ESTIMATION OF COMBINING ABILITY EFFECTS OF NEW WHITE MAIZE INBRED LINES (*ZEA MAYS* L.) VIA LINE X TESTER ANALYSIS

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Abstract

Five new white maize inbred lines derived from Giza-2 population in the S6 generation were topcrossed to four testers i.e. two inbred lines Sd7 and Sk9 and two single crosses SC10 and SC128 at Ismailia Agric. Res. Stn. in 2010 season. In the growing season 2011, twenty topcrosses and two check hybrids, SC128 and TWC324 were evaluated in two locations, Gemmeiza and Ismailia Agric. Res. Stns. Results showed that differences between the two locations were significant for all traits, except for ear diameter. Crosses and lines mean squares were significant for all traits. Testers mean squares were significant for all traits, except for no. of ears 100 plants-1, ear diameter and no. of rows ear-1. Line x tester interactions were significant or highly significant for all traits, except for ear diameter. Interactions of crosses and lines with locations were significant for all of the studied traits, except (crosses x location) for ear length and no. of rows ear-1, and ear length, ear diameter and no. of rows ear-1 for (line x location) interaction. Results indicated that the SCA variances played the major role in the inheritance of all traits, except for ear height and ear diameter. Non-additive type of gene action was affected more by environmental condition than additive type of gene action for all traits, except for no. of rows ear-1. Parental line 6164 had negative (desirable) and significant GCA effects for 50% silking, plant and ear heights toward earliness, shorter plant, and lower ear placement, respectively. Meanwhile, this line exhibited positive and significant GCA effects for grain yield indicating that it could be used as promising lines in maize breeding program. Inbred line 6177 has GCA effects for no. of ears 100 plants-1, ear length, ear diameter, and grain yield. On the other hand, the SC128 as tester was the best general combiner for plant and ear heights. But, line Sk9 as tester was the best general combiner for 50% silking, ear height and grain yield. Crosses L6192 x SC 10, L6177 x Sd7 and L6186 x Sd7 showed the highest SCA effects for grain yield and crosses L6164 x SC 128, L6167 x Sd7, L6186 x Sk9, and L6192 x Sk9 for 50% silking. These crosses could be used in maize breeding program to improve these traits. Crosses L6164 x Sd7 and L6164 x Sk9 were significantly superior compared with the high yielding check SC 128. Furthermore, no significant differences were detected between crosses L6177 x Sd7, L6168 x Sd7, L6177 x Sk9, L6167 x Sk9 and L6192 x Sk9 and the highest check. These crosses could be used in maize breeding program and evaluated in advanced stages as parents for new commercial hybrids.

Key words: Maize, Zea mays L., topcrosses, gene action

INTRODUCTION

Successful development of improved maize (*Zea mays* L.) hybrids is dependent on accurate evaluation of inbred lines under selection. The topcrosses procedure suggested by Davis (1927) was used to evaluate the combining ability of inbred lines. The concepts of general combining ability (GCA) and specific combining ability (SCA) are useful for characterizing inbred lines in their crosses as defined by Sprague and Tatum (1942). Hallauer (1975) indicated that a suitable tester should be characterized by its simplicity in use and provides information that correctly classifies the relative merits of lines and maximizes genetic base tester can be effectively used to identify lines having good GCA and most efficient tester is that one having a low frequency favorable alleles. Regarding to line x tester analysis, the different types of testers can be classified and compared as follows: testers that are genetically either narrow or broad based, testers that are either related or unrelated to the lines being evaluated, testers that have either high or low frequency of favorable alleles and testers that are either high or low yielding per se (Rissi and Hallauer, 1991). Nawar and El-Hosary (1984), Attia (1992), Zellek (2000), Aly and Amer (2008), Mousa and Abd El-Azeem (2009), Aly *et al.* (2011), Aly and Hassan (2011), and Mousa and Aly (2011). They reported that the variance components due to SCA for grain yield and other agronomic traits was relatively larger than that due to GCA, indicating the importance of non-additive type of gene action appeared to be more important in lines selected previously for grain yield performance. On the other hand, Mathur *et al.* (1998) and El-Zeir *et al.* (2002) stated that when the lines were relatively unselected GCA or additive type of gene action becomes more important. Zhang *et al.* (2005) reported that GCA and SCA provided useful genetic information to help plant breeders for device appropriate breeding and selection strategies, such as the choice of suitable testers in hybrid crop breeding programs. Interactions due to σ^2SCA x location were more affected by environmental conditions than those due to σ^2GCA x location for grain yield suggested by El-Morshidy *et al.* (2003), Aly and Amer (2008), Mousa and Abd El-Azeem (2009), Aly and Hassan (2011) and Mousa and Aly (2011).

