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Line X Tester Mating Design for Estimation Combining Ability in Maize

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Abstract

This investigation was carried out to evaluate eighty top-crosses and two checks SC-155 and TWC-324 at Experimental Farm, Faculty of Agriculture, Al-Azhar University at Assiut Branch. The obtained results exhibited highly significant differences among top-crosses and lines as well as, between two testers and the interaction of lines x testers for all studied traits, except number of days to 50% silking and number of rows/ear for testers. Significant desirable GCA effects were found in some lines for all studied traits. The tester SC-128 was significantly the best general combiner for ear length, 100-kernel weight and grain yield/plant, while the tester TWC-324 was significantly the best general combiner for plant height, ear height. Significant desirable SCA effects were found of some top-crosses for all studied traits. The variance due to GCA-L was higher than GCA-T for all studied traits, indicating that most of GCA variance was due to lines. The variance of SCA exceeded the variance of GCA (average) for all the studied traits, indicating that the non-additive gene action played an important role in the inheritance of all the studied traits. The lines contributed with the large percentage and played the major role in the inheritance of all studied traits. On the other hand, the testers contributed with the smallest percentage and played the lowest role in the inheritance of all studied traits.

Keywords: *line x tester, Combining ability, proportion contribution*

Introduction

Top-cross method was suggested by Davis 1927 and become common in maize hybrid breeding programs. In the 1980s, 78% of maize breeders assessed general combining ability (GCA) by top-cross, using one of the three first selfing generations (Bauman 1981). 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 in breeding (Jenkins 1935 and Sprague 1946). Knowledge of the effects of the general combining ability (GCA) and specific combining ability (SCA) helps in testing hypotheses and predicting crosses and is important for understanding the genetic structure of lines and populations **(**Hallauer and Miranda Filho, 1988). The variance of GCA/SCA ratio is useful in estimating that variability existed whether due to additive or non-additive or both types of gene action. Abd El Aziz *et al* 1994, Mahmoud 1996, Konak *et al* 1999, El-Beially *et al* 2007and Ram *et al* 2015 reported that the variance components due to SCA for grain yield and some of other agronomic traits was larger than that due to GCA, indicating the non-additive type of gene action played an important role in the inheritance of these traits. On the other hand, other results indicated the importance of

additive gene effects for inheritance grain yield and some of other agronomic traits (Paul and Debanth 1999, Mosa 2010, Aly *et al* 2011 and El-Arif *et al* 2011)

The aim of the present investigation was to identify the best combiners lines regarding to the general combining ability and identify the best combiners top-crosses regarding to the specific combining ability. Also, to determine the important mode of gene action that control studied traits.

Materials and Methods

This study was carried out during 2013 – 2015 seasons. In 2013 season, forty S_1 white maize lines were derived from Giza-2 population. In 2014 summer season, top-crosses were formed between selected 40 S_1 lines and the two testers i.e., Single Cross 128 (SC-128) and Three Way Cross 324 (TWC-324). In 2015 summer season, the 80 top-crosses and two checks i.e., SC-155 and TWC-324 were evaluated at Experimental Farm, Faculty of Agriculture, Al-Azhar University at Assiut Branch. The experiments were laid out in a randomized complete block design (R.C.B.D) with three replications. Experimental plot size was one ridge, 3 m in long with 70 cm between ridges. Planting was done in hills spaced 25 cm apart on one side of the ridge. The recommended cultural of maize production were applied at the proper time.

Data were collected for number of days to 50% silking, plant height (cm), ear height (cm), ear length (cm), ear diameter (cm), number of rows/ear, 100-kernel weight (g) and grain yield/plant (g).

Statistical analysis

Data was subjected to analysis of variance according to Gomez and Gomez (1984) and treatments means were compared statistically using the test of the Least Significant Differences (L.S.D). The combining ability effects were estimated according to Kempthorne (1957) and Singh and Shaudhary (1979).

Results and Discussion

Analysis of variance and mean performance

The analysis of variance of all the studied traits (Table 1) exhibited that highly significant differences were found among crosses for all the studied traits, indicating that the crosses were different from each other. Partitioning sum of squares due to crosses into its components lines, testers and lines x testers interaction showed highly significant differences among the lines and between the two testers for all the studied traits, except number of days to 50% silking and number of rows/ear for testers, indicating that great diversity among the lines and between the two testers. At the same time highly significant differences were found for lines x testers interaction of all the studied traits, indicating that the lines performed differently via its genetic make-up in crosses with each of the testers.

Table 1. Mean squares of top-crosses, lines, testers and lines x testers interaction for all the studied traits.

