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GENE ACTION AND COMBINING ABILITY FOR GRAIN YIELD AND OTHER ATTRIBUTTES IN YELLOW MAIZE

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ABSTRACT

Fifteen yellow maize inbred lines in the S_3 generation were topcrossed to each of three inbred line testers, viz. Gz-638, Gz-649 and Gm-1004 during 2006. Forty-eight entries (45 topcrosses and 3 check hybrids, SC. 155, SC. 3084 and SC. 3080) were evaluated at Sids and Sakha Agric. Res. Stns, ARC in 2007 for days to 50% silking, plant and ear height, number of ears 100 plant^{-1} and grain yield (ard/fad.) Mean squares due to crosses, lines (L), testers (T) and lines x testers were significant for all studied traits at each location and across locations, except for grain yield of testers and L x T at Sakha and for number of ears 100 plants^{-1} and grain yield of L x T at Sids. Highly significant differences were detected among locations for all studied traits, indicating that the two locations differed in their environmental conditions. In addition, the mean squares due to interaction of crosses and location (Loc) was significant for silking date, ear height and grain yield. Variance due to Loc. x Lines interaction was significant for all the studied traits, except for ears 100 plants^{-1}. Mean squares due to Loc x tester interaction were significant for ear height and grain yield. The variance due to interaction of L x T x locations showed no significance for all studied traits. Top crosses (L-4 x Gz-649), (L-4 x Gm-1004), (L-7 x Gz-638) and (L-7 x Gz-649) significantly outyielded SC. 155 (the best check) by 12.88, 10.81, 17.75 and 13.87%, respectively. The best GCA effects for grain yield were obtained by lines L-4, L-7, L-8 and L-12. These lines should be utilized in breeding programs to developed high yielding hybrids Crosses (L-1 x Gz-638), (L-4 x Gm-1004) and (L-5 x Gm-1004) showed significant positive SCA effects for grain yield. The magnitude of σ^2_{GCA} was larger than σ^2_{SCA} for all studied traits, except for ear height. The variance due to interaction of σ^2_{GCA} x Loc was greater than that of σ^2_{SCA} x Loc for all studied traits, except for days to 50% silking, indicating that the additive type of gene action is more affected by environmental conditions than the non-additive type of gene action for these traits.

Key words: ***Maize, Top crosses, Combining ability, Gene action.***

INTRODUCTION

Topcross (test cross) method using broad and/or narrow base testers is used to evaluate newly developed inbred lines for combining ability in maize hybrid breeding programs. Procedures for developing and improving inbred lines of maize were reported by Bauman (1981) and Hallauer and Miranda (1981) who concluded that improved inbred lines increased grain yield and maturity. Topcross procedure was first suggested by Davis (1927) as an early testing to determine the usefulness of an inbred for hybrid development programs. The concept of general (GCA) and specific (SCA) combining ability was firstly defined by Sprague and Tatum (1942). They and other investigators (Hassaballa *et al* 1980, El-Morshidy and Hassaballa 1982, Mahmoud 1996, Konak *et al* 1999 and Zelleke 2000) reported that the variance components due to SCA for grain yield and other agronomic traits was larger than that due to GCA, indicating the importance of non-additive type of gene action in the inheritance of these traits. Mathur *et al* (1998) found significant GCA variances for days to 50% silking, ear length, number of rows/ear and number of kernels/row, whereas SCA variance was significant for only ear length. Abd El-Moula and Ahmed (2006) found that, in two sets of topcrosses, variances due to GCA were larger than those of SCA for plant and ear height in set I, while the variances due to SCA were higher for silking date and grain yield. Also, the variances due to GCA x Loc and SCA x Loc were higher in magnitude for grain yield, silking date, ear height and ears/100 plants in set I. This indicates that the non-additive gene effect was more affected by location than the additive gene type. Amer and El-Shenawy (2007) reported that the additive genetic variance played an important role in the inheritance of grain yield and silking date while the non-additive genetic variance played an important role in the inheritance of plant height. The magnitude of the interaction between SCA with location was higher than that of GCA x location for grain yield and plant height. Soliman *et al* (2007) reported that the magnitude of the dominance variance was the major source of the total genetic variance responsible for the inheritance of grain yield. On the other hand, Hede *et al* (1999), Nass *et al* (2000), El-Zeir *et al* (2000) and El-Morshidy *et al* (2003) obtained significant GCA x Environments interaction for both lines and testers for grain yield.

The main objectives of this investigation were to: (1) evaluate 45 topcrosses (15 lines x 3 testers) for grain yield and other agronomic traits, 2) estimate GCA effects for both lines and testers as well as SCA effects for crosses, and 3) estimate variances due to GCA and SCA (σ^2GCA and σ^2SCA) and their interactions with location.

MATERIALS AND METHODS

Fifteen yellow selected maize inbred lines in the S_3 generation (L-1 through L-15) derived from a wide genetic base population (Puerto Rico Group 5 # 218) through selection in the disease nursery field at Sids Agric. Res. Stn., were used for the purpose of this study. In 2006 growing season, the 15 lines were topcrossed to each of three narrow base inbred lines, i.e. Gz-638, Gz-649 and Gm-1004 at Sids Exp. Stn. The three inbred testers are currently used in seed production of commercial single and three way cross hybrids. In 2007 growing season, the 45 resultant topcrosses along with three commercial check hybrids; i.e. S.C. 155, S.C. Pioneer 3084 and S.C.Pioneer 3080 were evaluated in replicated yield trials conducted at Sakha and Sids Agric. Res. Stns. The experimental design was a randomized complete block design with four replications. Plot size was one row, 6 m long and 80 cm apart. Sowing was in hills spaced at 25 cm along the row, at the rate of two kernels per hill and later thinned to one plant per hill to provide a plant population density of approximately 22000 plants/faddan (Faddan = 4200 m^2). All cultural practices for maize production were applied as recommended. Data were recorded for number of days to 50% silking, plant height (cm), ear height (cm), number of ears/100 plants and grain yield (adjusted to 15.5% moisture content) and converted to ardabs/faddan (one ard=140 kg). Analysis of variance was performed for separate locations, and for the combined data over locations according to Steel and Torrie (1980). Combining ability and types of gene effects were computed for all studied traits according to Kempthorne (1957) as outlined by Singh and Chaudhary (1979).

