Evaluation of New Yellow Inbred Lines of Maize Via Line X Tester Analysis over Two Different Locations

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ABSTRACT

Twenty six new inbred lines of yellow maize were top crossed with three testers i.e. homozygous inbred line Sk 8008 and heterozygous i.e. SC Sk 74 and Comp-Sk 21 during 2005 growing season at Sakha Agricultural Research Station. The resultant 78 top crosses and the two check SC 155 and SC 3084 were evaluated during 2006 growing season at the two locations, Sakha and Sids Agricultural Research Stations.

The mean squares of locations were found to be highly significant for all studied traits except for No. of kernels/row. Significance for mean squares due to lines, testers and line x tester interaction was detected for all studied traits except of L x T for plant height and number of kernels/ row. The interactions between L x Loc. and T x Loc., proven to be were significant for all studied traits except for number of kernels/ row for the two sources and No. of rows/ear for T x Loc. The interaction between L x T x Loc. was insignificant for all studied traits except of ear diameter.

Additive genetic variance was more important component than the non-additive genetic variance in the inheritance of silking date, plant height, ear height, ear length, ear diameter, number of rows/ear and weight of 100 kernels, while, the non-additive genetic variance played the major contribution in the inheritance of grain yield and number of kernels/row.

Positive and significant phenotypic and genotypic correlations among most pairs of studied traits were recorded , except for silking date with No. of rows/ear, ear height with No. of rows/ear, ear length with ear diameter and No. of rows/ear and No. of rows/ear with weight of 100 kernels.

The best three way crosses were Sk 5001/6 x SC Sk 74 (34.5 Ard./Fed.) and SC Sk 5001/50 x Sk 8008 (33.63 Ard./ Fed.) were higher for grain yield that of the commercial hybrids SC 155 (31.32 Ard./Fed.) and SC 3084 (32.29 Ard./Fed.), suggesting that these crosses are fruitful for using in future in maize breeding programs.

Significant and desirable GCA effects were exhibited in Sk 5001/6, Sk 5002/9, Sk 5005/12, Sk 5005/16, Sk 5001/50 and Sk 7070/62 for grain yield and other studied traits.

INTRODUCTION

Maize (*Zea mays*, L.) hybrid development has become an important factor in meeting the increasing world demand of this cereal during the last 30 years. The hybrids were developed from crossing between two inbred lines or more. Top crosse is the first step for evaluating the new inbred lines.

Different studies have provided definitions of either the best or the more convenient tester (Matzinger, 1953; Rawlings and Thompson, 1962; Allison and Curnow, 1966; Hallauer, 1975 and Hallauer *et al.*, 1988). Matzinger, (1953) defined a convenient tester as one that combines simplicity in use with the maximum information on the performance among the lines when they are tested in other combinations or in other environments. Russell (1961) concluded that the expression of greater genetic differences among test crosses is one of the main features of an ideal tester parent. Hallauer and Miranda, (1988) that either a homozygous recessive line or a population with low allele frequency for important traits under selection would be an effective tester to use in a hybrid breeding program.

The objectives of the present study were:

1-To determine the nature of gene action for nine traits of maize.

2-To estimate combining ability of new parental yellow maize inbred lines for all studied traits of maize.

3-To identify superior top crosses to improve the yielding ability in maize breeding programs.

4-To estimate the phenotypic and genotypic correlations among each pair of all studied traits.

MATERIALS AND METHODS

New 26 yellow maize inbred lines (developed at Sakha Agricultural Research Station) were top crossed to each of three testers i.e. inbred lines Sk 8008, single cross 74 and comp Sk-21 in 2005 growing season at Sakha Station. In 2006 growing season, the resulting 78 top crosses and the two commercial checks i.e. SC 155 and SC 3084 were evaluated at Sakha and Sids Experimental Stations. A randomized complete block design with 4 replications was used. The experimental unit was one row, 6m long and 80cm apart. Planting was in hills 25 cm distance. All cultural practices were applied as usual. Data were taken on silking date

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(number of days from planting to 50% emergence silking), plant and ear heights (cm), grain yield Ard./Fed. adjusted based on shelling percent at 15.5% moisture content, ear length (cm), ear diameter (cm), number of rows/ear, number of kernels/ row and weight of 100 kernels (g). Before calculating the combined analysis, test of homogeneity of error mean squares for the two locations was done as out lined by Steel and Torrie (1980). When differences among top crosses were found to be significant, line x tester analysis according to Kempthorne (1957) was done for each location and their combined data over the two locations.

RESULTS AND DISCUSSION

The mean squares of combined analysis over two locations for nine traits are shown in table (1). The mean squares of locations showed highly significant estimates for all studied traits except for No of kernels /row indicating the great difference between Sakha and Sids locations expression of different studied traits. These results are in agreement with those of El-Zeir *et al.*, (2000), Amer *et al.*, (2001), Amer *et al.*, (2003), El-Shenawy *et al.*, (2003), Abd El-Hadi *et al.*, (2004), Mosa (2004) and Abd El- Hadi *et al.*, (2007). The result also indicated that the mean squares of genotypes and genotypes x locations interactions were significant or highly significant for all studied traits except No. of kernels/row for g x loc. was insignificant. These findings cleared the important of choice of genotypes for suitable locations