The main objectives of the present study were to: (i) estimate the general combining ability of lines and testers and specific combining ability of crosses for grain yield and its components, (ii) study the nature of gene action controlling the inheritance of these traits (iii) determine the line which can be used as a good tester and (vi) identify the superior crosses to improve the yielding ability in maize breeding program.

MATERIALS AND METHODS

Five new white maize inbred lines derived from Giza-2 population in the S_6 generation, namely L6177, L6164, L6167, L6186, and L6192 through selfing and selection at Ismailia Agric. Res. Stn. were topcrosses to four testers, two inbred lines Sd7 and Sk9 and two single crosses SC10 and SC128 in 2010. In 2011 growing season, the 20 topcrosses along with two commercial check hybrids i.e. SC128 and TWC324 were evaluated in yield trails at two locations, Gemmeiza and Ismailia. A randomize complete block design with four replications was used in each location. Plot size was one row, 6 m long and 80 cm apart. Planting was made in hills spaced at 25 cm along the row at the rate of two kernels $hill^{-1}$, thinned to one plant $hill^{-1}$. All cultural practices for maize production were applied as recommended. Data were recorded for days to 50% silking date, plant and ear heights (cm), no. of ears 100 $plants^{-1}$, ear length(cm), ear diameter (cm), no. of rows ear^{-1} and adjusted grain yield at 15.5% grain moisture in ardab fed^{-1} (one ardab = 140 kg and one feddan = 4200 m^2). Analysis of variance was performed for the combined data across locations according Steel and Torrie (1980). The procedure of Kempthorne (1957) was performed to obtain valuable information about the combining abilities of lines and testers as well as their topcrosses.

RESULTS AND DISCUSSION

Analyses of variance for eight traits over two locations are presented in Table (1). Analysis of variance showed significant differences among locations for all of the studied traits, 50% silking, plant and ear heights, no. of ears 100 $plants^{-1}$, ear length, no. of rows ear^{-1} and grain yield, except for ear diameter, indicating that environmental conditions were different at both locations. These findings agreed with those reported by Amer *at al.* (2003), Aly and Amer (2008), and Mousa and Aly (2011). Significant and highly significant differences were detected among crosses and lines for all of the studied traits over the two locations. Significant or highly significant differences were detected among the four testers for all traits, except for no. of ears 100 $plants^{-1}$, ear diameter and no. of rows ear^{-1}. Similar results were obtained by El-Itriby *et al.* (1990), Shehata *et al.* (1997) and Habliza and Khalifa (2005) for plant height and grain yield, El-Zeir *et al.* (2002), Mousa and Abd El-Azeem (2009), Aly and Hassan (2011), and Aly *et al.* (2011) for 50% silking, plant height, and grain yield. Significant or highly significant differences were obtained between line x tester (L x T) interaction over locations for all of the studied traits, except for ear diameter. Significant and highly significant differences were observed between crosses x location (C x Loc) and line x location (L x Loc) interactions for all traits, except for ear length and no. of rows ear^{-1} for (C x Loc) and ear length, ear diameter and no. of rows ear^{-1} for (L x Loc). Meanwhile, location x tester interactions were highly significant for plant and ear heights. These interactions with locations indicated that the studied topcrosses had different performance from location to another. In addition, these results indicated that it would be worthwhile to evaluate testcrosses at many environments, especially for grain yield, which was regarded as a complex polygenic trait (Darrah and Hallauer 1972). The interaction between (L x T) with location was significant and highly significant for all of the studied traits, except for ear length and no. of rows ear^{-1}. Many researchers found that significant of crosses and their partitioning into lines, testers and line x tester and their interactions with locations for grain yield and the other agronomic traits, Salama *et al.* (1995), Abd El-Aziz *et al.* (1996), Sadek *et al.* (2002), Aly and Amer (2008), Mousa and Aly (2011), and Aly *et al.* (2011).