RESULTS AND DISCUSSION

Analysis of variance

Mean squares presented in Table (1) revealed that differences among crosses were highly significant for all traits at both locations and combined across locations. Partitioning the sum of squares due to crosses into its components showed that mean squares due to lines and testers were highly significant for all traits at both locations and combined data, except those of testers for grain yield at Sakha. These results indicate the presence of wide diversity among studied testers and lines in their contribution to the performance of topcrosses. However, mean squares due to lines x testers interaction were highly significant for all studied traits, except for number of ears 100 $plants^{-1}$ at Sakha and grain yield at both locations and combined across locations. This indicated that the lines (L) females differed in their performance in crosses with each of the testers (T) males. Highly significant differences were detected among locations (Loc) for all studied traits, indicating that the two locations differed in their environmental conditions. In addition, the interaction of Loc. x crosses was significant for days to 50% silking, ear height and grain yield. Loc x Lines interaction was also significant for all studied traits, except that of number of ears 100 $plants^{-1}$. Loc x testers interaction was significant for ear height and grain yield. Loc x L x T interaction showed no significance for all studied traits.

The significant interactions with locations may be attributed to the different ranking of genotypes from one location to another. The obtained results also clarified that it is worthwhile to evaluate topcrosses under more variable environments (locations) especially for grain yield. This would help in deciding which hybrids can be recommended for certain environments. Similar results were obtained by El-Itriby *et al* (1990), Salama *et al* (1995), Soliman *et al* (1995), Mahgoub *et al* (1996) Shehata *et al* (1997) , El-Zeir *et al* (1999), Soliman and Sadek (1999), El-Zeir *et al* (2000) Soliman (2000) and El-Morshidy *et al* (2003).

Table 1. Mean squares for grain yield and other agronomic traits at Sakha and Sids and over locations in 2007 season.

S.O.V	d.f.	MS				
		Days to 50%Silking	Plant height	Ear height	Ears/100 plants	Grain yield
Sakha						
Replications	3	4.57	482.73	162.11	177.47	73.83
Crosses	44	7.19**	747.20**	515.94**	295.52**	42.761**
Lines (L)	14	9.38**	1906.73**	1297.42**	533.31**	100.22**
Testers (T)	2	48.02**	568.16**	199.44*	528.99**	4.29
L x T	28	3.18**	180.22*	147.81*	161.37*	17.22
Error	132	1.13	103.28	82.44	100.76	10.10
C.V%		2.02	3.89	6.18	9.44	13.12
Sids						
Replications	3	19.03	283.03	126.66	114.84	51.89
Crosses	44	6.59**	832.91**	848.76**	130.60**	56.70**
Lines (L)	14	9.33**	2086.89**	2279.03**	175.07**	97.60**
Testers (T)	2	49.74**	876.22**	432.29*	612.10**	330.89**
L x T	28	2.13**	201.26*	163.37*	74.96	16.15
Error	132	0.94	108.09	94.04	71.28	8.66
C.V%		1.54	4.11	6.68	8.35	10.96
Combined						
Locations (Loc)	1	8.71**	6308.47**	311.74	2579.24**	67.58**
Rep/L	6	11.80	382.88	144.38	145.00	62.58
Crosses(C)	44	11.79**	1441.42**	1215.99**	337.66**	68.66**
Lin(L)	14	15.79**	3741.38**	3270.02**	582.97**	152.89**
Testers (T)	2	95.89**	1290.77**	291.26*	1102.22**	203.48**
L x T	28	3.78**	302.20**	255.03**	159.99**	16.91
C x Loc	44	1.99*	137.69	148.71**	90.32	30.76**
L x Loc	14	2.92**	252.25**	306.43**	125.41	44.93**
T x Loc	2	1.87	153.60	340.47*	38.87	131.71**
L x T x Loc	28	1.53	79.28	56.15	76.34	16.46
Pooled Error	264	1.03	105.68	88.24	86.06	9.38
C.V%		1.80	4.00	6.43	8.94	12.00

*& ** Significant at 0.05 and 0.01 level of probability, respectively.

The magnitude of variances due to lines was higher than that due to testers for all studied traits, except number of days to 50% silking at Sakha, Sids and combined data, number of ears 100 plant^{-1} and grain yield at Sids and combined data, indicating that the lines contributed much more to the total variation than the testers for these traits (Table 1). Based on the combined data, the variance due to Loc x lines was higher than that of Loc x testers for number of days to 50% silking, plant height and number of ears 100 plants^{-1}. This indicates that the lines were more affected by the environmental conditions than the testers. However, Loc x testers interaction was higher in its magnitude than that of Loc x lines for ear height and grain yield, indicating that the testers were more affected by the environmental conditions than the lines for such traits. Similar results were obtained by Gado *et al* (2000), Soliman (2000), Soliman *et al* (2001), Sadek *et al* (2002).and El-Morshidy *et al* (2003).

Mean performance

Mean performance of the 45 topcrosses along with the check varieties for the studied traits are presented in Table (2). For number of days to 50% silking, the earliest crosses were L-11 x Gz 649 (60.8 days), L-8 x Gz 638 (60.3 days) and L-8 x Gz 638 (60.9 days) at Sakha, Sids and combined across locations, respectively. On the contrary, the latest crosses were L-4 x Gm 1004 (66.0 days), L-7 x Gm 1oo4 (65.5 days) and L-7 x Gm 1004 (65.3 days) for the same locations and combined across locations, respectively. Out of the 45 topcrosses, 15, 9 and 15 crosses were significantly earlier than the earliest check (S.C. 155) at Sakha, Sids and combined across locations, respectively.

Plant height ranged from 226.3 to 289.5 cm at Sakha, from 229.0 to 294.8 cm at Sids and from 227.6 to 290.9 cm across locations, with cross (l-14 x Gm-1004) possessing the shortest plants at both locations. Meanwhile, minimum plant height was recorded for cross (L-8 x Gz-649) at Sakha, and for cross (L-7 x Gz-649) at Sids and across locations. Out of the 45 crosses, 25 crosses were significantly shorter than the shortest checks S.C. Pion 3080, for across location performance.

Respecting ear height, the lowest ear placement was for the crosses L-14 x Gz-649 (117.8 cm) at Sakha, L-14 x Gm-1004 (117.8 cm) at Sids, and both L-14 x Gz-649 and L-14 x Gm-1004 (119.1 cm) across locations. In contrast, the highest ear placement was recorded for the crosses L-8 x Gm-1004 (175.3 cm) at Sakha, L-7 x Gz-649 at Sids and across locations (188.8 and 179.6 cm, respectively). There were 3, 8 and 6 crosses exhibiting significantly lower ear placement than the lowest check S.C. Pion 3080 at Sakha, Sids and across locations, respectively.

Regarding number of ears 100 plants^{-1}, the lowest value was 94.8 for (L-9 x Gz-638) at Sakha, 89.2 and 95.0 for the cross (L-14 x Gm-1004) at Sids and across locations, respectively. However, the highest value of ears 100 plants^{-1} was recorded for the cross L-15 x Gz-649 at the two locations and combined (130.8, 119.2 and 125.0 ears 100 plants^{-1}, respectively). There were 3, 2 and 4 crosses at Sakha, Sids and across locations, respectively, which significantly surpassed the highest check hybrid S.C. 155 for number of ears 100 plants^{-1}.