Mean performances of 78 top crosses and two chech hybrids for all studied traits are presented in table (2.) The best top crosses were Sk 5009/30 x SC Sk 74 for silking date (earliness), Sk 5009/31 x SC Sk 74 for short plant height and ear height, Sk 5047/49 x Comp-Sk 21 for ear length, Sk 5002/9 x Comp-Sk 21 for ear diameter, Sk 5011/ 40 x SC Sk 74 for number of rows/ears, Sk 5002/9 x Comp-Sk 21 for number of kernels/row and Sk 5005/21 x Comp-Sk 21 for weight of 100 kernels. Values of mean performance for grain yield ranged from 13.2 Ard./Fed. for the top cross Sk 5047/49 x Sk 8008 to 40.14 Ard./Fed. for the top cross Sk 5002/9 x Comp-Sk 21, while 13 top crosses i.e: Sk 5001/5 x Comp-Sk 21 (34.47 Ard./Fed.), Sk 5001/6 x SC Sk 74 (34.5 Ard./Fed.), Sk 5001/6 x Comp-Sk 21 (35.65 Ard./Fed.), Sk 5002/9 x Comp-Sk 21 (40.14 Ard./Fed.), Sk 5002/10 x Comp-Sk 21 (34.33 Ard./Fed.), Sk 5005/ 12 x Comp-Sk 21 (33.8 Ard./Fed.), Sk 5008/26 x Comp-Sk 21 (33.87 Ard./Fed.), Sk 5009/31 x Comp-Sk 21 (34.05 Ard./Fed.), Sk 5012/42 x Comp-Sk 21 (33.29 Ard./Fed.), Sk 5047/49 x Comp-Sk 21 (35.07 Ard./Fed.), Sk 5001/50 x Sk 8008 (33.63 Ard./Fed.), Sk 5001/50 x Comp-Sk 21 (38.19 Ard./Fed.) and Sk 7070/62 x Comp-Sk 21 (33.69 Ard./Fed.) from the combine data surpassed from the two checks SC. 155 (31.32 Ard./Fed.) and SC. 3084 (32.90 Ard./Fed.) for grain yield. These results indicated that these 13 top crosses could be used in future for maize breeding programs.

Table (3) shows that the mean square of lines (L), testers (T) and line x tester (L x T) interaction, were highly significant for all studied traits except (L x T) for plant height and number of kernels/row. These results indicate that inbred lines significantly differed in their

Table 1. Combined analysis of variance for all studied traits over the two locations

S.V	d.f	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)
Locations (Loc)	1	1556.26**	230318.56**	51714.07**	6932.81**
Rep/Loc	6	13.356	2748.03	1732.91	39.801
Genotypes (G)	79	22.642**	1099.93**	1057.71**	99.0**
G x Loc	79	1.807*	309.735*	298.89**	18.89**
Error	474	1.388	215.690	167.72	10.399
C.V%		89	5.19	7.80	10.50

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

Table 1. Cont

S.V	d.f	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernels (g)
Locations (Loc)	1	439.901**	37.733**	91.658**	103.282	144445.79**
Rep/Loc	6	7.148	0.067	2.602	33.179	68.31
Genotypes (G)	79	8.81**	0.269**	6.721**	24.562**	77.148**
G x Loc	79	1.73**	0.25**	1.293**	7.576	17.74**
Error	474	0.946	0.042	0.768	7.02	8.332
C.V%		4.64	4.31	5.74	6.23	7.50

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

Table 2. Mean performance of 78 top crosses and the two check hybrids for all studied traits over the two locations

Hybrid	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernels (g)
Sk5001/1 x Sk8008	62.12	277.37	166.12	28.94	20.62	4.65	15.30	44.07	36.00
Sk5001/1 x SC Sk74	60.87	274.37	146.75	29.31	20.27	4.87	16.20	42.47	34.80
Sk5001/1 x Comp21	64.62	284.25	169.62	30.19	21.57	4.85	16.05	44.30	35.75
Sk5001/5 x Sk8008	62.62	270.00	163.12	28.44	21.10	4.52	13.40	42.57	34.94
Sk5001/5 x SC Sk74	61.25	271.75	157.37	31.78	20.00	4.82	15.85	42.45	32.96
Sk5001/5 x Comp21	64.62	290.00	181.87	34.37	21.42	4.75	15.05	44.95	36.78
Sk5001/6 x Sk8008	62.75	283.25	169.50	28.85	20.22	4.42	13.85	41.92	37.79
Sk5001/6 x SC Sk74	60.87	291.62	167.00	34.50	19.87	4.87	16.20	41.45	33.67
Sk5001/6 x Comp21	64.50	306.50	169.00	35.65	20.45	4.85	15.45	42.20	38.51
Sk5002/7 x Sk8008	61.50	293.87	177.87	28.11	19.82	4.60	14.35	40.82	36.20
Sk5002/7 x SC Sk74	61.25	294.37	172.62	29.93	18.80	4.92	16.40	38.87	34.07
Sk5002/7 x Comp21	62.37	301.00	182.12	31.01	20.57	4.87	15.20	43.10	36.10
Sk5002/9 x Sk8008	61.37	306.87	188.75	31.71	21.67	4.82	15.75	43.97	40.00
Sk5002/9 x SC Sk74	61.25	295.12	167.37	32.20	20.85	4.90	16.95	42.42	36.26
Sk5002/9 x Comp21	63.12	312.25	184.25	40.14	22.00	5.12	16.90	46.12	39.34
Sk5002/10 x Sk8008	61.50	273.00	158.87	27.47	21.00	4.60	15.35	42.52	37.15
Sk5002/10 x SC Sk74	60.50	269.50	148.25	29.68	20.90	4.90	16.05	42.35	36.93
Sk5002/10 x Comp21	61.62	282.75	166.87	34.33	21.60	4.95	16.35	43.05	40.45
Sk5002/11 x Sk8008	61.12	272.00	156.50	28.75	21.80	4.75	15.35	42.92	39.62
Sk5002/11 x SC Sk74	59.87	269.37	151.25	31.78	21.32	4.87	16.15	40.95	39.30
Sk5002/11 x Comp21	62.75	291.87	168.75	32.56	22.70	4.85	15.45	43.42	38.96
Sk5005/12 x Sk8008	62.37	272.62	164.25	30.40	21.00	4.70	15.60	43.07	40.27
Sk5005/12 x SC Sk74	60.37	282.12	158.75	30.78	20.42	5.00	16.75	43.65	38.77
Sk5005/12 x Comp21	62.37	283.50	170.25	33.80	22.15	5.05	16.15	43.90	40.92
Sk5005/13 x Sk8008	63.37	285.62	169.87	28.14	20.42	4.72	16.30	41.37	36.90
Sk5005/13 x SC Sk74	61.00	274.37	163.87	32.35	19.70	4.92	16.80	39.37	34.67
Sk5005/13 x Comp21	64.00	290.62	175.00	32.34	20.80	5.07	16.40	41.50	38.63
Sk5005/16 x Sk8008	62.00	287.75	177.87	30.02	20.20	4.72	15.50	39.62	41.31
Sk5005/16 x SC Sk74	61.37	291.50	164.37	32.66	19.95	4.95	16.35	40.95	39.89
Sk5005/16 x Comp21	64.50	297.37	186.50	32.16	20.77	4.85	14.95	41.67	43.40
Sk5005/19 x Sk8008	62.00	269.00	161.50	21.46	19.97	4.40	13.65	39.07	37.47
Sk5005/19 x SC Sk74	61.12	289.75	166.25	26.92	20.02	4.67	15.40	39.07	35.05
Sk5005/19 x Comp21	64.37	298.75	178.87	28.10	21.32	4.70	15.15	40.15	38.72
Sk5005/21 x Sk8008	61.37	282.25	161.87	27.21	21.02	4.50	14.00	40.30	43.62
Sk5005/21 x SC Sk74	60.12	273.50	150.75	31.58	20.40	4.72	14.55	38.55	41.65
Sk5005/21 x Comp21	62.00	289.12	172.75	32.47	21.05	4.72	14.60	39.27	45.63
Sk5007/21 x Sk8008	62.00	267.75	157.62	27.16	21.67	4.62	13.85	44.60	40.86
Sk5007/21 x SC Sk74	60.50	273.37	150.87	29.34	19.77	4.87	15.40	40.75	39.12

