ESTIMATION OF COMBINING ABILITY OF MAIZE INBRED LINES USING TOP CROSS MATING DESIGN

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ABSTRACT

Top crosses evaluation is used to determine the relative potential of maize inbred lines in a hybrid breeding program. Choice of tester is important for efficient selection among lines for their potential in hybrids. Nine new yellow maize inbred lines were top crossed with three testers i.e. two inbred lines (Gz653 and Gz654) and one single cross (Sk85)in 2007 growing season. Resulting 27 top crosses in addition to three commercial hybrids SC155, SC162 and TWC352 (as check varieties) were evaluated at Sakha and Sids Agriculture Research Station farms during 2008 growing season. Data were collected for number of days to 50% silking, plant height, ear height, grain yield and its components. Differences between the top crosses were found to be significant for all studied traits. Also, differences between check hybrids were significant only for days to 50% silking, grain yield, ear length and number of kernels/row. Meanwhile the contrast of top crosses vs. check hybrids was not significant for all traits.

Mean squares of lines, testers and lines x testers interaction were significant for all traits except those of lines for ear length and of testers for ear diameter and number of rows/ear. The additive genetic effects was most responsible for controlling the inheritance of all traits.

The inbred line tester Gz653 was capable of maximizing productivity of top crosses, express the widest range among crosses, best mean of the top cross and showed maximum variation in top crosses for most studied traits compared with other testers. Thus, the best tester for evaluating the inbred lines in top crosses for this study was the inbred line Gz653.

Best parental inbred lines which revealed desirable GCA effects were Sk10 for days to 50% silking, grain yield, ear diameter and number of kernels/row; Sk5027 for grain yield, ear diameter, number of rows/ear and number of kernels/row; Sk5026 for plant height and ear height, grain yield and number of rows/ear; Sk5002 for days to 50% silking, grain yield and number of rows/ear; and Sk8001 for plant height and number of rows/ear. While the best testers for GCA effects were Gz653 for grain yield, ear length and number of kernels/row and SC Sk85 for days to 50% silking, plant and ear heights.

Top crosses Sk5026 x Gz653 (37.03 ard/fed) and Sk5002 x Gz653 (38.76 ard/fed) exhibited similar grain productivity to that of check hybrid SC162 (38.21 ard/fed), since no significant differences. While top crosses Sk5002 x SC Sk85 (29.99 ard/fed), Sk10 x SC Sk85 (29.40 ard/fed). and Sk5027 x SC Sk85 (33.06 ard/fed.) were significantly outyielded the check hybrid TWC352 (22.81 ard/fed). It is recommended to benefit from these crosses in maize breeding programs.

INTRODUCTION

The national maize breeding of Egypt is adopting the policy of covering all the area devoted to maize with high yielding single and three way cross hybrids. Maize inbred lines are developed from segregating base populations due to self-pollination, through visual selection among and within ear-to-row progenies and testing for performance in hybrid combinations (Hallauer, 1990). Early testing relies on the assumption that the combining ability of a line is determined during the early stages of selfing and does not change substantially with continued inbreeding (Jenkins,1935 and Spargue, 1946). Bernardo (1991) found the effectiveness of early testing is limited mainly by non genetic effects. Because phenotypic correlations between early and late generation, top cross performance are expected to be < 1.0, early testing always involved some risk of discarding lines that would be genetically superior in top crosses at homozygosity. Top crossing have been used fairly widely for the preliminary evaluation of the combining ability of new inbred lines (Jenkins 1978), but there is no general agreement as to the best type of tester for this purpose. Matzinger (1953), Rawlings and Thompson (1962), Hallauer (1975), Hallauer and Miranda (1981), Russell *et al.* (1992) and Menz *et al.* (1999) concluded that the choice of a suitable tester should be based on simplicity in use, ability to classify the relative merit of lines, and maximizing genetic gain. However it is difficult to identify testers having all these characteristics. The use of the parental variety as a tester results in some improvement of the mean performance of the population (Rawlings and Thompson 1962). Allison and Curnow (1966) suggested the use of low-yielding varieties as tester. The use of a single cross as a tester has been reported by El-Ghawas (1963) and Horner *et al.* (1976). The use of an inbred line as a tester was suggested by Russell and Eberhart (1975) and it has been widely used by maize breeders (Walejko and Russell 1977, Darrah 1985 and Horner *et al.* 1989). Abel and Pollak (1991) suggested at least two (and perhaps more) divergent testers that contain an inherently high level of favorable alleles. Castellanos *et al.* (1998) studied 21 maize inbred lines and seven testers (five single crosses, one synthetic and one inbred line) to identify the best tester and concluded that the single cross was the best alternative in a breeding program oriented to generate superior three way and double cross hybrids.