Table 2. Average performance of 45 topcrosses for grain yield and other studied traits at Sakha (SK), Sids (SD) and combined across locations (Com.) in 2007 growing season

Crosses	Days to 50% silking			Plant height			Ear height		
	SK	SD	Com	SK	SD	Com	SK	SD	Com
L- 1 x Gz-638	62.5	63.0	62.8	256.5	253.8	255.1	140.8	140.8	140.8
L- 2 x Gz-638	61.8	61.8	61.8	260.5	248.3	254.4	140.8	138.3	139.5
L- 3 x Gz-638	62.8	61.5	62.1	268.0	248.0	258.0	150.0	138.8	144.4
L- 4 x Gz-638	63.0	62.0	62.5	261.8	247.5	254.6	151.8	134.8	143.3
L- 5 x Gz-638	64.0	63.0	63.5	274.0	260.5	267.3	146.8	150.3	148.5
L- 6 x Gz-638	63.5	61.3	62.4	266.5	256.5	261.5	138.8	145.8	142.3
L- 7 x Gz-638	63.0	64.0	63.5	280.5	289.0	284.8	160.0	176.5	168.3
L- 8 x Gz-638	61.5	60.3	60.9	282.3	271.0	276.6	155.8	162.5	159.1
L- 9 x Gz-638	62.8	62.8	62.8	262.0	250.8	256.4	146.3	146.5	146.4
L-10 x Gz-638	63.5	62.3	62.9	268.0	252.5	260.3	151.0	146.3	148.6
L-11 x Gz-638	61.8	61.8	61.8	258.8	245.8	252.3	144.3	134.5	139.4
L-12 x Gz-638	61.5	60.8	61.1	258.5	245.3	251.9	138.8	137.5	138.1
L-13 x Gz-638	61.5	60.5	61.0	260.5	248.8	254.6	141.0	139.8	140.4
L-14 x Gz-638	62.3	62.3	62.3	236.8	234.8	235.8	126.5	123.3	124.9
L-15 x Gz-638	62.3	62.8	62.5	260.0	248.3	254.1	144.0	145.5	144.8
L- 1 x Gz-649	63.3	63.0	63.1	246.3	252.0	249.1	138.5	144.3	141.4
L- 2 x Gz-649	64.3	64.0	64.1	263.3	249.5	256.4	142.5	140.5	141.5
L- 3 x Gz-649	63.0	62.3	62.6	242.3	243.0	242.6	139.5	130.0	134.8
L- 4 x Gz-649	62.5	62.3	62.4	261.3	250.3	255.8	151.5	144.5	148.0
L- 5 x Gz-649	64.5	63.8	64.1	266.0	264.5	265.3	145.5	153.8	149.6
L- 6 x Gz-649	62.0	63.8	62.9	278.8	266.0	272.4	155.0	155.0	155.0
L- 7 x Gz-649	63.8	64.8	64.3	287.0	294.8	290.9	170.5	188.8	179.6
L- 8 x Gz-649	63.3	63.5	63.4	289.5	289.5	289.5	175.3	177.0	176.1
L- 9 x Gz-649	62.3	62.0	62.1	251.3	239.8	245.5	134.3	134.8	134.5
L-10 x Gz-649	64.0	62.3	63.1	270.5	260.0	265.3	156.5	156.0	156.3
L-11 x Gz-649	60.8	61.5	61.1	252.8	244.5	248.6	133.3	137.8	135.5
L-12 x Gz-649	61.8	61.3	61.5	265.5	240.5	253.0	147.8	135.3	141.5
L-13 x Gz-649	62.0	61.8	61.9	253.8	245.8	249.8	149.0	138.8	143.9
L-14 x Gz-649	60.8	61.5	61.1	230.5	233.5	232.0	117.8	120.5	119.1
L-15 x Gz-649	64.3	64.3	64.3	274.5	271.5	273.0	150.8	166.0	158.4
L- 1 x Gm-1004	64.5	63.8	64.1	253.0	246.3	249.6	149.3	143.5	146.4
L- 2 x Gm-1004	64.5	65.0	64.8	263.5	239.3	251.4	150.5	140.8	145.6
L- 3 x Gm-1004	63.5	63.5	63.5	262.3	240.8	251.5	149.8	131.8	140.8
L- 4 x Gm-1004	66.0	64.3	65.1	252.5	248.8	250.6	149.3	145.8	147.5
L- 5 x Gm-1004	65.3	63.0	64.1	258.8	257.8	258.3	140.5	146.8	143.6
L- 6 x Gm-1004	65.3	64.3	64.8	266.3	254.3	260.3	152.8	145.0	148.9
L- 7 x Gm-1004	65.0	65.5	65.3	267.3	264.3	265.8	157.8	163.3	160.5
L- 8 x Gm-1004	64.8	63.8	64.3	287.8	272.0	279.9	175.3	168.3	171.8
L- 9 x Gm-1004	65.8	64.3	65.0	255.5	243.0	249.3	147.3	141.3	144.3
L-10 x Gm-1004	64.3	63.5	63.9	254.5	231.5	243.0	148.8	130.0	139.4
L-11 x Gm-1004	64.5	63.5	64.0	250.0	247.3	248.6	142.3	139.5	140.9
L-12 x Gm-1004	61.8	63.3	62.5	265.3	253.0	259.1	153.8	144.3	149.0
L-13 x Gm-1004	62.5	61.3	61.9	244.5	245.8	245.1	147.0	134.0	140.5
L-14 x Gm-1004	61.8	63.3	62.5	226.3	229.0	227.6	120.5	117.8	119.1
L-15 x Gm-1004	63.5	65.0	64.3	258.8	258.5	258.6	146.3	155.5	150.9
Check s									
SC-155	63.8	63.0	63.4	279.0	269.3	274.1	160.0	157.3	158.6
SC-3084	65.3	66.3	65.8	266.8	277.5	272.1	142.0	163.5	152.8
SC-3080	64.5	63.5	64.0	268.0	265.0	266.5	144.0	148.0	146.0
LSD 0.05	1.5	1.4	1.0	14.5	14.5	10.2	13.4	13.4	9.4

Table 2. Continued .