Mean performances for eight traits of maize over two locations are shown in Table (2). Results revealed that the mean performance of topcrosses for 50% silking toward earliness appeared in the single crosses L6167 x Sd7 (58.88), L6177 x Sk9 (59.00), L6186 x Sk9 (59.25) and L6192 x Sk9 (58.75 day) was earlier compared with the check SC128 (60.38 day). Furthermore, three way crosses, L6164 x SC128 (58.63) and L6186 x SC128 (59.63 day) were earlier compared with the commercial hybrid check TWC324 (61.00 day). For plant and ear heights toward shorter plant and lower ear placement, single crosses did not differ significantly compared with the check SC128. On the other hand, crosses L6177 x SC 128 (263.13 and 146.50), L6164 x SC 128 (252.00 and 135.63) were shorter and had lower ear placement compared with the check hybrids TWC 324 (274.75 and 158.88 cm), respectively. For no. of ear 100 plants^{-1}, single crosses L6167 x Sk9 (106.63), L6177 x Sd7 (105.13), and L6186 x Sk9 (104.50) were superior to the check SC 128. But, all the three way crosses did not differ significantly from the check TWC324.For grain yield, the single crosses L6164 x Sd7 (33.03) and L6164 x Sk9 (32.76 ard fed^{-1})) were significantly superior to the high yielding check SC 128 (30.17 ard fed^{-1}). In contrast, crosses L6177 x Sd7 (31.14), L6186 x Sd7 (31.35), L6177 x Sk9 (31.33), L6167 x Sk9 (31.48) and L6192 x Sk9 (31.45 ard fed^{-1}) were not significantly different from the high yielding check SC128. On the other hand, the three way crosses did not differ significantly from the check TWC324 (29.42 ard fed^{-1}). These results confirmed by Darrah and Hallauer (1972), Liakat and Tepora (1986) and Mosa *et al.* (2004). They indicated that importance of using maize homozygous inbred line testers in the evaluation process. All topcrosses did not differ significantly from the two checks for ear length and ear diameter.

Concerning no. of rows ear^{-1}, results showed that the cross L6186 x SC128 (13.93) was significantly superior to the check TWC324 for no. of rows ear^{-1} and the crosses L6164 x Sd7, L6167 x Sd7, L6164 x Sk9, L6186 x Sk9 and L6192 x Sk9 significantly surpassed the check SC128.

According to these results, the four single crosses that include lines L6177 and L6164 had the highest values when crossed with each of two line testers Sd7 and Sk9, compared with the check hybrid SC128 for, 50% silking (60.0, 59.0, 59.6, and 59.8 days), no. of ears 100 plants^{-1} (105.1, 102.2, 104.1, and 102.5), grain yield (31.1, 31.3, 33.0, and 32.7 ard fed^{-1}), ear length (19.7, 19.0, 18.4, and 19.5 cm), ear diameter (4.1, 4.2, 4.2, and 4.6 cm) and no. of rows ear^{-1} (13.2, 12.9, 13.4, and 13.3) for crosses (L6177 x Sd7, L6177 x Sk9), (L6164 x Sd7, and L6164 x Sk9), respectively and the crosses L6164 x SC 128, L6186 x SC 128 were earlier with shorter plants and lower ear placement compared with the two check hybrids. Results indicated that these inbred lines had favorable alleles for earliness and grain yield.