Table 2. Cont.

Hybrid	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernels (g)
Sk5007/21 x Comp21	62.75	285.75	167.87	32.12	22.82	4.65	14.50	44.35	40.74
Sk5008/25 x Sk8008	61.12	264.00	150.62	25.23	20.20	4.55	13.40	41.70	37.22
Sk5008/25 x SC Sk74	60.75	275.87	154.00	27.13	19.32	4.65	15.10	41.07	36.36
Sk5008/25 x Comp21	63.00	289.5	174.87	31.44	20.17	4.72	14.85	41.65	37.14
Sk5008/26 x Sk8008	61.62	293.75	184.0	29.33	20.67	4.67	14.05	41.72	37.93
Sk5008/26 x SC Sk74	62.00	282.62	168.50	28.74	19.75	4.75	15.05	40.67	36.44
Sk5008/26 x Comp21	62.50	300.87	191.50	33.87	20.95	4.87	15.55	42.15	36.95
Sk5009/27 x Sk8008	61.62	269.25	157.37	24.97	20.82	4.47	14.45	42.50	33.30
Sk5009/27 x SC Sk74	60.87	275.37	151.12	31.14	21.12	4.62	15.60	43.35	31.69
Sk5009/27 x Comp21	62.50	288.12	169.25	29.75	21.45	4.57	14.95	43.50	34.64
Sk5009/30 x Sk8008	59.87	276.87	160.75	29.93	20.85	4.62	14.05	42.00	38.45
Sk5009/30 x SC Sk74	59.25	270.75	152.62	30.53	19.62	4.67	14.75	38.67	37.23
Sk5009/30 x Comp21	61.75	279.87	160.12	32.28	20.37	4.77	14.95	41.87	38.23
Sk5009/31 x Sk8008	60.75	276.62	166.25	28.81	21.77	4.47	13.95	43.32	38.76
Sk5009/31 x SC Sk74	59.50	263.25	143.12	30.57	20.07	4.57	15.00	40.37	35.58
Sk5009/31 x Comp21	63.37	288.87	164.37	34.05	21.52	4.65	14.55	41.82	38.79
Sk5011/40 x Sk8008	63.62	273.62	156.5	28.78	20.17	4.82	15.55	44.37	35.21
Sk5011/40 x SC Sk74	61.50	273.37	151.75	28.37	18.20	4.97	17.40	41.95	35.22
Sk5011/40 x Comp21	63.50	281.50	159.75	32.40	19.32	4.92	15.97	42.27	32.99
Sk5012/42 x Sk8008	63.25	280.50	166.75	26.35	20.17	4.97	14.45	40.32	43.3
Sk5012/42 x SC Sk74	61.50	281.37	158.12	31.34	19.35	5.12	16.60	41.17	38.45
Sk5012/42 x Comp21	63.75	279.50	162.25	33.29	19.80	5.15	15.70	40.25	38.67
Sk5047/49 x Sk8008	62.00	237.62	150.12	13.20	22.77	4.75	14.95	43.40	41.07
Sk5047/49 x SC Sk74	59.62	278.00	144.00	32.38	21.62	4.70	15.30	42.95	36.67
Sk5047/49 x Comp21	61.25	294.50	169.75	35.07	24.25	4.75	15.20	45.87	42.91
Sk5001/50 x Sk8008	66.25	302.12	186.50	33.63	21.77	4.70	14.30	43.10	42.39
Sk5001/50 x SC Sk74	64.62	300.87	179.87	26.97	22.35	5.05	16.50	44.28	39.56
Sk5001/50 x Comp21	67.00	306.75	181.87	38.19	22.17	5.00	15.35	42.75	42.16
Sk5001/53 x Sk8008	65.62	289.87	177.12	30.56	20.22	4.57	14.60	41.27	38.82
Sk5001/53 x SC Sk74	62.75	295.00	169.87	30.51	20.00	4.85	15.75	42.95	34.81
Sk5001/53 x Comp21	67.25	312.50	196.50	27.18	21.30	5.02	16.25	43.47	36.59
Sk8001/57 x Sk8008	62.50	272.50	158.25	25.44	20.92	4.50	14.60	40.20	35.49
Sk8001/57 x SC Sk74	61.50	278.87	160.12	31.16	19.70	4.80	17.15	40.57	30.64
Sk8001/57 x Comp21	63.37	271.00	157.62	30.34	20.72	4.50	15.75	43.32	31.94

Table 2. Cont.