Crosses	No of ears/100 plants			Grain yield(ard/fed)		
	SK	SD	Com	SK	SD	Com
L- 1 x Gz-638	90.6	103.0	99.5	28.86	36.91	32.89
L- 2 x Gz-638	115.6	99.6	107.6	27.68	30.55	29.11
L- 3 x Gz-638	100.2	98.0	99.1	29.20	31.80	30.50
L- 4 x Gz-638	96.7	95.8	96.3	29.41	31.93	30.67
L- 5 x Gz-638	105.2	101.2	103.2	26.98	29.52	28.25
L- 6 x Gz-638	114.9	103.4	109.2	25.51	29.33	27.42
L- 7 x Gz-638	125.9	103.0	114.5	35.82	35.84	35.83
L- 8 x Gz-638	101.8	102.4	102.1	30.53	35.35	32.94
L- 9 x Gz-638	94.8	100.0	97.4	29.05	27.10	28.07
L-10 x Gz-638	106.1	98.2	102.1	32.50	30.28	31.39
L-11 x Gz-638	99.1	97.9	98.5	26.66	28.57	27.62
L-12 x Gz-638	102.3	101.1	101.7	33.34	29.06	31.20
L-13 x Gz-638	102.4	101.1	102.3	28.47	31.96	30.22
L-14 x Gz-638	99.1	98.7	98.9	24.21	23.81	24.01
L-15 x Gz-638	110.8	105.4	108.1	28.20	27.41	27.80
L- 1 x Gz-649	97.9	92.53	95.2	28.24	31.73	29.99
L- 2 x Gz-649	101.5	102.1	101.8	25.31	32.40	28.86
L- 3 x Gz-649	101.0	97.8	99.4	28.80	31.04	29.92
L- 4 x Gz-649	116.1	105.5	110.8	35.13	33.55	34.35
L- 5 x Gz-649	112.4	110.2	111.3	26.61	28.77	27.69
L- 6 x Gz-649	119.1	109.7	114.4	28.30	33.46	30.88
L- 7 x Gz-649	123.0	115.9	119.5	33.31	36.00	34.65
L- 8 x Gz-649	102.3	102.3	102.3	28.04	35.41	31.72
L- 9 x Gz-649	103.8	95.6	100.7	24.20	27.60	25.90
L-10 x Gz-649	103.0	98.1	100.0	32.36	28.34	30.35
L-11 x Gz-649	105.0	104.8	104.9	29.27	32.87	31.07
L-12 x Gz-649	118.0	108.5	113.3	33.03	31.56	32.29
L-13 x Gz-649	115.7	106.1	110.9	29.66	35.26	32.46
L-14 x Gz-649	99.3	99.0	99.13	25.21	26.34	25.77
L-15 x Gz-649	130.8	119.2	125.0	28.10	29.44	28.76
L- 1 x Gm-1004	105.6	93.5	99.6	28.01	27.19	27.60
L- 2 x Gm-1004	101.1	96.0	98.5	31.86	24.12	27.99
L- 3 x Gm-1004	104.3	96.7	100.5	32.83	23.53	28.18
L- 4 x Gm-1004	110.0	98.9	104.5	36.46	30.97	33.72
L- 5 x Gm-1004	107.8	101.0	104.4	27.78	29.89	28.84
L- 6 x Gm-1004	108.8	103.4	106.1	24.58	29.34	26.96
L- 7 x Gm-1004	114.7	90.8	102.8	32.36	28.65	30.51
L- 8 x Gm-1004	97.1	98.9	98.0	27.95	31.90	29.92
L- 9 x Gm-1004	95.0	99.2	97.1	25.94	25.56	25.75
L-10 x Gm-1004	102.2	101.0	101.6	30.92	26.86	28.89
L-11 x Gm-1004	101.3	96.43	98.8	26.54	27.57	27.06
L-12 x Gm-1004	106.1	102.1	101.1	30.81	28.20	29.50
L-13 x Gm-1004	117.0	101.2	109.1	25.42	28.23	26.83
L-14 x Gm-1004	100.8	89.2	95.0	23.31	18.30	20.81
L-15 x Gm-1004	99.3	105.3	102.3	24.28	26.55	25.42
Checks						
SC-155	106.2	99.86	103	30.29	30.57	30.43
SC-3084	100	95	97.5	20.42	20.92	20.67
SC-3080	101.6	98.93	100.3	27.33	29.58	28.45
LSD 0.05	13.9	11.92	9.07	4.4	4.07	3.00

Regarding grain yield (ard/fad), the topcross L-4 x Gm-1004 at Sakha, (L-1 x Gz-638) at Sids and (L-7 x Gz-638) across locations produced the highest grain yield (36.46, 36.91and 35.83 ard/fad, respectively). On the contrary, the topcross (L-14 x Gm-1004) produced the lowest yield at Sakha, Sids and across locations (23.31, 18.30 and 20.81 ard/fad, respectively). The highest yielding topcrosses were (L-4 x Gz-649), (L-4 x Gm-1004), (L-7 x Gz-638) at Sakha, (L-1 x Gz-638), (L-7 x Gz-638), (L-7 x Gz-649), (L-8 x Gz-638), (L-8 x Gz-649) and (L-13 x Gz-649) at Sids; and (L-4 x Gz-649), (L-4 x Gm-1004), (L-7 x Gz-638), and (L-7 x Gz-649) across locations. These topcrosses significantly outyielded the highest yielding check hybrid S.C. 155 by 16.1, 20.4 and 18.3% at Sakha and by 20.7, 17.2, 17.8, 15.6, 15.8 and 15.3% at Sids and by 12.9, 10.8, 17.8 and 13.9% across locations, respectively.

General (GCA) and specific (SCA) combining ability effects

Estimates of general combining ability (GCA) effects are shown in Table (3) for the studied traits. Inbred lines L-11, L-12, L-13 and L-14 at Sakha, L-11, L-12, L-13, and L-15 at Sids and L-11, L-12, L-13,L-14 and L-15 across locations possessed significantly negative GCA effects (desirable) toward earliness for days to 50% silking. On the contrary; L-4, L-5, L-7 and L-10 at Sakha; L-2, L-7 at Sids; and L-2, L-5 and L-7 across locations had significantly positive GCA effects (undesirable) toward lateness.

For plant height, Lines L-1, L-11, L-14 at Sakha, L-2, L-3, L-9, L-11, L-12, L-13 and L-14 at Sids, and L-1, L-3, L-9, L-11, L-13 and L-14 across locations had significantly negative GCA effects toward shortness. On the other hand, L-6, L-7 and L-8 at Sakha, Sids and across locations, as well as L-5 at Sids and across locations exhibited significantly positive GCA effects toward tallness.

Respecting ear height, L-11 and L-14 at both locations and across locations, in addition to L-3, and L-13 at Sids and across locations had significantly negative GCA effects toward low ear placement (desirable). It is worth noting that L-7 and L-8 exhibited significantly positive GCA effects toward high ear placement (undesirable).

For number of ears 100 $plants^{-1}$, L-6, L-7 and L-15 at Sakha; L-15 at Sids and L-6, L-7 and L-15 across locations possessed significantly positive GCA effects (desirable) toward producing hybrids of more ears $plant^{-1}$. On the contrary, Lines L-1, L-8, L-9 and L-14 at Sakha, L-14 at Sids and L-1, L-3, L-9 and L-14 across locations possessed undesirable significant GCA effects toward less ears per plant.