General combining ability (GCA) effects for the five inbred lines and the four testers at Gemmeiza and Ismailia are presented in Table (3). Desirable GCA effects were appeared in the inbred line 6164 for 50% silking (-0.2858*, plant and ear heights (-3.856* and -3.688*) and grain yield (1.328**) toward earliness, shorter plants, lower ear placement, and better grain yield, respectively. Line 6177 had positive and significant (desirable) GCA effects for no. of ears 100 plants^{-1} (1.600**), grain yield (0.912*), ear length (0.597*) and ear diameter (0.134**). According to these results, it could be concluded that L6177 and L6164 have favorable alleles and could be of great value in maize breeding programs for improving grain yield and other attributes. Regarding testers, the best testers possessed better GCA effects were SC 128 for plant height (-6.988**), ear height (-6.875**) and no. of rows ear^{-1}(0.295*) toward shorter plants, lower ear placement, and improving no. of rows ear^{-1}, respectively. The single cross tester SC10 had the best general combiner for longest ear length (0.474*), while, line Sd7 had desirable positive and significant GCA effects for grain yield (0.872*). The inbred line Sk9 as tester possessed negative (desirable) GCA effects for 50% silking (-0.631**), ear height (-3.575*), and grain yield (1.038*) toward earliness, lower ear placement and higher grain yield. These results revealed that the inbred lines as testers, Sd7 and Sk9 had high frequency of favorable dominant alleles, which contributed to the yield of topcrosses. These results confirmed the previous results as mentioned above in Table (2). Similar results were reported by Darrah and Hallauer (1972), Rissi and Hallauer (1991), Mosa *et al.* (2004), Aly *et al.* (2011), and Mousa and Aly (2011).

Estimates of specific combining ability (SCA) effects for topcrosses of eight traits over both locations are illustrated in Table (4). Results showed that the best SCA effects were recorded for the crosses, L6164 x SC 128 (-1.075**), L6167 x Sd-7 (-1.156**), L6186 x Sk9 (-0.619**), and L6192 x Sk9 (-0.838*) for 50% silking toward earliness, L6186 x SC10 (-7.469*), and L6167 x Sk9 (-11.581**) for plant height toward shorter plants, L6167 x Sk9 (-8.831*) for ear height toward lower ear placement, L6177 x SC10 (3.15**), and L6167 x Sk9 (2.544*) for no. of ears 100 plants^{-1}, L6192 x SC10 (1.845*), L6177 x Sd7 (2.355*), and L6186 x Sd7 (2.714**) for grain yield, L6177 x SC128 (0.991*) for ear length, L6186 x Sd7 (0.189*) for ear diameter and crosses L6186 x SC128 (0.593*), and L6186 x Sk9 (0.654*) for no. of rows ear^{-1}. These crosses were considered as good performing hybrids for grain yield, shorter plants, and prolific plants. Therefore, they could be used in maize breeding program to improve these traits.

Estimates of combining ability variances (σ^2GCA and σ^2SCA) and their interaction with locations for eight traits over two locations are illustrated in Table (5). Results showed that σ^2SCA variances played the major role in determining the inheritance for all of the studied traits, except for ear height and ear diameter. This indicated that the largest portion of the total genetic variability associated with these traits was due to non-additive gene action. Similar results were obtained by Mosa (2004) for 50% silking, plant height, grain yield, ear length, and no. of kernels row^{-1}, Kumara *et al.* (2005) and Parvez and Rather (2006) for ear length and grain yield, Aly and Amer (2008) for no. of ears 100 plants^{-1} and grain yield, Mousa and Aly (2011) for plant height and Ibrahim and Mousa (2011) for no. of ears 100 plants^{-1}, ear length and grain yield. On the other hand, estimates of σ^2GCA were higher than σ^2SCA for ear height and ear diameter over two locations, indicating that the additive genetic variance plays an important role in the inheritance of these traits. Similar results were obtained by Nawar and El-Hosary (1984), Mosa (2010) and Mousa and Aly (2011), they reported that additive genetic variance was more important than non-additive variances for ear diameter, Darrah and Hallauer (1972), Soliman and Sadek (1999) and Abd El-Azeem (2000) for ear height. Results revealed that σ^2SCA x Loc interaction was higher than σ^2GCA x Loc for all of the studied traits, except for no. of rows ear^{-1}. Results indicated that non-additive type of gene action was affected more by environmental conditions than additive types of gene action. These results are in agreement with the finding of Mosa (2010) and Mousa and Aly (2011).