The objectives of this study were :to determine the best tester for evaluating maize inbred lines, to identify inbred line superior in general combining ability effects, and determine the best single and three way crosses for use as commercial hybrids.

MATERIALS AND METHODS

The materials for this study consisted of nine new inbred lines i.e. Sk5026, Sk9215, Sk8008, Sk5002, Sk8001, Sk8008, Sk10, Sk5027 and Sk5029 developed at Sakha (Sk) Agricultural Research Station and three testers i.e. two inbred lines Gz653 and Gz654 developed at Giza ARS and promising single cross Sakha 85. In 2007 summer season, the 9 inbred lines were top crossed to each of the three testers. In 2008 summer season, resulting 27 top crosses and the three commercial check hybrids i.e. SC155, SC162 and TWC352 were evaluated in replicated yield trails conducted at two locations i.e. Sakha and Sids Agric. Res. Station. A randomized complete blocks design, with four replications was used at each location. The experimental plot trails consisted of one row, 6 m long and 0.8 m width. Planting was made in hills spaced at 0.25 m along the row at the rate of two kernels/hill later thinned to one plant per hill. All cultural practices were applied as recommended at the proper time. Data were taken for number of days to 50% silking, plant height (cm) and ear height (cm), grain yield ard/fed (1 ardab = 140 Kg, 1 feddan = 4200 m^2) adjusted to 15.5% moisture content and shelling percent , ear length (cm), ear diameter(cm), number of rows/ear and number of kernels/row. Analysis of variance was carried out for each location and when homogeneity of error mean squares for the two locations was proven , hence combined analysis of variance was done, according to Steel and Torrie (1980). The entries effect was assumed to be fixed while the locations effect was considered random in the analysis of variance. The procedure of Singh and Chaudhary (1979) was used for obtaining estimates of general and specific combining ability effects and variances.

RESULTS AND DISCUSSION

Combined analysis of variance of 30 entries for eight traits of maize over two locations is given in Table 1. Results showed that the differences between two locations (Loc) were highly significant for all studied traits except for number of kernels/row which was not significant. The source of variation for entries (E) was partitioned into, top crosses (C), checks (Ch) and (C vs Ch).Highly significant differences for (C) were detected for all studied traits, indicating that the tested top crosses varied from each other. The difference between check hybrids were highly significant for days to 50% silking and significant for grain yield, ear length and number of kernels/ row, meaning that the tested checks varied from each other for these traits. The contrast (C vs Ch) was not significant for all traits evaluated. The interaction (C x Loc.) was significant or highly significant for all traits, except for plant height and number of kernels/ row, indicating that the top crosses presented differential performance in the testing locations. The interactions; (Ch x Loc.) and (C vs Ch x Loc.) were not significant for all traits.

Table1: Combined analysis of variance for 30 entries for eight traits over two locations.

S.O.V.	d.f.	Days to 50% silking	Plant height	Ear height	Grain yield	Ear length	Ear diameter	No. of rows/ear	No. of kernels/row
Locations(Loc)	1	306.004**	104375.104**	21831.338**	2464.681**	177.848**	9.441**	164.04**	6.403
Rep/Loc	6	0.793	208.11	379.938	11.952	0.449	0.012	1.212	15.826
Entries (E)	29	47.475**	2336.449**	1134.72**	175.171**	18.727**	0.431**	11.878**	50.648**
Top crosses (C)	26	49.926**	2487.734**	1219.727**	157.266**	13.794**	0.457**	12.655**	40.534**
Checks (Ch)	2	38.375**	1529.167	536.542	486.66*	91.152*	0.047	7.647	206.372*
C vs Ch	1	1.949	17.603	120.894	17.723	2.135	0.523	0.138	2.164
E x Loc	29	1.996**	88.001	134.139**	21.001*	1.570**	0.05**	1.739**	7.312
C x Loc	26	2.201**	83.069	135.87**	20.858*	1.609**	0.051**	1.794**	7.483
Ch x Loc	2	0.292	87.5	127.792	25.613	1.182	0.020	1.820	5.662
C vs Ch x Loc	1	0.074	217.235	101.827	15.495	1.332	0.084	0.147	6.16
Error	174	0.750	77.653	69.139	11.744	0.793	0.026	0.750	5.636