Regarding grain yield, inbred lines L-7 possessed significantly positive GCA effects (desirable) toward high grain yield at both and across

Table (3). Estimates of general combining ability effects for grain yield and other studied traits at Sakha (SK), Sids (SD) and across locations (Com) in 2007 growing season.

Lines	Days to 50 % silking			Plant height			Ear height			No. of ears/100 plants			Grain yield		
	SK	SD	Com	SK	SD	Com	SK	SD	Com	SK	SD	Com	SK	SD	Com
L-1	0.250	0.3944	0.322	-9.272**	-2.150	-5.711*	-4.156	-2.294	-3.225	-6.633*	-4.744	-5.722**	-0.583	2.211**	0.813
L-2	0.333	0.728**	0.531*	1.228	-7.150*	-2.961	-2.406	-5.294	-3.850*	-0.383	-1.911	-1.159	-0.667	-0.706	-0.692
L-3	-0.083	-0.439	-0.261	-3.689	-8.900**	-6.294**	-0.572	-11.627**	-6.100**	-4.717	-3.494	-4.126*	1.333	-0.872	0.186
L-4	0.667*	-0.022	0.322	-2.689	-3.983	-3.336	3.844	-3.461	0.192	1.117	-0.994	0.032	4.833**	2.294**	3.565**
L-5	1.417**	0.394	0.906**	5.061	8.100**	6.580**	-2.739	5.122	1.192	2.033	2.922	2.474	-1.750	-0.372	-1.085
L-6	0.417	0.228	0.322	9.311**	6.100*	7.706**	1.844	3.455	2.650	7.867**	4.339	6.070**	-2.833**	0.878	-0.925
L-7	0.750*	1.894**	1.322**	17.061**	29.850**	23.456**	15.761**	31.038**	23.400**	14.700 **	2.089	8.424**	4.750**	3.711**	4.316**
L-8	0.000	-0.356	-0.178	25.311**	24.683**	24.997**	21.761**	24.122**	22.942**	-6.217*	0.089	-3.001	0.083	4.378**	2.183**
L-9	0.417	0.144	0.281	-4.939	-8.316**	-6.628*	-4.406	-4.294	-4.350*	-8.550 **	-2.244	-5.409**	-2.500**	-3.039 **	-2.771**
L-10	0.750*	-0.189	0.281	3.144	-4.817	-0.836	5.094	-1.044	2.025	-2.800	-2.411	-2.542	3.083**	-1.372	0.863
L-11	-0.833**	-0.606*	-0.719**	-7.356**	-6.983*	-7.169**	-7.072**	-7.877**	-7.475**	-4.717	-1.411	-3.051	-1.417	-0.122	-0.762
L-12	-1.500**	-1.106**	-1.303**	1.894	-6.567*	-2.336	-0.239	-6.127*	-3.183	2.367	2.756	2.537	3.417**	-0.122	1.654**
L-13	-1.167**	-1.689**	-1.428**	-8.272**	-6.067*	-7.169**	-1.32	-7.627*	-4.475*	5.617	1.672	3.616	-1.000	2.128*	0.489
L-14	-1.583**	-0.522	-1.053**	-30.022**	-20.400**	-25.211**	-25.406**	-24.627**	-25.017**	-6.717*	-5.494*	-6.134**	-4.750**	-6.956 **	-5.815**
L-15	0.167	1.144**	0.656**	3.228	6.600*	4.914*	0.011	10.538**	5.275*	7.033*	8.839**	7.991**	-2.000*	-2.039*	-2.018**
Tester Gz-638	-0.667**	-0.872**	-0.769**	2.444	0.550	1.497	-1.906	-1.078	-1.492	-1.633	-0.528	-1.106	0.167	0.811*	0.516
Gz-649	-0.350*	-0.072	-0.211**	1.012	3.517**	2.264*	0.178	3.056*	1.617	3.417 **	3.406 **	3.428**	0.133	1.861**	0.965**
Gm-1004	1.017**	0.944**	0.980**	-3.456**	-4.067**	-3.761**	1.728	-1.978	-0.125	-1.783	-2.878*	-2.322**	-0.300	-2.672**	-1.481**
SE.gi L	0.306	0.279	0.207	2.933	3.001	2.098	2.621	2.799	1.917	2.903	2.437	1.893	0.917	0.849	0.625
SE (gi-gj) L	0.433	0.395	0.292	4.148	4.244	2.967	3.706	3.958	2.711	4.097	3.446	2.677	1.297	1.201	0.884
SEgi T	0.137	0.124	0.093	1.312	1.342	0.938	1.172	1.251	0.857	1.298	1.089	0.846	0.410	0.379	0.279
SE (gi-gj)T	0.194	0.177	0.131	1.855	1.898	1.327	1.657	1.770	1.212	1.832	1.573	1.197	0.820	0.537	0.395

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

locations. Meanwhile, inbred lines L-4, L-7, L-10, and L-12 at Sakha, L-1, L-4, L-7, L-8 and L-13 at Sids and L-4, L-7, L-8 and L-12 across locations possessed significantly positive GCA effects. Meanwhile inbred lines L-9, L-14 and L-15 at all and across location possessed significantly GCA effects (undesirable) toward low grain yield.

Considering the tester lines, results in Table 3, revealed that the lines were of good general combining ability for the studied traits as follows: Gm-1004 for only plant height; Gz-638 for both earliness and ear height; while Gz-649 was for earliness, number of ears 100 plants^{-1} and grain yield.

Estimates of SCA effects for the studied traits are presented in Table (4). For number of days to 50% silking, 3, 4 and 6 crosses at Sakha, Sids and across locations, respectively showed significantly negative values of SCA (desirable) toward earliness. On the other hand, 6, 1, and 7 crosses had significantly positive SCA values (undesirable) toward late maturity at same and across locations, respectively. The two crosses L-2 x Gz 638 and L-8 x Gz 638 possessed highly significant negative SCA effects across locations (Table 4) and were earlier in flowering compared to the check hybrids.

Regarding the combined analysis across locations for plant height (Table 4) five topcrosses possessed either significant or highly significant negative SCA effects toward shortness. These crosses were (L-15 x Gz-638), (L-3 x Gz-649), (L-9 x Gz-649), (L-7 x Gm-1004) and (L-10 x Gm-1004). On the other hand, three topcrosses possessed significant positive SCA effects toward tallness (undesirable). These crosses were (L-7 x Gz 649), (L-15 x Gz 649) and (L-12 x Gm 1004).

For ear height, five topcrosses, i.e. L-8 x G 638, L-3 x Gz 649, L-9 x Gz 649, L-7 x Gm 1004 and L-10 x Gm 1004 across locations had either significant or highly significant negative SCA effect toward low ear placement.