Simple correlation coefficient between grain yield and the other traits of maize over two locations are illustrated in Table (6). Results revealed that positive and significant correlated was found between grain yield and each of the other traits, plant height, ear height, no. of ears 100 plants^{-1}, ear length, ear diameter and no. of rows ear^{-1}. While, correlation between 50% silking with almost of the studied traits were negative and significant. Correlation between plant height and ear diameter, ear height and no. of ears 100 plants^{-1} were positive and not significant. These results are in harmony with these of El-Sherbieny *et al.* (1994), Muhammad and Saleem (2001), Sadek and Abdel-Azeem (2005), Aly and Amer (2008) and Ibrahim and Mousa (2011).

CONCLUSION

Finally, it may be concluded that the superior crosses for grain yield and its components were obtained by L6164 x Sd7 and L6164 x Sk9 were superior to the high yielding check hybrid SC128. Inbred lines L6164 and L6177 exhibited high GCA effects for grain yield and might be used in developing new maize single crosses. Inbred line Sk9 had favorable alleles for earliness and grain yield followed by inbred line Sd7 for grain yield. Therefore, they could be used as good testers for determining superior crosses.

Table 1. Analysis of variance for eight traits of maize over two locations

S.O.V.	D.F.	Days to 50% silking	Plant height (cm)	Ear height (cm)	No. of ears 100 plants^{-1}	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows ear^{-1}
Locations (Loc.)	1	252.51**	20070.40**	96040.00**	36.10*	56.80*	10.44*	0.21	9.83*
Reps/Loc.	6	1.39	216.85	132.73	7.28	7.16	1.19	0.07	2.17
Crosses (C)	19	5.51**	526.16**	454.43**	21.36*	32.29**	4.06**	0.11*	1.12*
Lines (L)	4	1.99*	265.84*	272.61*	28.01*	38.49**	4.42*	0.27**	1.84*
Testers (T)	3	15.79**	1253.44**	1693.98**	16.75	42.12**	6.77*	0.06	0.86
Lines x Testers	12	4.11**	431.11**	205.18*	20.3*	27.76**	3.26*	0.07	0.94*
C x Loc.	19	1.95**	446.29**	359.61**	40.94**	38.80**	1.57	0.11*	0.56
Lines x Loc.	4	2.99*	338.15*	295.11*	70.41**	98.76**	0.77	0.06	0.87
Testers x Loc.	3	0.96	1066.52**	738.52**	10.62	9.92	0.93	0.05	0.30
L x T x Loc	12	2.19**	327.29*	286.38**	38.70**	26.04**	1.99	0.15*	0.53
Error	114	0.67	106.86	109.27	11.20	6.65	1.96	0.07	0.54

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

Table 2. Mean performances for eight traits of maize over two locations

Crosses	Days to 50% silking	Plant height (cm)	Ear height (cm)	No. of ears 100 plants^{-1}	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows ear^{-1}
L6177 x Sd7	60.00	278.63	154.38	105.13	31.14	19.77	4.16	13.20
L6177 x Sk9	59.00	279.38	155.75	102.25	31.33	19.05	4.28	12.90
L6164 x Sd7	59.63	265.88	145.63	104.13	33.03	18.44	4.20	13.45
L6164 x Sk9	59.88	272.38	153.50	102.50	32.76	19.53	4.67	13.35
L6167 x Sd7	58.88	274.25	154.00	101.50	28.84	19.22	4.35	13.35
L6167 x Sk9	60.25	255.25	138.38	106.63	31.48	18.41	4.35	12.60
L6186 x Sd7	60.13	272.88	152.75	102.13	31.35	19.31	4.41	13.08
L6186 x Sk9	59.25	261.50	143.63	104.50	26.30	18.62	4.27	13.45
L6192 x Sd7	60.88	270.63	153.00	101.13	27.02	17.70	4.03	13.21
L6192 x Sk9	58.75	264.00	150.88	102.63	31.45	19.09	4.19	13.37
L6177 x SC 10	60.88	271.88	162.63	103.88	28.09	19.63	4.40	13.75
L6177 x SC 128	60.50	263.13	146.50	102.75	29.91	19.48	4.33	13.70
L6164 x SC 10	61.00	272.38	154.50	102.50	29.43	19.26	4.26	12.65
L6164 x SC 128	58.63	252.00	135.63	104.25	28.62	17.87	4.22	13.50
L6167 x SC 10	61.00	276.25	161.13	100.50	28.55	19.15	4.23	13.15
L6167 x SC 128	60.63	269.63	145.63	104.50	28.46	19.16	4.47	13.25
L6186 x SC 10	61.00	279.75	159.88	102.75	25.85	19.04	4.44	13.70
L6186 x SC 128	59.63	254.75	150.88	102.25	28.34	17.39	4.21	13.93
L6192 x SC 10	60.75	267.63	159.38	101.00	30.38	19.72	4.17	13.25
L6192 x SC 128	60.50	268.13	142.00	101.13	29.88	17.87	4.13	12.98
Check SC 128	60.38	254.75	139.88	100.00	30.17	18.45	4.18	12.61
Check TWC 324	61.00	274.75	158.88	104.21	29.42	19.22	4.27	13.18
LSD 0.05	0.81	10.23	10.34	3.31	2.55	1.39	0.26	0.73