S.O.V	d.f	Days to 50% Silking	Plant height	Ear height	Ear length	Ear diameter	Number of rows/ear	100-kernel weight	Grain yield/plant
Crosses	79	26.00**	2911.08**	659.02**	17.56**	1.07**	13.69**	86.42**	3626.73**
Lines(L)	39	42.78**	5564.67**	1224.75**	30.68**	1.99**	24.63**	151.78**	6878.76**
Testers(T)	1	2.02	507.50**	209.07**	8.44**	0.29**	0.20	34.50**	543.00**
L x T	39	9.85**	319.12**	104.83**	4.68**	0.18**	3.09**	22.40**	453.77**
Error	158	1.32	14.84	4.82	0.97	0.02	0.42	1.66	54.24

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

Mean performance values of the 80 top-crosses and the two checks i.e., SC-155 and TWC-324 for all the studied traits are presented in Table 2. The obtained results exhibited that 41 and 71 top-crosses were significantly earlier silking than the two checks SC-155 and TWC-324, respectively. Regarding to plant height, 46 and 40 top-crosses were significantly shorter than the two respective checks. In respect of ear height, 29 and 72 top-crosses were significantly lower ear placement than the two respective checks. As for ear length, 30 and 53 top-crosses were significantly longer than the two respective checks. Concerning to ear diameter, 39 and 43 top-crosses were significantly superior than the two proposed checks. As for number of rows/ear, 28 and 35 top-crosses were significantly superior than the two ranked checks. Regarding to 100-kernel weight, 47 and 58 top-crosses were significantly heavier than the two same checks. With respect to grain yield/plant, 29 and 47 top-crosses were significantly out-yielded the two respective checks. These results are supported with the findings of El-Beially *et al* (2007), El-Arif *et al* (2011), Chandel and Mankotia (2014), Tamirat *et al* (2014), Anupam *et al* (2015), Ram *et al* (2015) and Shah *et al* (2015).

Table 2. Mean performance of all the studied traits for 80 top-crosses of maize.

Lines	Number of days to 50% silking			Plant height			Ear height		
	SC-128	TWC-324	Mean	SC-128	TWC-324	Mean	SC-128	TWC-324	Mean
L1	58.00	54.67	56.33	263.33	278.00	270.67	137.33	145.00	141.17
L2	57.67	56.00	56.83	274.67	287.00	280.83	162.67	165.00	163.83
L3	61.33	62.67	62.00	300.67	305.00	302.83	162.33	160.67	161.50
L4	55.67	54.33	55.00	293.33	298.00	295.67	152.00	161.00	156.50
L5	52.67	55.00	53.83	306.67	308.67	307.67	156.67	152.33	154.50
L6	62.33	60.67	61.50	311.00	306.00	308.50	148.67	140.67	144.67
L7	56.00	58.67	57.33	291.67	278.67	285.17	139.67	131.00	135.33
L8	55.00	53.00	54.00	290.67	277.67	284.17	135.00	126.33	130.67
L9	57.67	60.67	59.17	250.67	255.00	252.83	140.33	138.67	139.50
L10	55.67	53.33	54.50	216.00	201.00	208.50	157.33	157.67	157.50
L11	57.67	61.00	59.33	225.33	214.00	219.67	153.67	142.67	148.17
L12	62.67	59.33	61.00	214.33	205.00	209.67	154.33	145.33	149.83
L13	60.67	59.00	59.83	229.33	239.67	234.50	111.67	123.00	117.33
L14	57.00	55.67	56.33	256.33	271.67	264.00	127.67	135.00	131.33
L15	53.33	56.00	54.67	261.33	249.67	255.50	114.67	112.33	113.50
L16	54.00	55.33	54.67	235.67	252.33	244.00	112.00	118.67	115.33
L17	54.00	58.67	56.33	218.00	212.67	215.33	127.00	123.33	125.17
L18	56.33	60.00	58.17	201.00	186.00	193.50	124.33	113.67	119.00
L19	54.33	56.33	55.33	245.00	253.67	249.33	140.33	132.67	136.50
L20	53.33	53.67	53.50	226.67	221.00	223.83	142.67	139.00	140.83
L21	60.67	56.67	58.67	289.33	294.00	291.67	152.00	150.33	151.17
L22	60.33	58.67	59.50	275.33	283.00	279.17	128.00	131.00	129.50
L23	58.33	62.00	60.17	257.00	239.33	248.17	114.67	121.00	117.83
L24	59.67	56.00	57.83	244.67	227.00	235.83	113.33	113.33	113.33
L25	53.67	53.33	53.50	265.00	278.33	271.67	120.67	129.33	125.00
L26	57.00	56.33	56.67	233.33	237.00	235.17	133.33	129.00	131.17
L27	59.33	58.33	58.83	247.33	250.00	248.67	139.00	140.33	139.67
L28	54.67	53.33	54.00	271.00	251.00	261.00	152.67	122.67	137.67
L29	53.67	52.33	53.00	262.33	224.67	243.50	140.33	134.67	137.50
L30	54.00	56.67	55.33	238.00	215.67	226.83	115.33	112.33	113.83
L31	60.00	55.33	57.67	257.33	267.33	262.33	121.00	128.00	124.50
L32	55.67	56.33	56.00	221.67	211.33	216.50	133.33	130.33	131.83
L33	55.33	54.00	54.67	262.67	251.33	257.00	138.33	132.33	135.33
L34	56.33	57.33	56.83	283.67	256.33	270.00	151.00	143.00	147.00
L35	53.33	54.67	54.00	206.33	232.00	219.17	113.67	123.33	118.50
L36	55.00	59.67	57.33	258.67	273.33	266.00	125.33	134.00	129.67
L37	61.33	60.67	61.00	229.00	242.00	235.50	139.00	143.00	141.00
L38	57.67	60.67	59.17	270.33	240.00	255.17	146.00	126.00	136.00
L39	53.00	56.67	54.83	205.67	203.33	204.50	116.33	114.67	115.50
L40	63.67	62.33	63.00	295.33	291.67	293.50	154.67	151.00	152.83
Mean	56.95	57.13	57.04	254.64	251.73	253.19	136.21	134.34	135.28
SC-155	58.33			264.67			133.33		
TWC-324	62.67			259.00			158.33		
LSD 0.05	1.86			6.23			3.55		
LSD 0.01	2.45			8.23			4.69		

Table 2. Cont.