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

Mean performance of the 30 entries (27 top crosses and the 3 check hybrids) for eight traits over two locations are presented in Table 2. For number of days to 50% silking the top crosses ranged from 56.87 days for top cross (Sk5002 x SC Sk85) to 66.25 days for top cross (Sk5029 x Gz653). Top crosses (Sk9215 x SC Sk85), (Sk8008/8 x SC Sk85),(Sk5002 x SC Sk85),(Sk8001 x SC Sk85), (Sk8008 x SC Sk85) and (Sk10 x SC Sk85)were significantly earlier than the check hybrid TWC352. For plant height, top crosses ranged from 250.0 cm for top cross (Sk8001 x SC Sk85) to 314.1 cm for top cross (Sk5029 x Gz653).Three top crosses (Sk5026 x SCSk 85),(Sk9215 x SCSk85)and (Sk8001 x SCSk85) were significantly shorter plants than those of the shortest check hybrid TWC352. Regarding to ear height, top crosses ranged from 138.5 cm for top cross (Sk5026 x SC Sk85) to184 cm for (Sk5027 x Gz654). Same three top crosses exhibiting shorter plant height were the only top crosses to possesses significantly lower ear placement compared to best performing check hybrid TWC352 . For grain yield, top crosses ranged from 21.56 ard/fed for (Sk5029 x SC Sk85) to 38.76 ard/fed for (Sk5002 x Gz653). Only two top crosses Sk5026 x Gz653 (37.03 ard/fed) and Sk5002 x Gz653 (38.76 ard/fed) were significantly outyielded the check hybrid SC155 (28.39 ard/fed), meanwhile, exhibited a similar performance to that of the highest yielding check hybrid SC162 (38.21 ard/fed), since no significant differences. Comparing top crosses of the single cross tester(SCSk85) to the check hybrid TWC352 indicated the superiority of only three top crosses Sk5002 x SC Sk85 (29.99 ard/fed), Sk10 x SC Sk85 (29.40 ard/fed) and Sk5027 x SC Sk85 (33.06 ard/fed). For ear length, top crosses ranged from 17.70 cm for (Sk8008 x Gz654) to 22.27cm for (Sk8008/8 x Gz653), while check hybrid SC162 possessed significantly longer ears than all other entries. Ear diameter, top crosses ranged from 3.82 cm for (Sk5029 x Gz653) to 5.05 cm for (Sk10 x Gz654). Number of rows/ear, top crosses ranged from 11.70 cm for (Sk5029 x Gz653) to 17.11cm for(Sk10 x Gz654). For number of kernels/row, top crosses ranged from 37.07 for (Sk8001 x SC Sk85) to 46.07 for (Sk5027 x Gz653), while the check hybrid SC162 possessed the highest number of kernels /row compared to all other entries.

Table 2: Mean performances of 30 entries (27 top crosses and 3 check hybrids) for eight traits over two locations.