Table 3. General combining ability effects for nine genotypes, five inbred lines and four testers at Gemmeiza and Ismailia in 2011.

Parents	Days to 50% silking	Plant height (cm)	Ear height (cm)	No. of ears 100 plants^{-1}	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows ear^{-1}
L6177	0.038	4.738*	3.813*	1.600**	0.912*	0.597*	0.134**	0.112
L6164	-0.285*	-3.856*	-3.688*	0.444	1.328**	-0.109	-0.053	-0.113
L6167	0.121	1.331	-1.219	0.381	-0.374	0.100	0.097*	-0.188
L6186	-0.056	-1.294	0.781	0.006	-1.994*	-0.295	0.067	0.262*
L6192	0.163	-0.919	0.313	-2.455**	0.115	-0.292	-0.214**	-0.074
SE (g_i)	0.144	1.827	1.847	0.591	0.455	0.247	0.046	0.129
SE (g_i-g_j)	0.204	2.584	2.613	0.883	0.644	0.35	0.066	0.183
SC10	0.869**	5.063**	8.500**	-0.775	-1.346**	0.474*	0.038	0.025
SC 128	-0.081	-6.988**	-6.875**	0.075	-0.563	-0.529*	0.008	0.295*
Sd7	-0.156	3.938*	1.951	-0.111	0.872*	0.001	-0.034	-0.178
Sk9	-0.631**	-2.013	-3.575*	0.821	1.038*	0.055	-0.012	-0.142
SE (gi)	0.129	1.634	1.652	0.529	0.407	0.221	0.041	0.116
SE (gi-gj)	0.183	2.311	2.337	0.748	0.576	0.313	0.059	0.164

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

Table 4. Specific combining ability effects for eight traits of the twenty topcrosses at Gemmeiza and Ismailia in 2011.