Hybrid	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernels (g)
Sk8203/61 x Sk8008	63.87	273.87	161.50	29.86	21.37	4.75	13.80	42.05	42.95
Sk8203/61 x SC Sk74	61.87	286.00	157.12	32.56	20.75	4.97	16.00	41.27	39.38
Sk8203/61 x Comp21	65.37	300.75	176.12	31.66	21.30	4.77	15.05	39.65	40.95
Sk7070/62 x Sk8008	61.75	288.00	166.25	30.63	21.75	4.72	14.65	42.40	40.38
Sk7070/62 x SC Sk74	60.87	293.87	162.25	30.74	21.40	4.72	15.05	42.90	34.25
Sk7070/62 x Comp21	63.00	286.87	159.75	33.79	21.87	4.70	15.40	43.05	39.20
SC155	62.00	289.00	165.87	31.32	19.62	4.95	14.70	42.00	42.99
SC3084	65.50	297.25	170.25	32.90	23.92	4.92	14.85	48.45	42.25
LSD0.05	1.115	14.39	12.69	3.16	0.95	0.2	0.85	2.59	2.82
LSD0.01	1.570	19.60	17.28	4.15	1.25	0.26	1.13	3.41	3.72

Table 3. Mean squares of lines, testers, line x tester and their interaction with locations for all studied traits over the two locations

S.V	d.f	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)
Lines (L)	25	36.68**	2063.3**	18899.32**	88.2**
Testers (T)	2	317.62**	9493.3**	11670.94**	12.93**
(L x T)	50	3.07**	296.768	251.72*	60.46**
L x Loc	25	2.72**	419.23**	364.57**	23.21**
T x Loc	2	10.23**	932.95*	2072.8**	94.61**
L x T x Loc	50	1.02	241.79	206.38	12.66
Error	474	1.388	215.690	167.72	10.399

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

Table 3. Cont

S.V	d.f	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernels (g)
Lines (L)	25	16.44**	0.514**	10.30**	42.92**	170.13**
Testers (T)	2	64.02**	1.601**	95.39**	75.86**	405.09**
(L x T)	50	1.65**	0.103**	1.64**	8.98	12.44*
L x Loc	25	2.33**	0.224**	1.14	9.71	49.48**
T x Loc	2	3.76*	0.357**	14.34**	8.9	158.19**
L x T x Loc	50	1.176	0.112**	0.822	5.09	8.651
Error	474	0.946	0.042	0.768	7.02	8.332

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

behaviour with respect to top crosses. Also, the three testers were different from each other in top crosses. The significance of line x tester indicates that the main of certain hybrid top crosses production is function of both the male and female parents. These results are in agreement with those of Mosa (2001), Amer *et al.*, (2003), El-Shenawy *et al.*, (2003) and Mosa (2004). The interactions between L x Loc and T x Loc were significant for all studied traits except number of kernels/row. While, the interaction between L x T x Loc was not significant for all studied traits except ear diameter.

Estimates of variance due to general (σ^2GCA) and specific (σ^2SCA) combining ability and their interaction with locations are presented in Table 4. The results showed that the σ^2GCA estimated values were higher than those of σ^2SCA for silking date, plant height, ear height, ear length, ear diameter, number of rows/ear and weight of 100 kernels. These results indicate that the additive effects played a major rule in the inheritance of these traits as reported by several authers (e.g. El-Zeir *et al.*, 2000; Konak *et al.*, 2001; El-Shenawy, 2003 ; Yousif *et al.*, 2003; Abd El-Hadi *et al.*, 2005; Barakat and Ibrahim 2006 and Mosa *et al.*, 2007. On the other hand, the non additive genetic effects played a major rule in the inheritance of grain yield and No. of kernels/row. These results are in agreement with those obtained by Abd El-Aziz (1991), Gabr (1997), Soliman (1997), Abd El-Aal (2002) and Abd El-Hadi *et al.*, (2004).

Table 4. Estimates of variance due to general combining ability (GCA), specific combining ability (SCA) and their interaction with locations

S.V	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)
σ^2GCA	1.452	44.60	47.58	5.032
σ^2SCA	0.256	-9.07	5.66	6.282
σ^2GCAxLoc	0.093	6.385	17.44	0.796
σ^2SCAxLoc	-0.213	21.99	9.682	0.615

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

Table 4. Cont

S.V	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernels (g)
σ^2GCA	0.316	0.006	0.381	0.397	1.550
σ^2SCA	0.059	0.001	0.204	0.486	0.473
σ^2GCAxLoc	0.031	0.002	0.118	0.466	1.640
σ^2SCAxLoc	0.060	0.017	0.012	-0.447	0.136

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

Table 5. Estimates of general combining ability effects for 26 inbred lines and three the testers over the two locations