Lines	Ear length			Ear diameter			Number of rows/ear		
	SC-128	TWC-324	Mean	SC-128	TWC-324	Mean	SC-128	TWC-324	Mean
L1	16.33	15.00	15.67	4.07	3.70	3.88	11.67	10.33	11.00
L2	14.67	16.33	15.50	3.47	3.47	3.47	11.33	10.00	10.67
L3	15.67	15.00	15.33	3.60	3.53	3.57	11.33	10.67	11.00
L4	20.67	19.00	19.83	4.97	4.73	4.85	13.67	14.67	14.17
L5	14.00	16.00	15.00	3.37	3.70	3.53	10.33	11.67	11.00
L6	17.33	15.33	16.33	4.07	3.63	3.85	13.33	12.33	12.83
L7	15.00	16.67	15.83	3.67	3.93	3.80	10.33	12.33	11.33
L8	16.00	14.33	15.17	3.90	3.57	3.73	12.33	11.67	12.00
L9	19.67	19.67	19.67	4.93	4.97	4.95	15.33	15.67	15.50
L10	20.67	19.67	20.17	5.00	4.87	4.93	15.67	14.33	15.00
L11	17.67	15.33	16.50	4.63	4.53	4.58	13.67	12.67	13.17
L12	14.67	16.67	15.67	3.63	4.27	3.95	10.67	12.33	11.50
L13	15.67	18.00	16.83	3.60	4.10	3.85	12.00	13.67	12.83
L14	14.67	15.33	15.00	3.73	3.47	3.60	12.67	10.67	11.67
L15	20.67	18.33	19.50	5.10	4.93	5.02	16.33	15.67	16.00
L16	15.33	16.33	15.83	3.70	4.03	3.87	12.00	13.67	12.83
L17	18.00	16.00	17.00	4.77	4.23	4.50	14.33	12.33	13.33
L18	19.67	21.33	20.50	5.00	5.10	5.05	16.67	16.33	16.50
L19	21.67	19.33	20.50	5.10	4.60	4.85	16.00	14.33	15.17
L20	20.67	17.00	18.83	4.77	4.40	4.58	14.67	12.33	13.50
L21	17.33	15.33	16.33	4.50	4.17	4.33	12.67	13.33	13.00
L22	15.67	16.33	16.00	3.80	3.63	3.72	11.33	11.67	11.50
L23	14.00	14.00	14.00	3.40	3.80	3.60	10.33	11.67	11.00
L24	19.67	20.67	20.17	4.77	4.90	4.83	14.67	14.67	14.67
L25	16.67	14.67	15.67	4.77	4.33	4.55	14.33	12.33	13.33
L26	14.33	15.67	15.00	3.47	3.87	3.67	10.67	11.67	11.17
L27	22.33	20.33	21.33	5.13	4.87	5.00	16.67	16.33	16.50
L28	20.00	17.00	18.50	5.07	4.40	4.73	16.67	14.33	15.50
L29	22.33	19.67	21.00	5.27	4.97	5.12	17.67	17.33	17.50
L30	18.33	20.67	19.50	4.80	5.10	4.95	14.67	16.67	15.67
L31	21.00	19.33	20.17	5.07	4.83	4.95	15.67	14.33	15.00
L32	15.67	14.67	15.17	4.10	3.80	3.95	12.67	11.67	12.17
L33	16.00	15.33	15.67	3.77	3.57	3.67	12.33	11.67	12.00
L34	18.67	20.00	19.33	4.60	4.93	4.77	14.33	16.67	15.50
L35	14.33	16.33	15.33	3.53	4.00	3.77	10.33	12.67	11.50
L36	17.33	19.67	18.50	4.20	4.70	4.45	12.67	15.00	13.83
L37	19.00	17.33	18.17	4.67	4.17	4.42	14.67	16.33	15.50
L38	20.67	21.33	21.00	5.10	5.03	5.07	16.67	16.33	16.50
L39	15.33	14.33	14.83	3.83	3.53	3.68	12.33	11.67	12.00
L40	20.67	19.67	20.17	5.27	5.00	5.13	17.33	16.67	17.00
Mean	17.70	17.33	17.51	4.35	4.28	4.32	13.58	13.52	13.55
SC-155	20.00			4.61			15.67		
TWC-324	17.33			4.43			15.00		
LSD 0.05	1.59			0.23			1.05		
LSD 0.01	2.10			0.30			1.38		

Table 2. Cont.