Cross	Days to 50% silking	Plant height (cm)	Ear height (cm)	No. of ears 100 plants^{-1}	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows ear^{-1}
L6177 x SC 10	-0.088	6.438	-0.688	3.150**	-0.884	0.927	0.171	0.338
L6164 x SC 10	0.350	1.656	-1.313	-0.069	-0.362	0.015	0.008	-0.537*
L6167 x SC 10	-0.056	2.344	2.844	-2.006	0.363	-0.308	-0.157	0.038
L6186 x SC 10	0.131	-7.469*	-0.406	0.619	-0.962	-0.428	0.073	0.138
L6192 x SC 10	-0.338	-5.031	-0.438	0.306	1.845*	0.648	0.005	0.024
L6177 x SC 128	0.488	-3.138	-1.438	-0.825	0.355	0.991*	0.029	0.118
L6164 x SC 128	-1.075**	-6.669	-4.813	0.831	-2.750**	-1.372**	0.089	0.143
L6167 x SC 128	0.569*	7.769*	2.719	1.144	-0.309	0.705	0.111	-0.032
L6186 x SC 128	-0.294	-5.481	5.969	-0.731	0.945	-0.669	-0.129	0.593*
L6192 x SC 128	0.363	7.519*	-2.438	-1.919	0.759	-0.393	-0.011	-0.821*
L6177 x Sd7	0.063	1.438	-1.388	1.725	2.355*	0.284	-0.100	-0.110
L6164 x Sd7	0.445	-3.719	-2.638	0.881	1.426	-0.391	0.024	0.065
L6167 x Sd7	-1.156**	1.469	3.269	-1.681	-2.163*	0.232	0.030	0.340
L6186 x Sd7	0.281	3.719	0.019	-0.981	2.714**	0.717	0.189*	-0.385
L6192 x Sd7	0.813**	-0.906	0.738	-0.244	-3.332**	-0.493	-0.063	0.089
L6177 x Sk9	-0.463	8.138*	3.513	-2.500*	0.173	-0.486	0.0001	-0.946*
L6164 x Sk9	0.725*	8.731*	8.763*	-1.644	0.686	0.638	-0.112	0.329
L6167 x Sk9	0.694*	-11.581**	-8.831*	2.544*	1.110	-0.630	0.015	-0.346
L6186 x Sk9	-0.619*	-3.706	-5.581	0.994	-2.697**	-0.020	-0.052	0.654*
L6192 x Sk9	-0.838*	-1.581	2.138	0.356	0.728	0.438	0.069	0.309
SE (S_{ij})	0.289	3.654	3.695	1.183	0.911	0.494	0.093	0.259
SE (S_{ij}-S_{kl})	0.409	5.168	5.226	1.673	1.289	0.7	0.132	0.367

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

Table 5. Genetic parameters and interaction with locations for eight traits of maize over two locations

Traits Genetic parameters	Days to 50% silking	Plant height (cm)	Ear height (cm)	No. of ears 100 plants^{-1}	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows ear^{-1}
σ^2_{GCA}	0.133	9.115	21.614	0.058	0.348	0.064	0.002	0.011
σ^2_{SCA}	0.430	40.531	11.988	1.137	2.638	0.162	0.0001	0.050
$\sigma^2_{GCA}/\sigma^2_{SCA}$	0.31	0.22	1.80	0.05	0.13	0.40	20.00	0.22
$\sigma^2_{GCA \times Loc}$	-0.012	20.835	12.802	0.100	1.572	-0.063	-0.005	0.003
$\sigma^2_{SCA \times Loc}$	0.380	55.107	44.277	6.875	4.847	0.007	0.020	-0.003
$\sigma^2_{GCA \times Loc}/\sigma^2_{SCA \times Loc}$	-0.03	0.38	0.29	0.01	0.32	-9.00	-0.25	-1.00

Negative estimates are considered zero (Robinson *et al.*, 1955)

Table 6. Correlation coefficient between grain yield and the other traits of maize over two locations

Traits	Plant height (cm)	Ear height (cm)	No. of ears 100 plants^{-1}	Grain yield (ard/fed)	Ear length (cm)	Ear diameter (cm)	No. of rows ear^{-1}
Days to 50% silking	-0.364**	-0.613**	-0.065	-0.161*	-0.192*	0.041	-0.311**
Plant height (cm)		0.775**	0.202*	0.185*	0.321**	0.152	0.201*
Ear height (cm)			0.032	0.237**	0.225**	0.168*	0.284**
No. of ears 100 plants^{-1}				0.356**	0.174*	0.167*	0.255**
Grain yield (ard/fed)					0.267**	0.148*	0.319**
Ear length (cm)						0.204**	0.166*
Ear diameter (cm)							0.196*
No. of rows ear^{-1}							

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

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تقدير تأثيرات القدرة على التآلف لسلالات بيضاء جديدة من الذرة الشامية (*Zea mays* L.)عن طريق إستخدام تحليل السلالة فى الكشاف