Entries	Days to 50% silking	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/row
Sk5026 x Gz653	62.5	289.6	158.8	37.03	20.62	4.62	15.40	43.8
Sk5026 xGz654	62.5	285.6	160.1	32.94	18.90	5.02	16.80	40.4
Sk5026 xSC Sk85	59.62	255.6	138.5	23.36	18.95	4.60	16.80	40.5
Sk9215 x Gz653	64.12	284.6	159.6	31.88	21.25	4.42	14.05	42.2
Sk9215 xGz654	62.25	287.6	167.5	31.34	19.50	4.70	14.95	41.45
Sk9215 xSC Sk85	58.87	254.6	143.3	24.74	18.47	4.52	15.07	37.90
Sk8008/8 x Gz653	63.75	290.2	171.3	28.15	22.27	4.45	13.55	44.45
Sk8008/8 xGz654	60.62	277.2	165.0	26.51	18.60	4.60	14.20	39.67
Sk8008/8xSCSk85	57.75	256.3	147.6	24.89	18.85	4.57	14.85	39.77
Sk5002 x Gz653	61.12	292.0	165.8	38.76	21.42	4.42	14.90	43.00
Sk5002 xGz654	60.12	283.0	166.0	26.75	19.45	4.70	16.55	42.17
Sk5002 xSC Sk85	56.87	261.1	148.0	29.99	18.75	4.67	16.55	40.22
Sk8001 x Gz653	62.50	273.7	162.8	27.25	20.22	4.50	15.90	43.02
Sk8001 xGz654	61.50	274.2	159.2	24.97	19.47	4.50	15.40	41.50
Sk8001 xSC Sk85	57.62	250.0	143.2	24.81	17.77	4.67	17.10	37.07
Sk8008 x Gz653	63.37	301.3	178.5	30.23	20.42	4.57	15.05	41.97
Sk8008 xGz654	61.50	281.7	165.8	26.29	17.70	4.65	15.10	37.62
Sk8008 xSC Sk85	59.25	266.2	156.2	25.16	18.70	4.70	15.95	39.10
Sk10 x Gz653	60.87	297.1	159.6	35.93	22.20	4.72	14.65	46.02
Sk10 xGz654	60.25	296.2	156.1	33.04	19.77	5.05	17.11	41.00
Sk10 xSC Sk85	57.0	264.5	146.2	29.40	19.40	4.77	15.02	41.07
Sk5027 x Gz653	64.37	300.5	179.6	33.01	21.87	4.67	15.15	46.07
Sk5027 xGz654	64.25	301.7	184.0	28.85	19.17	4.92	16.15	40.40
Sk5027 xSC Sk85	60.75	285.2	166.3	33.06	19.77	5.02	16.75	42.12
Sk5029 x Gz653	66.25	314.1	180.7	24.62	22.07	3.82	11.70	41.05
Sk5029 xGz654	65.12	310.6	177.7	25.74	20.02	4.47	13.50	39.50
Sk5029 xSC Sk85	60.37	270.1	150.7	21.56	19.47	4.05	14.85	39.75
SC155 check	58.87	284.2	163.6	28.39	18.00	4.80	15.30	37.32
SC162 check	63.25	295.5	172.1	38.21	24.02	4.70	14.20	47.17
TWC352 check	60.87	268.0	155.7	22.81	18.37	4.85	16.15	40.10
$LSD_{0.05}$	1.41	9.19	11.58	4.58	1.25	0.22	1.31	2.70

Mean squares of line x tester analysis for 27 top crosses for eight traits over two locations are presented in Table 3. The source of variation for top crosses was partitioned into, lines (L), testers (T) and L x T interaction. Significant to highly significant differences were detected among (L), (T) and L x T interaction for all studied traits, except for ear length of lines (L) and for ear diameter and number of rows/ear of tester (T). This indicates that the inbred lines behaved differently in their respective top crosses, and that greater diversity exist between the two testers. Meanwhile, significant (L x T) interaction indicated that the inbred lines performed differently in their respective top crosses depending on the type of testers used for these traits. These results are in agreement with those conclusions reached by El-Itriby (1979).

Nawar and El-Hosary (1984), Habliza and Khalifa (2005) and Mosa *et al.* (2008). Mean squares due to (L x Loc) interaction were significant to highly significant for all traits except for plant height, grain yield and number of kernels/row. This means that the inbred lines performed differently as reflected in their respective top crosses from one location to another. Also, mean squares of (T x Loc) interaction were significant for ear length and ear diameter. While mean squares of (L x T x Loc) interaction were significant for grain yield and number of rows/ear.

Table 3: Line x Tester analysis of 27 top crosses for eight traits over two locations.

S.O.V.	d.f.	Days to 50% silking	Plant height	Ear height	Grain yield	Ear length	Ear diameter	No. of rows/ear	No. of kernels/row
Lines (L)	8	56.341**	2580.24**	1579.716*	238.21**	7.337	0.825**	24.714**	30.957*
LxLoc	8	4.362**	100.911	303.015**	13.834	2.873*	0.067*	1.97**	7.295
Testers(T)	2	396.463**	20006.056**	8465.907*	561.994*	132.001*	1.396	38.127	292.824*
TxLoc	2	0.963	151.796	137.852	29.57	2.537*	0.113*	5.016	15.42
LxT	16	3.400*	251.691**	133.959*	66.203*	2.247**	0.155**	3.442*	13.786*
LxTxLoc	16	1.275	65.557	52.05	23.281*	0.861	0.035	1.303*	6.584
Error	174	0.75	77.653	69.139	11.744	0.793	0.026	0.75	5.636