Inbred lines	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernels (g)
Sk5001/1	0.256	-5.642	-5.080	-0.873	-0.078	0.025	0.504**	1.540**	-2.403**
Sk5001/5	0.548*	-7.059*	1.544	1.043	0.004	-0.016	-0.578**	1.373*	-2.987**
Sk5001/6	0.423	9.482**	5.919*	2.543**	-0.661**	-0.057	-0.120	-0.209	-1.237*
Sk5002/7	-0.576*	12.102**	11.628**	-0.748	-1.078**	0.025	0.088	-1.168*	-2.403**
Sk5002/9	-0.368	20.44**	14.21**	4.334**	0.713**	0.192**	1.213**	2.081**	0.679
Sk5002/10	1.076**	-9.226**	-7.913**	0.126	0.338	0.150**	0.713**	0.498	0.346
Sk5002/11	-1.035**	-6.559*	-7.080**	0.584	1.129**	0.025	0.254	0.331	1.346*
Sk5005/12	-0.576*	-4.892	-1.496	1.293*	0.338	0.150**	0.754**	1.540**	2.137**
Sk5005/13	0.506*	-0.767	3.669	0.584	-0.453*	0.109**	1.213**	-1.334*	-1.153*
Sk5005/16	0.339	7.899**	10.336**	1.290*	-0.495*	0.150**	0.171	-1.376*	3.637**
Sk5005/19	0.214	1.524	2.961	-4.998**	-0.328	-0.182**	-0.536**	-2.584**	-0737
Sk5005/21	-1.118**	-2.684	-4.121	0.001	-0.036	-0.182**	-0.953**	-2.668**	5.637**
Sk5007/21	-0.535*	-8.684**	-7.121**	-0.915	0.546**	-0.099*	-0.661**	1.123*	2.304**
Sk5008/25	-0.66*	-7.934**	-6.08*	-2.415**	-0.911**	-0224**	1.036**	-0.668	-1.028
Sk5008/26	-0.243	8.107**	15.419**	0.293	-0.370	0.025	-0.411*	-0.626	-0.737
Sk5009/27	-0.618*	-6.726*	-6.663*	-1.790**	0.254	-0.224**	-0.245	1.081	-4.612**
Sk5009/30	-1.993**	-8.476**	-8.08**	0.459	-0.536**	-0.099*	0.713**	-1.293*	0.096
Sk5009/31	-1.076**	-8.059**	-7.996**	0.793	0.254	-0.224**	-0.870**	-0.209	-0.237
Sk5011/40	0.589*	-8.142**	-9.913**	-0.581	-1.620**	0.150**	1.004**	0.790	-3.487**
Sk5012/42	0.548*	-3.851	-3.538	-0.081	-1.078**	0.275**	0.296	-1.418**	2.262**
Sk5047/49	-1.326**	-2.267	-11.288**	-3.498**	2.129**	0.025	-0.245	1.915**	2.304**
Sk5001/50	3.673**	18.94**	16.836**	2.584**	1.338**	0.109**	0.004	1.290*	3.387**
Sk5001/53	2.923**	14.815**	15.253**	-0.873	-0.245	0.109**	0.171	0.456	-1.112
Sk8001/57	0.173	-10.184**	-7.246**	-1.373*	-0.411*	-0.224**	0.629**	-0.043	-5.237**
Sk8203/61	1.423**	2.565	-0.996	1.006	0.379	0.025	-0.411*	-1.001	3.221**
Sk7070/62	-0.410	5.274	-3.163	1.293*	0.879**	-0.016	-0.245	0.581	0.012
Sk8008	0.022	-4.463**	0.076	-2.568**	0.099	0.101**	-0.737**	0.030	0.851
SC Sk74	-1.246**	-3.309**	-7.528**	0.157	-0.597**	0.057**	0.594**	-0.618**	-1.610**
Comp21	1.224**	7.772**	7.451**	2.411**	0.498**	0.043**	0.142	0.588**	0.759**
LSD$_{gi}$ 0.05	0.471	5.875	5.181	1.29	0.389	0.081	0.350	1.060	1.154
LSD$_{gi}$ 0.01	0.746	7.734	6.820	1.698	0.512	0.107	0.461	1.395	1.520
LSD$_{gt}$ 0.05	0.160	1.995	1.760	0.438	0.186	0.027	0.119	0.360	0.392
LSD$_{gt}$ 0.01	0.210	2.627	2.316	0.576	0.246	0.036	0.156	0.474	0.516

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

Table 6. Estimates of specific combining ability effects of 78 top crosses for all studied traits over the two locations