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إستخدمت فى هذه الدراسة خمسة سلالات بيضاء جديدة من الذرة الشامية فى الجيل السادس تم تهجينهم مع أربعة كشافات عبارة عن إثنين من السلالات وهما سدس٧ وسخا٩ وإثنين من الهجن هما الهجين الفردى ١٠ والهجين الفردى١٢٨ فى محطة البحوث الزراعية بالإسماعيلية موسم ٢٠١٠ . فى الموسم الزراعى ٢٠١١ تم تقييم الهجن العشرون الناتجة مع إثنين من الهجن كمقارنة وهما الهجين الفردى ١٢٨ والهجين الثلاثى ٣٢٤ فى محطتى البحوث الزراعية بالجميزة والإسماعيلية. أظهرت النتائج وجود إختلافات معنوية بين موقعى الدراسة لجميع الصفات المدروسة فيما عدا صفة قطر الكوز. كانت التباينات للهجن والسلالات معنوية لجميع الصفات المدروسة بينما كان تباين الكشافات و(السلالات فى الكشافات) وكذلك تباين تفاعلهم مع المواقع معنوياً لمعظم الصفات تحت الدراسة. إشارت النتائج إلى أن تباين الفعل الجينى غير المضيف يلعب الدور الأكبر فى وراثة هذه الصفات فيما عدا صفتى إرتفاع النبات وقطر الكوز إلى جانب ذلك كان تآثر الفعل الجينى غير المضيف بالتغيرات البيئية (المواقع) أكبر من تأثر الفعل الجينى المضيف لكافة الصفات المدروسة ما عدا عدد السطور بالكوز. أظهرت السلالة ٦١٦٤ قدرة إئتلاف عامة سالبة (مرغوبة) ومعنوية لصفات التزهير، إرتفاع النبات وإرتفاع الكوز وكذلك قدرة إئتلاف موجبة ومعنوية (مرغوبة) لصفة محصول الحبوب موضحاً أهمية إستخدام هذه السلالة فى برنامج تربية الذرة الشامية. وأظهرت السلالة ٦١٧٧ قدرة إئتلاف عامة موجبة ومعنوية لصفات عدد الكيزان لكل ١٠٠ نبات ، طول الكوز ، قطر الكوز ومحصول الحبوب. على الجانب الآخر أظهر الهجين الفردى ١٢٨ أفضلية إستخدامه ككشاف لتأثير القدرة العامة على التآلف لصفات إرتفاع النبات وإرتفاع الكوز بينما السلالة سخا-٩ كانت أفضل كشاف لتأثير القدرة العامة على التآلف لصفة التزهير وإرتفاع الكوز ومحصول الحبوب موضحا أهمية إستخدام السلالات (قاعدة وراثية ضيقة) فى عملية التقييم وإستخدامها ككشافات. أفضل قدرة خاصة على التآلف تم الحصول عليها من خلال الهجن (السلالة ٦١٩٢ x هجين فردى ١٠)، (السلالة ٦١٧٧ x سدس ٧) و(السلالة ٦١٨٦ x سدس٧) لصفة محصول الحبوب وللهجن (السلالة ٦١٦٤ x هجين فردى ١٢٨) ،(السلالة ٦١٦٧ x سدس٧) ، (السلالة ٦١٨٦ x سخا٩) و(السلالة ٦١٩٢ x سخا٩) لصفة التزهير. زادت الهجن السلالة (٦١٦٤ x سدس ٧) (٣٣,٠٣) و السلالة (٦١٦٤ x سخا ٩) (٣٢,٧٦) زيادة معنوية عن أفضل وأعلى هجن المقارنة هجين فردى ١٢٨ (٣٠,١٧ أردب/فدان) فى حين أعطت الهجن (السلالة ٦١٧٧ x سدس٧) ، (السلالة ٦١٦٨ x سدس٧) ،(السلالة ٦١٧٧ x سخا٩) ،(السلالة ٦١٦٧ x سخا٩) و(السلالة ٦١٩٢ x سخا٩) محصولاً غير معنوى عن أفضل وأعلى هجن المقارنة محصولياً مشيراً لأهمية تقييم مثل هذه الهجن فى المراحل المتقدمة للبرنامج للوقوف على مدى تفوقها وإستخدامها فى برنامج الذرة الشامية وإطلاقها كهجن جديدة عد إجتيازها كافة مراحل التقييم.