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

Estimates of the variance due to general combining ability (GCA), specific combining ability (SCA) and their interaction with locations for eight traits are shown in Table 4. The additive genetic effects (K^2GCA) seemed to have played an important role than non additive genetic effects (K^2SCA) in the expression of all studied traits. This result supports the findings of Nawar and El-Hosary (1984) for ear diameter and number of rows/ear; Mosa (2004) for ear height; El-Shenawy (2005) for silking date, ear length and grain yield; Motawei and Ibrahim (2005) for number of kernels/row; and Amer *et al.* (2002) for plant height. Estimates of σ^2GCA x Loc were higher than those of σ^2SCA x Loc for plant height, ear height, ear length and number of kernels/row. While estimates of σ^2SCA x Loc. were more than those of σ^2GCA x Loc for days to 50% silking, grain yield, ear diameter and number of rows/ear. Rojas and Sprague (1952), Lonnquist and Gardner (1961) and Shehata and Dhawn (1975), found that SCA x environment interaction was significantly larger than GCA x environment interaction .In other words, the non additive component of the genetic variation was more affected by the environment than additive component.

Matzinger *et al.* (1959),and Silva and Hallauer (1975) found that GCA x environment interaction was significantly larger than SCA x environment interaction, even though the variance estimate of SCA was more than that of GCA.

Table 4: Estimates of the variance due to general combining ability GCA, specific combining ability SCA and their interaction with locations for eight traits ,over two locations.

Genetic parameters	Days to 50% silking	Plant height	Ear height	Grain yield	Ear length	Ear diameter	No. of rows/ear	No. of kernels/row
K^2GCA	4.92	245.55	106.69	9.05	1.41	0.024	0.699	3.23
K^2SCA	0.265	23.266	10.23	5.365	0.174	0.015	0.267	0.935
$\sigma^2GCAxLoc$	0.117	2.27	8.739	0.436	0.101	0.002	0.126	0.301
$\sigma^2SCAxLoc$	0.131	0	0	2.88	0.017	0.003	0.138	0.167

Estimates of mean, range, best performing top cross and mean squares for eight traits for three testers as expressed by performance of their respective top crosses over two locations are presented in Table 5. The inbred line tester Gz653 exhibited the highest mean for all studied traits except ear diameter and number of rows/ear, also, showed the widest range for all traits except ear height and ear length. Comparing performance of the testers, inbred line Gz653 had the capability to produced best top crosses for grain yield, ear length and number of kernels/row, while inbred line tester Gz654 gave best top crosses for ear diameter and number of rows/ear. Meanwhile the single cross tester SC Sk85 produced best top crosses for number of days to 50% silking and plant and ear height, Moreover inbred line Gz653 as a tester showed the highest mean squares in other words maximum variation in its top crosses for all traits except number of days to 50% silking and plant height. Thus, it may be concluded that the best tester for evaluating inbred lines for current study was the inbred line Gz653. These results agree with those obtained by Allison and Curnow (1966) who defined the best tester as one that is capable of giving higher maximum grain yield of its top crosses. Darrah *et al.* (1972) and Horner *et al.* (1973) reported that genetic variance among test cross progenies using inbred testers was about twice as large as when broad-base testers were used. Russell and Eberhart (1975) suggested the use of inbred lines extracted from the reciprocal population as testers in reciprocal recurrent selection studies instead of the populations themselves. Moentono (1989) stated that an efficient tester is a tester which is capable of showing a greater range of variability of top cross hybrids performance. Such tester would give most precise and accurate classification among entries for a given amount of testing.

Table 5: Estimates of mean, range, best performing top cross and mean squares for eight traits for each of three testers as expressed by performance of their respective top crosses over two locations.