Out of the 45 studied topcrosses, two crosses at Sakha (L-2 x Gz 638, L-15 x Gz 649); one at Sids (L-7 x Gz 649) and one across locations (L-15 x Gz 649) possessed significant positive SCA effects toward higher number of ears per plants, which is desirable.

Respecting grain yield, data in Table (4) showed that , topcrosses L-2 x Gm 1004 at Sakha, L-1 x Gz 638 and L-5 x Gm 1004 at Sids and L-1 x Gz 638, L-4 x Gm 1004 and L-5 x Gm 1004 across locations possessed significant positive SCA estimates.

In this connection, Sprague and Tatum (1942) emphasized the importance of single and three-way cross trials for determining the most productive specific combination. Mahgoub *et al* (1996), Shehata *et al* (1997) and El-Zeir (1999), reported that inbred testers were more effective to select lines that combine well with unrelated testers. Moreover, they emphasized that inbred testers were more effective in detecting small differences in combining ability more than wide genetic base testers.

Table 4. Estimates of specific combining ability for grain yield and other studied traits at Sakha (SK), Sids (SD) and combined across locations (Com.) in 2007 season.

Crosses	Days to 50% silking			Plant height			Ear height		
	SK	SD	Com	SK	SD	Com	SK	SD	Com
L- 1 x Gz-638	-0.25	0.62	0.19	2.14	2.53	2.34	-0.18	- 1.01	-0.59
L- 2 x Gz-638	-1.08*	-0.96*	-1.02**	-4.36	2.03	- 1.16	-1.93	- 0.51	-1.22
L- 3 x Gz-638	0.33	-0.04	0.14	8.06	3.53	5.79	5.49	6.33	5.91
L- 4 x Gz-638	-0.17	0.04	-0.06	0.81	- 1.88	- 0.54	2.82	- 5.84	-1.51
L- 5 x Gz-638	0.08	0.62	0.35	5.31	- 0.97	2.17	4.41	1.08	2.74
L- 6 x Gz-638	0.58	-0.96*	-0.19	-6.44	- 2.97	- 4.71	-8.18	- 1.76	-4.97
L- 7 x Gz-638	-0.25	0.12	-0.06	-0.19	5.78	2.79	-0.84	1.41	0.28
L- 8 x Gz-638	-1.00	-1.38**	-1.19**	-6.69	- 7.05	- 6.87	-11.09**	- 5.67	-8.38*
L- 9 x Gz-638	-0.17	0.62	0.23	3.31	5.70	4.50	5.57	6.74	6.16
L-10 x Gz-638	0.25	0.46	0.35	1.22	3.95	2.59	0.82	3.24	2.03
L-11 x Gz-638	0.08	0.37	0.23	2.47	- 0.63	0.92	6.24	- 1.67	2.28
L-12 x Gz-638	0.50	-0.13	0.19	-7.03	- 1.55	- 4.29	-6.09	- 0.42	-3.26
L-13 x Gz-638	0.17	0.21	0.19	5.14	1.45	3.29	-2.76	3.33	0.28
L-14 x Gz-638	1.33*	0.79	1.06**	3.14	1.78	2.46	6.82	3.83	5.33
L-15 x Gz-638	-0.42	-0.38	-0.40	-6.86	-11.72*	- 9.29*	-1.09	- 9.09	-5.09
L- 1 x Gz-649	0.18	-0.18	0.00	-6.68	- 2.18	- 4.43	-4.51	- 1.64	-3.08
L- 2 x Gz-649	1.10*	0.49	0.79*	-0.18	0.32	0.07	-2.26	- 2.39	-2.33
L- 3 x Gz-649	0.27	-0.09	0.09	-16.26**	- 4.43	-10.35**	-7.09	- 6.56	-6.83*
L- 4 x Gz-649	-0.98	-0.51	-0.75*	1.74	- 2.10	- 0.18	0.49	- 0.22	0.13
L- 5 x Gz-649	0.27	0.57	0.42	-1.26	0.07	- 0.60	1.07	0.44	0.76
L- 6 x Gz-649	-1.23*	0.74	-0.25	7.24	3.57	5.40	5.99	3.36	4.68
L- 7 x Gz-649	0.18	0.07	0.13	7.74	8.57	8.15*	7.57	9.53*	8.55**
L- 8 x Gz-649	0.43	1.07**	0.75*	1.99	8.48	5.24	6.32	4.69	5.51
L- 9 x Gz-649	-0.98	-0.93	-0.96*	-6.01	- 8.27	- 7.14*	-8.51	- 9.14	-8.83**
L-10 x Gz-649	0.43	-0.34	0.05	5.16	8.48	6.82	4.24	8.86	6.55*
L-11 x Gz-649	-1.23*	-0.68	-0.96*	-2.09	- 4.85	- 3.47	-6.84	- 2.56	-4.70
L-12 x Gz-649	0.43	-0.43	0.00	1.41	- 9.27	- 3.93	0.82	- 6.81	-2.99
L-13 x Gz-649	0.35	0.66	0.50	-0.18	- 4.52	- 2.35	3.16	- 1.81	0.68
L-14 x Gz-649	-0.48	-0.76	-0.62	-1.68	- 2.43	- 2.06	-4.01	- 3.06	-3.53
L-15 x Gz-649	1.27*	0.32	0.80*	9.07	8.57	8.82*	3.57	7.28	5.43
L- 1 x Gm-1004	0.07	-0.44	-0.19	4.54	- 0.35	2.09	4.69	2.64	3.67
L- 2 x Gm-1004	-0.02	0.47	0.23	4.54	- 2.35	1.09	4.19	2.89	3.54
L- 3 x Gm-1004	-0.60	0.14	-0.23	8.21	0.90	4.55	1.61	0.23	0.92
L- 4 x Gm-1004	1.10*	0.47	0.81*	-2.54	3.98	0.72	-3.31	6.06	1.38
L- 5 x Gm-1004	-0.35	-1.19*	-0.77*	-4.04	0.90	- 1.57	-5.48	- 1.52	-3.50
L- 6 x Gm-1004	0.65	0.22	0.44	-0.79	- 0.60	- 0.70	2.19	- 1.61	0.29
L- 7 x Gm-1004	0.07	-0.19	-0.06	-7.54	-14.35**	-10.95**	-6.73	-10.94*	-8.83**
L- 8 x Gm-1004	0. 57	0.31	0.44	4.71	- 1.43	1.64	4.77	0.98	2.88
L- 9 x Gm-1004	1.15*	0.31	0.73*	2.71	2.57	2.64	2.94	2.39	2.67
L-10 x Gm-1004	-0.68	-0.11	-0.40	-6.38	-12.43*	- 9.41**	-5.06	-12.11**	-8.58**
L-11 x Gm-1004	1.15*	0.31	0.73*	-0.38	5.48	2.55	0.61	4.23	2.42
L-12 x Gm-1004	-0.93	0.56	-0.19	5.62	10.82 *	8.22*	5.27	7.23	6.25
L-13 x Gm-1004	-0.52	-0.86	-0.69	-4.96	3.07	- 0.95	-0.39	- 1.52	-0.96
L-14 x Gm-1004	-0.85	-0.03	-0.44	-1.46	0.65	- 0.41	-2.81	- 0.77	-1.79
L-15 x Gm-1004	-0.85	0.06	-0.40	-2.21	3.15	0.47	-2.48	1.81	-0.33
SE.S_{ij}	0.53	0.48	0.36	5.08	5.19	3.63	4.54	4.85	3.32
SE (Sij-Skl)	0.75	0.68	0.51	7.18	7.35	5.13	6.42	6.85	3.83

Table 4. Continued.