Lines	100-kernel weight			Grain yield/plant		
	SC-128	TWC-324	Mean	SC-128	TWC-324	Mean
L1	40.67	34.00	37.33	192.67	169.33	181.00
L2	34.67	36.33	35.50	182.67	189.67	186.17
L3	32.00	27.67	29.83	176.33	164.33	170.33
L4	39.67	35.00	37.33	203.33	200.33	201.83
L5	29.00	33.00	31.00	157.33	174.00	165.67
L6	40.67	36.00	38.33	207.33	189.33	198.33
L7	28.00	25.33	26.67	140.67	144.67	142.67
L8	35.33	34.67	35.00	183.33	181.67	182.50
L9	42.00	43.00	42.50	231.00	235.00	233.00
L10	39.00	36.33	37.67	235.00	224.33	229.67
L11	42.67	38.00	40.33	221.00	209.67	215.33
L12	27.00	31.00	29.00	153.00	165.00	159.00
L13	32.67	35.67	34.17	178.00	196.33	187.17
L14	36.33	27.67	32.00	184.67	152.33	168.50
L15	39.67	37.67	38.67	231.33	230.67	231.00
L16	29.67	33.00	31.33	149.00	168.00	158.50
L17	39.33	34.00	36.67	203.00	178.67	190.83
L18	38.67	40.67	39.67	227.33	234.33	230.83
L19	41.00	37.33	39.17	231.67	219.00	225.33
L20	42.67	37.33	40.00	223.00	211.00	217.00
L21	34.33	30.67	32.50	179.33	168.00	173.67
L22	25.33	24.67	25.00	151.67	134.00	142.83
L23	22.67	26.33	24.50	122.33	131.33	126.83
L24	35.33	40.00	37.67	199.67	210.67	205.17
L25	36.67	31.67	34.17	202.33	185.67	194.00
L26	31.00	35.67	33.33	132.00	174.00	153.00
L27	42.00	38.33	40.17	231.00	187.33	209.17
L28	39.00	37.33	38.17	222.00	219.00	220.50
L29	43.00	41.33	42.17	244.33	240.33	242.33
L30	37.33	41.00	39.17	214.67	231.33	223.00
L31	37.00	33.67	35.33	212.00	194.67	203.33
L32	31.00	28.33	29.67	156.00	130.67	143.33
L33	36.00	38.33	37.17	168.00	163.00	165.50
L34	36.67	35.00	35.83	187.33	180.00	183.67
L35	22.33	26.67	24.50	118.67	125.00	121.83
L36	27.33	33.33	30.33	158.33	192.67	175.50
L37	37.33	41.33	39.33	219.67	232.67	226.17
L38	41.00	40.67	40.83	238.67	230.00	234.33
L39	33.00	28.33	30.67	145.00	127.00	136.00
L40	41.00	43.33	42.17	235.67	235.00	235.33
Mean	35.50	34.74	35.12	191.26	188.25	189.75
SC-155	37.00			219.67		
TWC-324	34.33			194.00		
LSD 0.05	2.08			11.91		
LSD 0.01	2.75			15.74		

Combining ability

General combining ability

Estimates of general combining ability effects for all the studied traits of the 40 S_1 white maize lines and the two testers i.e., SC-128 and TWC-324 are presented in Table 3.

General combining ability for the two testers

The obtained results exhibited that the tester SC-128 was significantly the best general combiner for ear length, 100-kernel weight and grain yield/plant. Meanwhile, the tester TWC-324 was significantly the best general combiner for plant height and ear height.

General combining ability for the lines

The obtained results in Table 3 exhibited that the line number 29 was significantly the highest desirable general combiner for number of days to 50% silking, number of rows/ear and grain yield/plant with values -4.04, 3.95 and 52.58, respectively. The line number 18 with value -59.69 and the line number 24 with value - 21.94 were significantly the most superior general combiners for plant height and ear height, respectively. The line number 27 with value 3.82 and the line number 40 with value 0.81 were significantly the highest desirable general combiners for ear length and ear diameter, respectively. The line number 9 with value 7.38 was significantly the most superior general combiner for 100-kernel weight.

16 lines out of 40 possessed significant desirable GCA effects for number of days to 50% silking. As well as, 18 lines for ear height and grain yield/plant, 17 lines for ear length and number of rows/ear and 20 lines for ear diameter and 100-kernel weight possessed significant desirable GCA effects. These results are supported with the findings of Osman and Ibrahem (2007), Senthil and Bharathi (2011), Chandel and Mankotia (2014) and Shah *et al* (2015).

Table 3. Estimates of general combining ability effects for all the studied traits of 40 S_1 lines and 2 testers.