Hybrid	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernels (g)
Sk5001/1 x Sk8008	-0.439	3.171	5.214	2.027	-0.224	0.017	0.153	0.469	-0.350
Sk5001/1 x SC Sk74	-0.419	-0.982	-6.554	-0.323	0.097	-0.016	-0.302	-0.381	0.860
Sk5001/1 x Comp21	0.858*	-2.189	1.339	-1.703	0.126	-0.001	0.149	-0.088	-0.509
Sk5001/5 x Sk8008	-0.230	-2.786	-4.410	-0.639	0.192	0.059	-0.637*	-0.738	-0.767
Sk5001/5 x SC Sk74	-0.336	-2.190	-2.554	0.009	-0.360	0.025	0.405	-0.339	-0.306
Sk5001/5 x Comp21	0.567	4.977	6.964	0.629	0.168	-0.084	0.232	1.078	1.073
Sk5001/6 x Sk8008	0.029	-6.078	-2.410	-1.0639	-0.016	-0.149*	-0.591	-0.030	0.232
Sk5001/6 x SC Sk74	-0.586	1.142	2.695	1.257	0.181	0.067	0.572	-0.118	-1.306
Sk5001/6 x Comp21	0.567	4.935	-0.285	0.379	-0.165	0.081	0.024	-0.088	1.073
Sk5002/7 x Sk8008	-0.230	1.921	0.256	0.902	0.025	-0.107	-0.304	-0.072	0.100
Sk5002/7 x SC Sk74	0.788	1.267	2.612	0.176	-0.277	0.108	0.613*	-1.423	0.235
Sk5002/7 x Comp21	-0.557	-3.189	-2.868	-1.078	0.251	-0.001	-0.309	1.495	-0.134
Sk5002/9 x Sk8008	-0.564	6.588	8.548	-0.556	-0.016	-0.024	-0.054	-0.197	0.690
Sk5002/9 x SC Sk74	0.580	-6.315	-5.221	-2.657*	-0.193	-0.057	-0.136	-1.048	-0.722
Sk5002/9 x Comp21	-0.016	-0.272	-3.326	3.213*	0.209	0.081	0.190	1.245	0.032
Sk5002/10 x Sk8008	0.269	2.379	0.798	-0.347	-0.266	-0.107	0.320	-0.238	-1.850
Sk5002/10 x SC Sk74	0.538	-2.274	-2.221	-1.037	0.431	0.108	-0.511	0.410	0.360
Sk5002/10 x Comp21	-0.807	-0.105	1.423	1.421	-0.165	-0.001	0.190	-0.171	1.490
Sk5002/11 x Sk8008	-0.147	-1.286	-2.410	0.443	-0.182	0.017	0.403	0.427	-0.600
Sk5002/11 x SC Sk74	-0.128	-5.065	-0.054	0.592	-0.110	-0.141	-0.177	-0.923	1.610
Sk5002/11 x Comp21	0.275	6.352	2.464	-1.036	0.293	0.123	-0.225	0.495	-1.009
Sk5005/12 x Sk8008	0.644	-2.328	0.243	1.485	-0.266	-0.107	0.153	-0.530	-0.517
Sk5005/12 x SC Sk74	-0.086	0.017	1.862	-1.115	-0.193	-0.016	-0.052	0.868	0.318
Sk5005/12 x Comp21	-0.557	-3.689	-1.618	-0.370	0.459	0.123	-0.100	-0.338	0.198
Sk5005/13 x Sk8008	0.560	6.546	-0.214	-0.181	0.025	0.065	0.570	0.594	-0.725
Sk5005/13 x SC Sk74	-0.544	-5.857	1.820	1.342	-0.027	-0.099	-0.511	-0.631	-0.389
Sk5005/13 x Comp21	-0.016	-0.689	-2.035	-1.161	0.001	0.165*	-0.059	0.036	1.115
Sk5005/16 x Sk8008	-0.647	0.004	1.548	0.943	-0.182	0.017	0.737	-1.238	-1.017
Sk5005/16 x SC Sk74	-0.003	2.600	-4.346	0.967	0.264	-0.016	0.155	0.910	-0.056
Sk5005/16 x Comp21	0.650	-2.605	2.798	-1.911	-0.081	-0.001	-0.892**	0.328	1.073
Sk5005/19 x Sk8008	-0.522	-12.370*	-7.451	-1.472	-0.599	-0.149*	-0.304	-0.405	-0.392
Sk5005/19 x SC Sk74	-0.128	7.225	4.903	1.176	0.097	0.067	0.113	0.243	-0.556
Sk5005/19 x Comp21	0.650	5.144	2.548	0.296	0.501	0.081	0.190	0.161	0.948
Sk5005/21 x Sk8008	0.185	5.088	0.006	-0.597	0.108	0.100	0.362	0.802	-0.767
Sk5005/21 x SC Sk74	0.205	-4.815	-3.512	0.801	0.056	-0.057	-0.594	-0.048	-0.431
Sk5005/21 x Comp21	-0.391	-0.272	3.506	-0.203	-0.165	-0.043	0.232	-0.754	1.198
Sk5007/21 x Sk8008	0.227	-3.411	-1.243	0.193	0.150	0.017	0.195	1.261	-0.309
Sk5007/21 x SC Sk74	-0.003	1.059	-0.387	-0.407	-1.027**	-0.016	0.113	-1.839*	0.527

Table 6. Cont.

Hybrid	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernels (g)
Sk5007/21 x Comp21	-0.224	2.352	1.631	0.213	0.876*	-0.001	-0.309	0.578	-0.217
Sk5008/25 x Sk8008	-0.522	-7.911	-9.285*	-0.056	0.233	0.142*	-0.429	0.177	-0.475
Sk5008/25 x SC Sk74	0.371	2.809	1.695	-1.032	0.056	-0.141	0.113	0.201	1.110
Sk5008/25 x Comp21	0.150	5.102	7.589	1.088	-0.290	0.001	0.316	-0.379	-0.634
Sk5008/26 x Sk8008	-0.439	5.796	2.589	1.360	0.067	0.017	-0.054	0.261	-0.142
Sk5008/26 x SC Sk74	1.205*	-6.482	-5.304	-2.115	0.014	-0.016	-0.386	-0.214	0.943
Sk5008/26 x Comp21	-0.766	0.685	2.714	0.754	0.081	-0.001	0.440	-0.046	-0.801
Sk5009/27 x Sk8008	-0.064	-3.870	-1.951	-1.056	-0.432	0.142*	0.153	-0.447	-0.767
Sk5009/27 x SC Sk74	0.455	1.100	-0.596	2.342*	0.639	-0.016	-0.052	0.701	0.068
Sk5009/27 x Comp21	-0.391	2.769	2.548	-1.286	-0.206	-0.126	-0.100	-0.254	0.698
Sk5009/30 x Sk8008	-0.439	5.504	2.839	1.568	0.358	0.017	0.237	0.927	-0.350
Sk5009/30 x SC Sk74	0.205	-1.774	2.320	-0.532	0.056	0.108	-0.344	-1.423	0.985
Sk5009/30 x Comp21	0.233	-3.730	-5.160	-1.036	-0.415	-0.126	0.107	0.495	-0.634
Sk5009/31 x Sk8008	-0.480	4.838	8.256	0.235	0.567	0.017	0.028	1.469	0.232
Sk5009/31 x SC Sk74	-0.461	-9.690	-7.262	-0.740	-0.360	-0.106	-0.052	-1.006	-0.556
Sk5009/31 x Comp21	0.942	4.852	-0.993	0.504	-0.206	-0.001	0.024	-0.463	0.323
Sk5011/40 x Sk8008	0.727	1.921	0.423	1.485	0.942**	0.017	0.028	1.469	-0.142
Sk5011/40 x SC Sk74	-0.128	0.517	3.278	-1.740	-0.485	-0.016	0.447	-0.256	2.443*
Sk5011/40 x Comp21	-0.599	-2.439	-3.701	0.254	-0.456	-0.001	-0.475	-1.213	-2.301*
Sk5012/42 x Sk8008	0.394	4.504	4.298	-1.514	0.275	0.017	-0.387	-0.072	2.232*
Sk5012/42 x SC Sk74	-0.086	4.225	3.278	0.759	0.222	-0.141	0.280	0.951	-0.056
Sk5012/42 x Comp21	-0.307	-8.730	-7.576	0.754	-0.498	0.123	0.107	-0.879	-2.176*
Sk5047/49 x Sk8008	1.019*	-3.953	-4.576	-11.09**	-0.182	0.142*	0.403	-0.780	-0.059
Sk5047/49 x SC Sk74	-0.086	-0.732	-3.096	5.301**	-0.610	-0.016	-0.427	-0.506	-1.847
Sk5047/49 x Comp21	-0.932	4.685	7.673	5.796**	0.793*	-0.126	0.024	1.286	1.907
Sk5001/50 x Sk8008	0.269	3.338	3.673	3.193**	-0.516	-0.065	-0.346	-0.530	0.107
Sk5001/50 x SC Sk74	-0.086	0.934	4.653	6.032**	0.931**	0.025	0.572	1.743	-0.181
Sk5001/50 x Comp21	-0.182	-4.272	-8.326	2.838*	-0.415	0.040	-0.225	-1.213	0.073
Sk5001/53 x Sk8008	0.394	-4.786	-4.118	3.652**	0.432	-0.190**	-0.262	-1.197	1.232