Crosses	No of ears 100 plants^{-1}			Grain yield(ard/fed)		
	SK	SD	Com.	SK	SD	Com.
L- 1 x Gz-638	- 2.03	7.11	2.54	0.25	4.19**	2.22*
L- 2 x Gz-638	11.22*	1.03	6.12	- 0.67	0.61	- 0.03
L- 3 x Gz-638	0.05	0.86	0.46	- 1.17	2.27	0.55
L- 4 x Gz-638	- 9.03	- 3.64	-6.34	- 4.42**	- 1.14	- 2.78*
L- 5 x Gz-638	- 1.70	- 2.31	-2.00	- 0.33	- 0.73	- 0.53
L- 6 x Gz-638	2.22	- 1.72	0.25	- 0.75	- 1.98	- 1.36
L- 7 x Gz-638	6.38	0.28	3.33	1.67	1.44	1.55
L- 8 x Gz-638	3.05	1.78	2.41	1.33	0.27	0.80
L- 9 x Gz-638	- 1.37	1.61	0.12	2.42	- 0.56	0.93
L-10 x Gz-638	3.88	0.03	1.96	0.33	1.02	0.68
L-11 x Gz-638	- 0.95	- 1.22	-1.09	- 1.17	- 1.98	- 1.57
L-12 x Gz-638	- 4.78	- 2.39	-3.59	0.75	- 1.48	- 0.36
L-13 x Gz-638	- 6.78	- 1.06	-3.92	0.42	- 0.73	- 0.16
L-14 x Gz-638	1.05	3.61	2.33	0.17	0.11	0.14
L-15 x Gz-638	- 1.20	- 3.97	-2.59	1.17	- 1.31	- 0.07
L- 1 x Gz-649	- 5.58	- 7.07	-6.33	- 0.22	- 1.86	- 1.04
L- 2 x Gz-649	- 8.08	- 0.66	-4.37	- 3.13*	1.56	- 0.79
L- 3 x Gz-649	- 4.25	- 3.07	-3.66	- 1.63	0.47	- 0.58
L- 4 x Gz-649	4.92	1.93	3.42	1.37	- 0.44	0.46
L- 5 x Gz-649	0.75	2.51	1.63	- 0.80	- 2.53	- 1.66
L- 6 x Gz-649	1.42	0.84	1.13	2.03	0.72	1.38
L- 7 x Gz-649	- 1.67	9.34*	3.84	- 0.55	0.64	0.04
L- 8 x Gz-649	- 1.50	- 2.41	-1.95	- 0.88	- 0.53	- 0.71
L- 9 x Gz-649	2.58	- 4.82	-1.12	- 2.30	- 0.86	- 1.58
L-10 x Gz-649	- 4.17	- 5.16	-4.66	0.37	- 2.03	- 0.83
L-11 x Gz-649	- 0.25	1.59	0.67	1.62	1.47	1.54
L-12 x Gz-649	5.67	1.43	3.55	0.53	0.22	0.38
L-13 x Gz-649	0.17	- 0.24	-0.04	1.70	1.72	1.71
L-14 x Gz-649	- 3.75	- 0.07	-1.91	0.70	1.56	1.13
L-15 x Gz-649	13.75**	5.84	9.80**	1.20	- 0.11	0.54
L- 1 x Gm-1004	7.62	- 0.04	3.79	- 0.03	- 2.33	- 1.18
L- 2 x Gm-1004	- 3.13	- 0.37	-1.75	3.80*	- 2.16	0.82
L- 3 x Gm-1004	4.20	2.21	3.21	2.80	- 2.74	0.03
L- 4 x Gm-1004	4.12	1.71	2.91	3.05	1.59	2.32*
L- 5 x Gm-1004	0.95	- 0.21	0.37	1.13	3.26*	2.19*
L- 6 x Gm-1004	- 3.63	0.88	-1.38	- 1.28	1.26	- 0.01
L- 7 x Gm-1004	- 4.72	- 9.62*	-7.17*	- 1.12	- 2.08	- 1.60
L- 8 x Gm-1004	- 1.55	0.63	-0.46	- 0.45	0.26	- 0.10
L- 9 x Gm-1004	- 1.22	3.21	1.00	- 0.12	1.42	0.65
L-10 x Gm-1004	0.28	5.13	2.71	- 0.70	1.01	0.15
L-11 x Gm-1004	1.20	- 0.37	0.41	- 0.45	0.51	0.03
L-12 x Gm-1004	- 0.88	0.96	0.04	- 1.28	1.26	- 0.01
L-13 x Gm-1004	6.62	1.29	3.96	- 2.12	- 0.99	-1.56
L-14 x Gm-1004	2.70	- 3.54	-0.42	- 0.87	- 1.66	-1.26
L-15 x Gm-1004	-12.50*	- 1.87	-7.21*	- 2.37	1.42	- 0.47
SE.Sij	5.03	4.22	3.28	1.59	1.47	1.08
SE (Sij-Skl)	7.09	5.96	3.78	3.17	2.08	1.53

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

In this connection, Sprague and Tatum (1942) emphasized the importance of single and three-way cross trials for determining the most productive specific combination. Mahgoub *et al* (1996), Shehata *et al* (1997) and El-Zeir (1999), reported that inbred testers were more effective to select lines that combine well with unrelated testers. Moreover, they emphasized that inbred testers were more effective in detecting small differences in combining ability more than wide genetic base testers.

