. كما اظهرت السلالة رقم ٧ قدرة عالية على التالف لصفات طول النبات، ارتفاع الكوز وعدد الحبوب فى الصف ومحصول النبات كما اظهرت السلالة رقم ٨ قدرة عامة على التالف لصفات ميعاد ظهور النورة المؤنثة والمذكرة ومساحة ورقة الكوز، عدد الحبوب فى الصف، وزن المائة حبة، نسبة التصافى ومحصول النبات. كانت معظم القدرة الخاصة على التالف فى هجين ٤x١ و٥x٧ لميعاد ظهور النورة المؤنثة والمذكرة وهجين ٧x٥، ٣x١، ٥x١ و٦x٣ لمحصول النبات.