Tester	Variable	Days to 50% silking	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/ row
Gz653	Mean of top crosses	63.20	293.70	168.56	31.87	21.37	4.46	14.48	43.51
	Range	5.37	40.37	21.87	14.13	2.05	0.90	4.20	5.02
	Best top cross	60.87	273.75	158.87	38.76	22.27	4.725	15.9	46.07
	M.S.	22.54	1045.61	670.69	182.11	5.02	0.56	12.60	24.46
Gz654	Mean of top crosses	62.01	288.68	166.84	28.49	19.17	4.73	15.52	40.41
	Range	5.00	36.37	27.87	8.06	2.32	0.55	3.60	4.56
	Best top cross	60.12	274.25	156.13	33.04	20.02	5.05	17.11	42.17
	M.S.	24.08	1139.31	636.3	80.45	3.93	0.36	11.90	14.85
SC Sk85	Mean of top crosses	58.68	262.65	148.98	26.33	18.90	4.67	15.88	39.72
	Range	3.75	20.125	27.88	11.50	2.00	0.52	2.25	4.22
	Best top cross	56.87	250.00	138.50	33.06	19.77	5.02	17.10	42.12
	M.S.	16.44	898.45	540.38	107.97	2.85	0.20	7.05	19.15

Estimates of general combining ability effects of nine inbred lines for eight traits over two locations are presented in Table 6. The best inbred lines for general combining ability effects were Sk5002 and Sk10 for earliness; Sk5026, Sk9215, Sk8008/8 and Sk8001 for short plant height; Sk5026 for short ear height;Sk5026, Sk5002, Sk10 and Sk5027 for grain yield; Sk5029 for ear length; Sk10 and Sk5027 for ear diameter; Sk5026, Sk5002, Sk8001 and Sk5027 for number of rows/ear; and Sk10 and Sk5027 for number of kernels/row.

Table 6: Estimates of general combining ability effects of nine inbred lines for eight traits over two locations.

Line	Days to 50% silking	Plant height	Ear height	Grain yield	Ear length	Ear diameter	No. of rows/ear	No. of kernels/row
Sk5026	0.241	-4.722*	-8.967*	2.138*	-0.347	0.055	1.041*	0.393
Sk9215	0.449	-6.055*	-4.634	0.388	-0.097	-0.028	-0.708*	-0.689
Sk8008/8	-0.593	-7.055*	-0.134	-2.361*	0.069	-0.069	-1.125*	0.06
Sk5002	-1.926*	-2.972	-1.509	2.972*	0.111	-0.027	0.666*	0.602
Sk8001	-0.759	-15.680*	-6.342	-3.277*	-0.639	-0.027	0.833*	-0.689
Sk8008	0.074	1.444	5.407	-1.569	-0.888*	-0.28*	0.125	-1.606*
Sk10	-1.927*	4.278	-7.301	3.931*	0.611	0.222*	0.375	1.518*
Sk5027	1.824*	14.153*	15.199*	2.722*	0.444	0.222*	0.708*	1.601*
Sk5029	2.616*	16.61*	8.282*	-4.944*	0.736	-0.319*	-1.916*	1.189
LSD gL0.05	0.96	4.71	8.18	1.74	0.78	0.11	0.64	1.26

* Significant at 0.05 level of probability.

Estimates of general combining ability effects of the three testers for eight traits over two locations are shown in Table 7. The best testers for determining general combining ability effects were inbred line Gz653 for grain yield, ear length and number of kernels/row; and single cross SC Sk85 for earliness and shorter plant type. The superiority of inbred lines as good testers was noticed by several investigators among them Russell and Eberhart (1975), Darrah (1985), Horner *et al.* (1989) and Al-Naggar *et al.* (1997). While the superiority of single crosses as good testers was reported by El-Ghawas (1963), Horner *et al.* (1976) and El-Shenawy and Mosa (2005).

Table7: Estimates of general combining ability effects of three testers for eight traits over two locations.

Tester	Days to 50% silking	Plant height	Ear height	Grain yield	Ear length	Ear diameter	No. of rows/ear	No. of kernels/row
Gz653	1.907*	12.028*	7.102*	2.958*	1.555*	-0.152*	-0.791	2.324*
Gz654	0.713*	7.00*	5.379	-0.389	-0.638	0.111	0.222	-0.828
SCSk85	-2.620*	-19.028*	-12.481*	-2.569	-0.917*	0.041	0.569	-1.496
LSD g_t 0.05	0.47	6.23	5.93	2.7	0.77	0.12	1.11	1.97

* Significant at 0.05 level of probability.

Estimates of specific combining ability effects of the 27 top crosses for eight traits over the two locations are presented in Table 8. The desirable SCA effects were obtained for the crosses Sk8008 x Gz654, Sk5027 x Gz653 and Sk5029 x SC Sk85 for plant height; Sk5002 x Gz653 and Sk5027 x SC Sk85 for grain yield; Sk8001 x Gz654 for ear length; Sk5026 x Gz654, Sk9215 x Gz654, Sk5002 x SC Sk85, Sk8001 x SC Sk85, Sk8008 x Gz653 and Sk5029 x SC Sk85 for ear diameter; and Sk10 x Gz654 and Sk5029 x SC Sk85 for number of rows/ear.