Lines	Number of days to 50% silking	Plant height	Ear height	Ear length	Ear diameter	Number of rows/ear	100-kernel weight	Grain yield/plant
L1	-0.71	17.48**	5.89**	-1.85**	-0.44**	-2.55**	2.21**	-8.75**
L2	-0.21	27.65**	28.56**	-2.01**	-0.85**	-2.88**	0.38	-3.59
L3	4.96**	49.65**	26.23**	-2.18**	-0.75**	-2.55**	-5.29**	-19.42**
L4	-2.04**	42.48**	21.23**	2.32**	0.53**	0.62**	2.21**	12.08**
L5	-3.21**	54.48**	19.23**	-2.51**	-0.79**	-2.55**	-4.12**	-24.09**
L6	4.46**	55.31**	9.39**	-1.18**	-0.47**	-0.71**	3.21**	8.58**
L7	0.29	31.98**	0.06	-1.68**	-0.52**	-2.21**	-8.45**	-47.09**
L8	-3.04**	30.98**	-4.61**	-2.35**	-0.59**	-1.55**	-0.12	-7.25*
L9	2.13**	-0.35	4.22**	2.15**	0.63**	1.95**	7.38**	43.25**
L10	-2.54**	-44.69**	22.23**	2.65**	0.61**	1.45**	2.55**	39.91**
L11	2.29**	-33.52**	12.89**	-1.01*	0.26**	-0.38**	5.21**	25.58**
L12	3.96**	-43.52**	14.56**	-1.85**	-0.37**	-2.05**	-6.12**	-30.75**
L13	2.79**	-18.69**	-17.94**	-0.68	-0.47**	-0.71**	-0.95	-2.59
L14	-0.71	10.81**	-3.94**	-2.51**	-0.72**	-1.88**	-3.12**	-21.25**
L15	-2.38**	2.31	-21.78**	1.99**	0.70**	2.45**	3.55**	41.25**
L16	-2.38**	-9.19**	-19.94**	-1.68**	-0.45**	-0.71**	-3.79**	-31.25**
L17	-0.71	-37.85**	-10.11**	-0.51	0.18**	-0.21**	1.55**	1.08
L18	1.13*	-59.69**	-16.28**	2.99**	0.73**	2.95**	4.55**	41.08**
L19	-1.71**	-3.85*	1.22	2.99**	0.53**	1.62**	4.05**	35.58**
L20	-3.54**	-29.35**	5.56**	1.32**	0.26**	-0.05	4.88**	27.25**
L21	1.63**	38.48**	15.89**	-1.18**	0.01	-0.55**	-2.62**	-16.09**
L22	2.46**	25.98**	-5.78**	-1.51**	-0.60**	-2.05**	-10.12**	-46.92**
L23	3.13**	-5.02**	-17.44**	-3.51**	-0.72**	-2.55**	-10.62**	-62.92**
L24	0.79	-17.35**	-21.94**	2.65**	0.51**	1.12**	2.55**	15.41**
L25	-3.54**	18.48**	-10.28**	-1.85**	0.23**	-0.21**	-0.95	4.25
L26	-0.38	-18.02**	-4.11**	-2.51**	-0.65**	-2.38**	-1.79**	-36.75**
L27	1.79**	-4.52**	4.39**	3.82**	0.68**	2.95**	5.05**	19.41**
L28	-3.04**	7.81**	2.39**	0.99*	0.41**	1.95**	3.05**	30.75**
L29	-4.04**	-9.69**	2.22*	3.49**	0.80**	3.95**	7.05**	52.58**
L30	-1.71**	-26.35**	-21.44**	1.99**	0.63**	2.12**	4.05**	33.25**
L31	0.63	9.15**	-10.78**	2.65**	0.63**	1.45**	0.21	13.58**
L32	-1.04*	-36.69**	-3.44**	-2.35**	-0.37**	-1.38**	-5.45**	-46.42**
L33	-2.38**	3.81*	0.06	-1.85**	-0.65**	-1.55**	2.05**	-24.25**
L34	-0.21	16.81**	11.73**	1.82**	0.45**	1.95**	0.71	-6.09*
L35	-3.04**	-34.02**	-16.78**	-2.18**	-0.55**	-2.05**	-10.62**	-67.92**
L36	0.29	12.81**	-5.61**	0.99*	0.13*	0.29**	-4.79**	-14.25**
L37	3.96**	-17.69**	5.72**	0.65	0.10	1.95**	4.21**	36.41**
L38	2.13**	1.98	0.72	3.49**	0.75**	2.95**	5.71**	44.58**
L39	-2.21**	-48.69**	-19.78**	-2.68**	-0.64**	-1.55**	-4.45**	-53.75**
L40	5.96**	40.31**	17.56**	2.65**	0.81**	3.45**	7.05**	45.58**
S.E lines 0.05	0.93	3.11	1.77	0.80	0.11	0.52	1.04	5.95
0.01	1.23	4.12	2.35	1.05	0.15	0.69	1.38	7.87
Testers								
SC-128	-0.09	1.45**	0.93**	0.19*	0.04	0.03	0.38**	1.50**
TWC-324	0.09	-1.45**	-0.93**	-0.19*	-0.04	-0.03	-0.38**	-1.50**
S.E testers 0.05	0.20	0.37	0.28	0.19	0.07	0.15	0.21	0.51
0.01	0.26	0.48	0.37	0.25	0.09	0.20	0.28	0.67

Specific combining ability

Estimates of specific combining ability effects of the 80 top-crosses for all the studied traits are presented in Table 4. The obtained results exhibited that the top-crosses L31 x TWC-324 with value - 2.43, L29 x TWC-324 with value - 17.38 and L28 x TWC-324 with value - 14.07 were significantly the most desirable specific combiners for number of days to 50% silking, plant height and ear height, respectively. As well as, the top-crosses L20 x SC-128 with value 1.65, L34 x TWC-324, L35 x TWC-324 and L36 x TWC-324 with value 1.20, L14 x SC-128 with value 3.95 and L26 x TWC-324 with value 22.50 were significantly the most desirable specific combiners for ear length, ear diameter, number of rows/ear, 100-kernel weight and grain yield/plant.