Table 6. Cont.

Hybrid	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernels (g)
Sk5001/53 x SC Sk74	-1.211*	-0.815	-3.762	1.051	0.264	0.025	-0.344	0.951	-0.306
Sk5001/53 x Comp21	0.817	5.602	7.881	-4.703**	0.168	0.165*	0.607*	0.245	-0.926
Sk8001/57 x Sk8008	0.019	2.838	-0.493	-0.972	0.358	0.017	-0.471	-1.822	1.857
Sk8001/57 x SC Sk74	0.288	8.059	8.987*	2.051	-0.193	0.108	0.691*	1.076	-0.431
Sk8001/57 x Comp21	-0.307	-10.897*	-8.493	-1.078	-0.165	-0.126	-0.225	0.745	-1.426
Sk8203/61 x Sk8008	0.144	-8.536	-3.493	1.027	0.067	0.017	-0.304	0.886	1.024
Sk8203/61 x SC Sk74	-0.586	2.434	-0.262	1.051	0.264	0.108	0.488	1.035	-0.139
Sk8203/61 x Comp21	0.442	6.102	3.756	-2.07	-0.331	-0.126	-0.184	-1.921*	-0.884
Sk7070/62 x Sk8008	-0.147	2.879	3.423	1.610	-0.057	0.184*	0.403	-0.447	1.732
Sk7070/62 x SC Sk74	0.246	7.600	7.028	-1.119	0.264	0.025	-0.677*	0.826	-2.181*
Sk7070/62 x Comp21	-0.009	-10.480*	-10.415*	-0.495	-0.206	-0.209**	0.274	-0.379	0.448
$LSDS_{ij}$ 0.05	0.950	10.177	8.974	2.235	0.674	0.142	0.607	1.836	2.00
$LSDS_{ij}$ 0.01	1.251	13.396	11.813	2.942	0.887	0.187	0.799	2.417	2.633

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

Table 7. Phenotypic and genotypi. correlations among some important traits for F_1 hybrids from the combined data over the two locations

Traits	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row	Weight of 100 kernels (g)
Silking date (days)	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Plant height (cm)	0.565**	-	-	-	-	-	-	-	-
	-0.009	-	-	-	-	-	-	-	-
Ear height (cm)	0.649**	0.858**	-	-	-	-	-	-	-
	0.740**	0.887**	-	-	-	-	-	-	-
Grain yield (ard/fed)	0.161**	0.454**	0.313**	-	-	-	-	-	-
	0.184**	0.533**	0.355**	-	-	-	-	-	-
Ear length (cm)	0.292**	0.284**	0.230**	0.122*	-	-	-	-	-
	0.329**	0.342**	0.265**	0.123**	-	-	-	-	-
Ear diameter (cm)	0.205**	0.404**	0.215**	0.433**	-0.039	-	-	-	-
	0.241**	0.493**	0.246**	0.487**	-0.002	-	-	-	-
No. of rows/ear	-0.028	0.210	0.016	0.326**	-0.183**	0.715**	-	-	-
	-0.028	0.245**	0.013	0.369**	-0.203**	0.827**	-	-	-
No. of kernels/row	0.287**	0.223**	0.171**	0.193**	0.652**	0.151**	0.116*	-	-
	0.332**	0.310**	0.228**	0.230**	0.723**	0.131**	0.119*	-	-
Weight of 100 kernels (g)	0.232**	0.246**	0.246**	0.119*	0.439**	0.165**	-0.013	0.053	
	0.255**	0.286**	0.283**	0.123**	0.483**	0.187**	-0.017	0.064	

Where: Phenotypic correlation above and genotypic correlation below.

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

The magnitude the GCA x Loc interaction was higher than that of SCA x Loc for all studied traits except plant height, ear length and ear diameter. These results indicating that additive type of gene action was more influenced by environment than non additive gene action for these traits. These results are in agreement with those by El-Zeir (1999), El-Zeir *et al.*, (2000) and Amer *et al.*, (2002).

The general combining ability effects of inbred lines and testers for all studied traits over the two locations are presented in Table 5. The results revealed that the GCA effects showed desirable negative significant or highly significant values for 10 different inbred lines for silking date (earliness), plant height and ear height. The inbred lines Sk 5009/30 and Sk 5009/31 were the best for silking date, plant height (short plant) and ear height (short ear height). Also, the tester SC Sk 74 exhibited highly significant GCA effects for the same previous traits.

Highly significant value and desirable GCA effects were observed in the inbred lines, Sk 5001/6, Sk 5002/9, Sk 5005/12, Sk 5005/16, Sk 5001/50 and Sk 7070/62 for grain yield, Sk 5001/50 and Sk 5047/49 for ear length, Sk 5002/9 and Sk 5012/42 for ear diameter, Sk 5005/13 and Sk 5002/9 for number of rows/ear, Sk 5002/9 and Sk 5047/49 for number of kernels/row and Sk 5005/21 and Sk 5001/50 for weight of 100 kernels. Also, the results cleared that the parental tester Comp Sk-21 showed highly significant GCA effects for most studied traits.