Table 8: Estimates of specific combining ability effects of 27 top crosses for eight traits over two locations.

Top cross	Days to 50% silking	Plant height	Ear height	Grain yield	Ear length	Ear diameter	No. of rows/ear	No. of kernels/row
Sk5026 x Gz653	-0.949	0.638	-0.726	2.833	-0.472	-0.097	-0.166	-0.074
Sk5026 xGz654	0.245	1.666	2.245	2.305	-0.027	0.263*	0.319	-0.296
Sk5026 xSC Sk85	0.704	-2.305	-1.518	-5.138*	0.500	-0.166*	-0.152	0.370
Sk9215 x Gz653	0.467	-3.027	-4.310	-0.541	-0.097	-0.013	0.208	-0.615
Sk9215 xGz654	-0.212	5.00	5.287	2.555	0.347	0.222*	-0.055	1.787
Sk9215 xSC Sk85	-0.254	-1.972	-0.976	-2.013	-0.250	-0.208*	-0.152	-1.171
Sk8008/8 x Gz653	1.134*	3.597	2.939	-1.291	0.736	0.027	0.125	1.0092
Sk8008/8 xGz654	-0.796	-4.375	-1.712	0.305	-0.569	0.013	-0.138	-0.962
Sk8008/8xSCSk85	-0.337	0.777	-1.226	0.986	-0.166	-0.041	0.013	-0.046
Sk5002 x Gz653	-0.157	1.263	-1.185	3.875*	-0.055	-0.138	-0.291	-1.032
Sk5002 xGz654	0.037	-2.708	0.662	-4.652*	0.138	-0.027	0.319	1.120
Sk5002 xSC Sk85	0.120	1.444	0.523	0.777	-0.083	0.166*	-0.027	-0.087
Sk8001 x Gz653	0.050	-4.277	0.648	-1.250	-0.430	0.111	0.666	0.134
Sk8001 xGz654	0.245	1.250	-1.254	-0.277	1.013*	-0.277*	-1.097*	1.787
Sk8001 xSC Sk85	-0.296	3.027	0.606	1.527	-0.583	0.166*	0.430	-1.921*
Sk8008 x Gz653	0.092	6.222	4.523	0.041	0.069	0.236*	0.500	0.050
Sk8008 xGz654	-0.587	-8.375*	-6.379	-0.611	-0.611	-0.152*	-0.388	-1.171
Sk8008 xSC Sk85	0.495	2.152	1.856	0.569	0.541	-0.083	-0.111	1.120
Sk10 x Gz653	-0.407	-0.861	-1.643	0.166	0.069	0.111	-0.125	1.050
Sk10 xGz654	0.162	3.291	-3.421	0.638	0.013	-0.027	1.236*	-0.921
Sk10 xSC Sk85	0.245	-2.430	5.064	-0.805	-0.083	-0.083	-1.111*	-0.129
Sk5027 x Gz653	-0.657	-7.361*	-4.143	-1.625	0.111	-0.013	-0.083	0.842
Sk5027 xGz654	0.412	-1.083	1.953	-2.402	-0.569	-0.027	-0.097	-1.504
Sk5027 xSC Sk85	0.245	8.444*	2.189	4.027*	0.458	0.041	0.180	0.662
Sk5029 x Gz653	0.425	3.805	3.898	-2.208	0.069	-0.222*	-0.833	-1.365
Sk5029 xGz654	0.495	5.333	2.620	2.138	0.263	0.013	-0.097	0.162
Sk5029 xSC Sk85	-0.921	-9.138*	-6.518	0.069	-0.333	0.208*	0.930*	1.203
LSD S_{ii} 0.05	1.06	6.58	8.42	3.30	0.90	0.14	0.88	1.88

* Significant at 0.05 level of probability.

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الملخص العربى

تقدير القدرة على الائتلاف لسلالات من الذرة الشامية باستخدام طريقة الهجن القمية

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تستخدم الهجن القمية فى برنامج التربية لمعرفة القدرة الائتلافية للسلالات. ومن المهم اختيار الكشاف المناسب لفاعلية الانتخاب مابين السلالات ومعرفة كفاءتها فى الهجن.