13, 35 and 24 top-crosses possessed significant negative desirable SCA effects for number of days to 50% silking, plant height and ear height, respectively. On the other hand, 8, 9, 26 and 31 top-crosses possessed significant positive desirable SCA effects for ear length, number of rows/ear, 100-kernel weight and grain yield/plant, respectively.

It is worth noting that a cross exhibiting high SCA value may come from two parents possessing good GCA for example L20 x SC-128 for ear length, two parents possessing poor GCA for example L26 x TWC-324 for grain yield/plant or parent with poor GCA and another with good GCA for example L29 x TWC-324 for plant height. These results are supported with the findings of Abd El-Moula (2005), Sunil *et al* (2012), Chandel and Mankotia (2014) and Shah *et al* (2015).

Table 4. Estimates of specific combining ability effects for all the studied traits of 80 top-crosses of maize.

Lines	Number of days to 50% silking		Plant height		Ear height	
	SC-128	TWC-324	SC-128	TWC-324	SC-128	TWC-324
L1	1.76**	-1.76**	-8.79**	8.79**	-4.77**	4.77**
L2	0.93	-0.93	-7.62**	7.62**	-2.10*	2.10**
L3	-0.58	0.58	-3.62**	3.62**	-0.10	0.10
L4	0.76	-0.76	-3.79**	3.79**	-5.43**	5.43**
L5	-1.08	1.08	-2.45*	2.45*	1.23	-1.23
L6	0.92	-0.93	1.05	-1.05	3.07**	-3.07**
L7	-1.24	1.24	5.05**	-5.05**	3.40**	-3.40**
L8	1.09	-1.09	5.05**	-5.05**	3.40**	-3.40**
L9	-1.41*	1.41*	-3.62**	3.62**	-0.10	0.10
L10	1.26	-1.26	6.05**	-6.05**	-1.10	1.10
L11	-1.58*	1.58*	4.21**	-4.21**	4.57**	-4.57**
L12	1.76**	-1.76**	3.21**	-3.21**	3.57**	-3.57**
L13	0.93	-0.93	-6.62**	6.62**	-6.60**	6.60**
L14	0.76	-0.76	-9.12**	9.12**	-4.60**	4.60**
L15	-1.24	1.24	4.38**	-4.38**	0.23	-0.23
L16	-0.58	0.58	-9.79**	9.79**	-4.27**	4.27**
L17	-2.24**	2.24**	1.21	-1.21	0.90	-0.90
L18	-1.74**	1.74**	6.05**	-6.05**	4.40**	-4.40**
L19	-0.91	0.91	-5.79**	5.79**	2.90**	-2.90**
L20	-0.08	0.08	1.38	-1.38	0.90	-0.90
L21	2.09**	-2.09**	-3.79**	3.79**	-0.10	0.10
L22	0.93	-0.93	-5.29**	5.29**	-2.43**	2.43**
L23	-1.74**	1.74**	7.38**	-7.38**	-4.10**	4.10**
L24	1.93**	-1.93**	7.38**	-7.38**	-0.93	0.93
L25	0.26	-0.26	-8.12**	8.12**	-5.27**	5.27**
L26	0.42	-0.42	-3.29**	3.29**	1.23	-1.23
L27	0.59	-0.59	-2.79*	2.79*	-1.60	1.60
L28	0.76	-0.76	8.55**	-8.55**	14.07**	-14.07**
L29	0.76	-0.76	17.38**	-17.38**	1.90*	-1.90*
L30	-1.24	1.24	9.71**	-9.71**	0.57	-0.57
L31	2.43**	-2.43**	-6.45**	6.45**	-4.43**	4.43**
L32	-0.24	0.24	3.71**	-3.71**	0.57	-0.57
L33	0.76	-0.76	4.21**	-4.21**	2.07*	-2.07*
L34	-0.41	0.41	12.21**	-12.21**	3.07**	-3.07**
L35	-0.58	0.58	-14.29**	14.29**	-5.77**	5.77**
L36	-2.24**	2.24**	-8.79**	8.79**	-5.27**	5.27**
L37	0.43	-0.43	-7.95**	7.95**	-2.93**	2.93**
L38	-1.41*	1.41*	13.71**	-13.71**	9.07	-9.07**
L39	-1.74**	1.74**	-0.29	0.29	-0.10	0.10
L40	0.76	-0.76	0.38	-0.38	0.90	-0.90
SE sca 0.05	1.27		2.32		1.75	
SE sca 0.01	1.67		3.07		2.31	

Table 4. Cont.