The estimates of SCA effects of seventy eight top crosses for all studied traits over the two locations are presented in table (6.) The results indicated that the significant desirable SCA effects (negative) were obtained from the hybrids Sk 5001/53 x SC Sk 74 for earliness, Sk 7070/62 x Comp Sk 21, Sk 5005/19 x Sk 8008 and Sk 8001/57 x Comp Sk 21 for short plant height, Sk 5008/25 x Sk 8008 and Sk 7070/62 x Comp-Sk 21 for short ear height. Meanwhile, the top crosses (Sk 5047/49 x SC Sk 74, Sk 5047/49 x Comp. Sk 21 and Sk 5001/50 x SC Sk 74) had significant positive SCA effects for grain yield (Ard./Fed.), Sk 5011/40 x Sk 8008 for ear length, Sk 7070/62 x Sk 8008 for ear diameter, Sk 8001/57 x Sc Sk 74 for No. of rows/ear, Sk 5001/50 x Sc Sk 74 for No. of kernels/row and Sk 5011/40 x Sc Sk 74 for weight of 100 kernels. These crosses could be used as new hybrids or in a breeding program to improve these traits.

Phenotypic and genotypic correlation among some important traits for F_1 hybrids from the combined data over the two locations are shown in table 7. A positive phenotypic and genotypic correlations among most pairs of studied traits were recorded except for silking date with No. of rows/ear, ear height with No. of rows/ear, ear length with ear diameter and No. of rows/ear, and No. of rows/ear with weight of 100 kernels. In general, the results of this study cleared that most studied traits showed positive phenotypic and genotypic correlations between each other. These results could indicate that these traits may be linked to each other. In this respect similar results were obtained by many investigators among them (e.g.Nawar *and El -Hossary* ,1984; Khalid *et al.*, 1998); Aly 1999; Chaukan, 2000 and Vidal *et al.*, 2001).

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الملخص العربي

تقييم سلالات الذرة الصفراء الجديدة من خلال تحليل السلالة × الكشاف في منطقتين مختلفتين

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تم إجراء التهجين القمى بين ٢٦سلالة مختلفة المصادر الوراثية من الذرة الشامية الصفراء مع ثلاث كشافات الأول: متماثل وراثياً وهى(سلالة ٨٠٠٨) والثانى والثالث خليط وراثياً وهما الهجين الفردى سخا٧٤ والصنف التركيبى سخا٢١ خلال موسم النمو ٢٠٠٥ فى محطة البحوث الزراعية بسخا. تم تقييم جميع الهجن القمية الناتجة (٧٨ هجيناً) مع إثنين من الهجن التجارية وهما هـ. ف ١٥٥، هـ. ف ٣٠٨٤ فى محطات البحوث والتجارب الزراعية بسخا وسدس عام ٢٠٠٦.

كانت الإختلافات بين الموقعين عالية المعنوية لجميع الصفات المدروسة عدا صفة عدد الحبوب/ سطر.

كان تباين السلالات والكشافات وتفاعلهما معنوياً فى جميع الصفات المدروسة ما عدا تباين السلالة × الكشاف كان غير معنوى فى صفتى إرتفاع النبات وعدد الحبوب/ سطر. كان تباين السلالات × المواقع وتباين الكشاف × المواقع معنوياً فى كل الصفات المدروسة ما عدا عدد الحبوب/ سطر وكذلك صفة عدد السطور/ كوز بالنسبة لتباين الكشاف × المواقع. بينما كان تفاعل تباين السلالة × الكشاف × الموقع كان غير معنوياً فى كل الصفات المدروسة ما عدا قطر الكوز.

كان التباين الوراثى المضيف أكثر أهمية فى وراثة معظم الصفات المدروسة مثل صفة تاريخ ظهور ٥٠% من النورات المؤنثة، إرتفاع النبات، إرتفاع الكوز، طول الكوز، قطر الكوز، عدد السطور/ الكوز ووزن ١٠٠ حبة. بينما يلعب التباين الوراثى الغير المضيف دوراً هاماً فى وراثة صفات المحصول أردب/ فدان، وعدد الحبوب/ سطر.

أظهر التباين المظهرى والوراثى فروقاً معنوية وموجبة بين معظم الصفات المدروسة ما عدا صفة ظهور ٥٠% من النورات المؤنثة مع عدد السطور/ كوز، ارتفاع الكوز مع عدد السطور/ كوز، طول الكوز مع قطر الكوز وعدد السطور/ كوز، وعدد السطور/ كوز مع وزن ١٠٠حبة.

أظهرت متوسطات الهجن القمية لصفة محصول الحبوب وهى الهجين الثلاثى سخا ٥٠٠١/٦ × هـ. ف سخا ٧٤ (٣٤,٥ أردب/ فدان) والهجين الفردى سخا ٥٠٠١/٥٠ × سخا ٨٠٠٨ (٣٣,٦٣ أردب/ فدان) تتفوق فى محصولها عن هجين المقارنة هـ. ف ٣٠٨٤ (٣٢,٢٩ أردب/ فدان) وهـ. ف ١٥٥ (٣١,٣٢ أردب/ فدان) ولذلك يمكن إعتبار هذه الهجن متفوقة ومفيدة فى برامج التربية فى المستقبل.

أظهرت السلالات سخا ٥٠٠١/٦ وسخا ٥٠٠٢/٩ وسخا ٥٠٠٥/١٢ وسخا ٥٠٠٥/١٦ وسخا ٥٠٠١/٥٠ وسخا ٧٠٧٠/٦٢ فروقاً معنوية وموجبة (مرغوبة) لصفة محصول الحبوب والصفات الأخرى المدروسة.