Variance components

Estimates of combining ability variances of lines and testers (σ^2_{GCA}) and of crosses (σ^2_{SCA}) for grain yield and other agronomic traits at each location and across locations are presented in Table (5). Results revealed that values of σ^2_{GCA} for lines (L) were higher than those of σ^2_{GCA} for testers (T) for all studied traits, except for days to 50% silking at Sakha and combined across locations. These results indicate that most of the total variance was due to GCA of the lines. The variance interaction of σ^2_{GCA} lines x Loc. was larger than that of σ^2_{GCA} testers x Loc. for all studied traits, indicating that σ^2_{GCA} for lines was more affected by environmental conditions than that for testers. The σ^2_{SCA} variances was larger than that of σ^2_{GCA} at Sakha and Sids for all the studied traits, indicating that the non-additive gene were more important than additive gene effects in the inheritance of these traits.

Furthermore, the magnitude of σ^2_{SCA} x Loc. interaction was greater than that of σ^2_{GCA} x Loc interaction for days to 50% silking, indicating that the non-additive gene action interacted more with the environmental conditions than the additive component for this trait. Whereas, the magnitude of σ^2_{SCA} x Loc for grain yield was less than that for σ^2_{GCA}x loc., indicating that the additive gene action was affected more by the environment than the non-additive gene action. These result are in agreement with the findings of several investigators who reported specific combining ability variance to be more sensitive to environmental changes than general combining ability variance (Gilbert, 1958). Also, Shehata and Dahawan (1975) and Sadek *et al* (2000 and 2002) also found that the non-additive genetic variation interacted more with the environment than the additive component. On the other hand, El-Itrby *et al* (1990), and Soliman *et al* (2001) reported that the additive types of gene action were more affected by the environment than non-additive ones.

It could be concluded that, the promising inbred lines L-4, L-7, L-8 and L-12 which possessed the best GCA effects for grain yield should be immediately utilized in hybridization program to improve maize productivity.

Table 5. Estimates of general (σ^2_{gca}) and specific (σ^2_{sca}) combining ability variances for grain yield and other studied traits at Sakha, Sids and combined across locations.

Parameters	Traits				
	Days to 50% silking	Plant height	Ear height	Ears/100 plants	Grain yield
			Sakha		
σ^2_{gca} (lines)	0.516	143.876	95.800	31.214	6.917
σ^2_{gca} (testers)	0.747	3.293	0.264	3.162	-0.215
σ^2_{gca}	0.16	5.827	3.796	1.412	0.51
σ^2_{sca}	0.160	5.827	3.796	1.412	0.510
			Sids		
σ^2_{gca} (lines)	0.600	157.136	176.306	8.209	6.787
σ^2_{gca} (testers)	0.500	6.365	2.064	5.449	5.246
σ^2_{gca}	0.044	6.474	7.038	0.566	0.51
σ^2_{sca}	0.514	156.265	95.638	56.012	1.778
			Combined		
σ^2_{gca} (lines)	0.500	143.299	125.624	17.624	5.666
σ^2_{gca} (testers)	0.767	8.238	0.302	7.852	1.555
σ^2_{gca} (lines x Loc)	0.116	14.415	20.857	4.089	2.373
σ^2_{gca} (testers x Loc)	0,006	1.238	4.837	-0.624	1.921
σ^2_{gca}	0.442	29.031	17.476	9.399	1.242
σ^2_{gca} x Loc	0.024	3.435	7.425	0.161	1.996
σ^2_{sca}	0.344	24.564	20.849	9.241	0.942
σ^2_{sca} x Loc	0.126	-6.602	-8.022	-2.431	1.768

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طرز فعل الجين و القدرة على التآلف لمحصول الحبوب وبعض الصفات الأخرى في الذرة الشامية

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هجنت ١٥ سلالة فى الجيل الاخصابى الذاتى الثالث(S_3) من الذرة الشامية الصفراء مع ٣ كشافات (سلالات تربية داخلية) مختلفة هي : جيزة-٦٣٨ وجيزة ٦٤٩ وجميزة ١٠٠٤ وذلك بمحطة البحوث الزراعية بسدس في موسم ٢٠٠٦ . وفي موسم ٢٠٠٧ تم تقييم ٤٥ هجين قمي مع ثلاثة هجن للمقارنة (هـ. ف. ١٥٥ ، هـ. ف. ٣٠٨٤ ، هـ. ف. ٣٠٨٠ في كل من محطة البحوث الزراعية بسخا (محافظة كفر الشيخ) ، وسدس (محافظة بنى سويف) وذلك لصفات عدد الأيام من الزراعة حتى ظهور ٥٠ % من الحرابر ، ارتفاع كل من النبات والكوز، عدد الكيزان/١٠٠ نبات ، محصول الحبوب بالأردب للفدان. وقد وجدت اختلافات معنوية بين الهجن القمية ، السلالات ، الكشافات ومعنوية لتباين تفاعل السلالات × الكشافات لكل الصفات موضع الدراسة في كلا الموقعين وكذلك بالنسبة للتحليل المجمع عبر المواقع عدا الكشافات ، السلالات × الكشافات لصفة محصول الحبوب في سخا و السلالات × الكشافات لصفتي عدد الكيزان/١٠٠ نبات ومحصول الحبوب في سدس . كذلك وجدت اختلافات معنوية بين الموقعين لجميع الصفات المدروسة مما يدل عل ان الموقعين مختلفتين في الظروف البيئية. وكان تباين التفاعل بين المواقع والهجن القمية معنويا لصفات التزهير ، ارتفاع النبات ، ومحصول الحبوب. كما كان تباين التفاعل بين السلالات والمواقع معنويا لجميع الصفات ما عدا صفة عدد الكيزان/١٠٠ نبات ، كان تباين التفاعل بين الكشافات والمواقع معنويا لصفتي ارتفاع الكوز ومحصول الحبوب. كما كان تباين التفاعل بين السلالات × الكشافات × المواقع غير معنوي لجميع الصفات. وتفوقت الهجن (L-4 x Gz-649), (L-7 x Gz-649), (L-7 x Gz-638), (L-4 x Gm-1004) معنويا على أحسن هجن المقارنة (هجين فردى ١٥٥) فى محصول الحبوب. أظهرت السلالات رقم ١، ٤، ٧، ٨ ، ١٢ أحسن قدرة عامة (مرغوبة) لصفة المحصول وقد اظهرت ٣ هجن قمية هي (L-1 x Gz-638) (L-4 x Gm-1004) and (L-5 x Gm-1004) أحسن تأثيرات للقدرة الخاصة على التالف لصفة المحصول. كان تباين القدرة العامة على التآلف عاليا لجميع الصفات موضع الدراسة عدا صفة إرتفاع الكوز . وكان التباين الراجع لتفاعل القدرة العامة على التآلف مع المواقع أعلى من تباين تفاعل القدرة الخاصة على الائتلاف مع المواقع لجميع الصفات المدروسة عدا صفة عدد الايام حتى ظهور ٥٠% من الحرابر، مما يدل على ان الفعل الجيني المضيف لتلك الصفات اكثر تاثرا بالمواقع عن الفعل غير المضيف.

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