Lines	Ear length		Ear diameter		Number of rows/plant	
	SC-128	TWC-324	SC-128	TWC-324	SC-128	TWC-324
L1	0.48	-0.48	0.15	-0.15	0.64	-0.64
L2	-1.02	1.02	-0.04	0.04	0.64	-0.64
L3	0.15	-0.15	0.01	0.01	0.30	-0.30
L4	0.65	-0.65	0.08	-0.08	-0.53	0.53
L5	-1.19*	1.19*	-0.20	0.20	-0.70	0.70
L6	0.81	-0.81	0.18	-0.18	0.47	-0.47
L7	-1.02	1.02	-0.17	0.17	-1.03*	1.03*
L8	0.65	-0.65	0.13	-0.13	0.30	-0.30
L9	-0.19	0.19	-0.05	0.05	-0.20	0.20
L10	0.31	-0.31	0.03	-0.03	0.64	-0.64
L11	0.98	-0.98	0.02	-0.02	0.47	-0.47
L12	-1.19*	1.19*	-0.35	0.35	-0.86	0.86
L13	-1.35*	1.35*	-0.29	0.29	-0.86	0.86
L14	-0.52	0.52	0.10	-0.10	0.97*	-0.97*
L15	0.98	-0.98	0.05	-0.05	0.30	-0.30
L16	-0.69	0.69	-0.20	0.20	-0.86	0.86
L17	0.81	-0.81	0.23	-0.23	0.97*	-0.97*
L18	-1.02	1.02	-0.09	0.09	0.14	-0.14
L19	0.98	-0.98	0.22	-0.22	0.80	-0.80
L20	1.65**	-1.65**	0.15	-0.15	1.14*	-1.14*
L21	0.81	-0.81	0.13	-0.13	-0.36	0.36
L22	-0.52	0.52	0.05	-0.05	-0.20	0.20
L23	-0.19	0.19	-0.24	0.24	-0.70	0.70
L24	-0.69	0.69	-0.10	0.10	-0.03	0.03
L25	0.81	-0.81	0.18	-0.18	0.97*	-0.97*
L26	-0.85	0.85	-0.24	0.24	-0.53	0.53
L27	0.81	-0.81	0.10	-0.10	0.14	-0.14
L28	1.31*	-1.31*	0.30	-0.30	1.14*	-1.14*
L29	1.15	-1.15	0.12	-0.12	0.14	-0.14
L30	-1.35*	1.35*	-0.19	0.19	-1.03*	1.03*
L31	0.65	-0.65	0.08	-0.08	0.64	-0.64
L32	0.31	-0.31	0.12	-0.12	0.47	-0.47
L33	0.15	-0.15	0.07	-0.07	0.30	-0.30
L34	-0.85	0.85	-0.20	0.20	-1.20*	1.20*
L35	-1.19*	1.19*	-0.27	0.27	-1.20*	1.20*
L36	-1.35*	1.35*	-0.29	0.29	-1.20	1.20*
L37	0.65	-0.65	0.22	-0.22	-0.86	0.86
L38	-0.52	0.52	0.01	0.01	0.14	-0.14
L39	0.31	-0.31	0.11	-0.11	0.30	-0.30
L40	0.31	-0.31	0.10	-0.10	0.30	-0.30
SE sca 0.05	1.17		0.44		0.95	
SE sca 0.01	1.55		0.59		1.26	

Table 4. Cont.

Lines	100-kernel weight		Grain yield/plant	
	SC-128	TWC-324	SC-128	TWC-324
L1	2.95**	-2.95**	10.16**	-10.16**
L2	-1.21	1.21	-5.00**	5.00**
L3	1.79**	-1.79**	4.50**	-4.50**
L4	1.95**	-1.95**	0.01	0.01
L5	-2.38	2.38**	-9.84**	9.84**
L6	1.95**	-1.95**	7.50**	-7.50**
L7	0.95	-0.95	-3.50*	3.50*
L8	-0.05	0.05	-0.67	0.67
L9	-0.88	0.88	-3.50*	3.50*
L10	0.95	-0.95	3.83*	-3.83*
L11	1.95**	-1.95**	4.16*	-4.16*
L12	-2.38**	2.38**	-7.50**	7.50**
L13	-1.88**	1.88**	-10.67**	10.67**
L14	3.95**	-3.95**	14.66**	-14.66**
L15	0.62	-0.62	-1.17	1.17
L16	-2.05**	2.05**	-11.00**	11.00**
L17	2.29**	-2.29**	10.66**	-10.66**
L18	-1.38*	1.38*	-5.00**	5.00**
L19	1.45*	-1.45*	4.83**	-4.83**
L20	2.29**	-2.29**	4.50**	-4.50**
L21	1.45*	-1.45*	4.16*	-4.16*
L22	-0.05	0.05	7.33**	-7.33**
L23	-2.21**	2.21**	-6.00**	6.00**
L24	-2.71**	2.71**	-7.00**	7.00**
L25	2.12**	-2.12**	6.83**	-6.83**
L26	-2.71**	2.71**	-22.50**	22.50**
L27	1.45*	-1.45*	20.33**	-20.33**
L28	0.45	-0.45	0.01	0.01
L29	0.45	-0.45	0.50	-0.50
L30	-2.21**	2.21**	-9.84**	9.84**
L31	1.29	-1.29	7.16**	-7.16**
L32	0.95	-0.95	11.16**	-11.16**
L33	-1.55*	1.55*	1.00	-1.00
L34	0.45	-0.45	2.16	-2.16
L35	-2.55**	2.55**	-4.67**	4.67**
L36	-3.38**	3.38**	-18.67**	18.67**
L37	-2.38**	2.38**	-8.00**	8.00**
L38	-0.21	0.21	2.83	-2.83
L39	1.95**	-1.95**	7.50**	-7.50**
L40	-1.55*	1.55*	-1.17	1.17
SE sca 0.05	1.34		3.21	
SE sca 0.01	1.77		4.24	