تم تهجين ٩ سلالات صفراء جديدة من الذرة الشامية مع ثلاثة كشافات سلالتين(جيزة ٦٥٣وجيزة ٦٥٤) وهجين فردى (سخا ٨٥) فى موسم ٢٠٠٧.تم تقييم ٢٧ هجين قمى الناتجة مع ثلاثة من الهجن التجارية فى محطتي بحوث سخا وسدس فى موسم ٢٠٠٨. أخذت النتائج على صفات تاريخ ظهور حرائر ٥٠% من النورات المؤنثة وارتفاع النبات والكوز كذلك لصفة المحصول ومكوناته.

كانت الاختلافات بين الموقعين كذلك بين الهجن القمية عالية المعنوية لجميع الصفات المدروسة بينما معنوية الاختلافات بين الهجن التجارية كانت فقط لصفات تاريخ ظهور حرائر ٥٠% من النورات المؤنثة و محصول الحبوب وطول الكوز وعدد الحبوب بالصف. بينما كانت الاختلافات ما بين الهجن القمية فى مقابل الهجن التجارية غير معنوية لجميع الصفات. اظهرت مجزئات الهجن القمية، السلالات، الكشافات وتفاعل السلالات x الكشافات معنوية. لجميع الصفات ما عدا السلالات لصفة طول الكوز والكشافات لصفة قطر الكوز وعدد السطور بالكوز .كان الفعل الوراثي المضيف للجين هو الأكثر تحكما فى وراثة جميع الصفات. أعطت السلالة الكشاف جيزة ٦٥٣ اعلى متوسط فى

الهجن القمية الداخلة فى تكوينها كذلك اكبر مدى بين هجنها القمية المختبرة وأفضل الهجن الناتجة كذلك اكبر تباين فى هجنها فى معظم الصفات مقارنة بالكشافات الاخرى. مما يجعلنا نقترح أفضلية السلالة ككشاف.

تبين ان أفضل السلالات فى القدرة العامة على الائتلاف كانت السلاله سخا ١٠ لصفات تاريخ ظهور حرائر ٥٠% من النورات المؤنثة ومحصول الحبوب وقطر الكوز وعدد الحبوب فى الصف وسلاله سخا ٥٠٢٧ لصفات محصول الحبوب ، قطر الكوز ، عدد الصفوف بالكوز وعدد الحبوب بالصف وسلاله سخا ٥٠٢٦ لصفات ارتفاع النبات والكوز ومحصول الحبوب وعدد الصفوف بالكوز وسلاله سخا ٥٠٠٢ لصفات تاريخ ظهور حرائر ٥٠% من النورات المؤنثة ومحصول الحبوب وعدد الصفوف بالكوز وسلاله سخا ٨٠٠١ لصفات ارتفاع النبات وعدد الصفوف بالكوز. بينما أفضل الكشافات فى القدرة العامة على الائتلاف كانت السلاله الكشاف جيزة ٦٥٣ لصفات محصول الحبوب وطول الكوز وعدد الحبوب بالكوز والكشاف هـ.ف سخا ٨٥ لصفات تاريخ ظهور حرائر ٥٠% من النورات المؤنثة وارتفاع النبات والكوز. الهجن القمية سخا٥٠٢٦ x جيزة ٦٥٣ (٣٧,٠٥ اردب/فدان) سخا٥٠٠٢ x جيزة ٦٥٣ (٣٨,٧٦ اردب/فداب) لا تختلف معنويا عن الهجين التجارى هـ.ف١٦٢ (٣٨,٢١ اردب/فدان) بينما الهجن القمية سخا ٥٠٠٢ x هـ.ف سخا ٨٥ (٢٩,٩٩اردب/فدان) وسخا ١٠ x هـ.ف سخا ٨٥ (٢٩,٤٠ اردب/فدان) وسخا ٥٠٢٧ x هـ.ف سخا٨٥ (٣٣,٠٦ اردب/فدان) تزيد معنويا فى محصولها عن هجين المقارنة هـ.ث ٣٥٢ (٢٢,٨١ اردب/فدان) ولذلك توصى هذه الدراسة باستخدام هذه الهجن الفردية والثلاثية فى برنامج التربية للهجن عالية المحصول.