Genetic variance components

Estimation of the general combining ability variances of S_1 lines (σ^2GCA-L) and testers (σ^2 GCA-T) in addition to, specific combining ability variance of top-crosses (σ^2SCA) for all the studied traits are shown in Table 5. The obtained results revealed that the variance due to GCA-L was higher than GCA-T for all the studied traits, indicating that most of GCA variance was due to lines. The variance of SCA exceeded that the variance of GCA (average) for all the studied traits, indicating that the non-additive gene action played an important role in the inheritance of all the studied traits. These results are supported with the findings of El-Beially *et al* (2007), Barakat and Abd El-Moula (2008), Mosa (2010), El-Arif *et al* (2011), Chandel and Mankotia (2014) and Ram *et al* 2015.

Table 5. Genetic parameters for grain yield and other agronomic traits.

Parameters	Silking date	Plant height	Ear height	Ear length	Ear diameter	Number of rows/ear	100-kernel weight	Grain yield /plant
σ^2GCA-L	5.49	874.26	186.65	4.33	0.30	3.59	21.56	1070.83
σ^2GCA-T	-0.07	1.57	0.87	0.03	0.001	-0.02	0.10	0.74
σ^2GCA(average)	0.09	14.46	3.09	0.07	0.005	0.06	0.36	17.70
σ^2SCA	2.84	101.43	33.34	1.24	0.05	0.89	6.91	133.18

All negative estimates of variance were considered equal zero.

Proportion contribution

Proportion contributions of the lines, testers and their interaction for all the studied traits are presented in Table 6. The obtained results illustrated that the lines contributed with the large percentage and played the major role in the inheritance of all the studied traits. As well as, the lines x testers interaction followed the lines of the previous result for all the studied traits. On the other hand, the testers contributed with the smallest percentage and played the lowest role in the inheritance of all the studied traits. These results are supported with the findings El-Beially *et al* (2007), Aly *et al* (2011), El-Arif *et al* (2011), Chandel and Mankotia (2014) and Ram *et al* (2015).

Table 6. Proportion contributions of lines, testers and their interaction for all the studied traits.

Traits	Lines	Testers	Lines x testers
Days to 50% silking	81.20	0.10	18.70
Plant height	94.37	0.22	5.41
Ear height	91.75	0.40	7.85
Ear length	86.23	0.61	13.16
Ear diameter	91.36	0.34	8.30
Number of rows/ear	88.82	0.03	11.15
100-kernel weight	86.69	0.51	12.80
Grain yield/ear	93.63	0.19	6.18

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استخدام طريقه السلاله X الكشاف لتقدير القدرة على التآلف فى الذرة الشاميه

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قسم المحاصيل – كليه الزراعه – جامعه الأزهر باسيوط

الملخص

أجريت هذه الدراسه خلال الفترة من ٢٠١٣-٢٠١٥ بهدف الاختبار المبكر للقدرة العامه والخاصه على التآلف وطبيعه الفعل الجينى لـ ٤٠ سلاله من الذرة الشاميه البيضاء الحبوب المرباه داخليا (الجيل الذاتى الاول) المستنبطه من العشيره Giza-2. حيث فى موسم ٢٠١٣ تم الحصول على ١٠٠ سلاله بالتلقيح الذاتى لأفضل النباتات وبذلك تم الحصول على الجيل الذاتى الاول. فى موسم ٢٠١٤ تم عمل التهجين القمى بين الـ ١٠٠ سلاله مع كشافين وهما الهجين الفردى ١٢٨ والهجين الثلاثى ٣٢٤ نجحت منهم ٤٠ سلاله بالتهجين مع كلا الكشافين وبذلك تم الحصول على ٨٠ هجين قمى. فى موسم ٢٠١٥ تم تقييم الـ ٨٠ هجين قمى بالأضافه الى الهجين الفردى ١٥٥ والهجين الثلاثى ٣٢٤ للمقارنه وذلك فى تصميم القطاعات الكامله العشوائيه فى ثلاث مكررات وقد دونت البيانات على صفات عدد الأيام حتى ظهور ٥٠% من الحرايز، ارتفاع النبات ، ارتفاع الكوز ، طول الكوز، قطر الكوز، عدد صفوف الكوز، وزن الـ ١٠٠ حبه ومحصول حبوب النبات.

أوضحت نتائج التحليل وجود اختلافات عاليه المعنويه لكلا من الهجن والسلالات والكشافين وتفاعل السلالات x الكشافين لكل الصفات المدروسه ما عدا صفتي عدد الأيام حتى ظهور ٥٠% من الحرايز وعدد صفوف الكوز للكشافين. اظهرت السلاله رقم ٢٩ معنويا اعلى قدره عامه على التآلف لصفات عدد الأيام حتى ظهور ٥٠% من الحرايز وعدد صفوف الكوز ومحصول حبوب النبات. سجل الهجين القمى (السلاله ٢٦ x الهجين الثلاثى-٣٢٤) معنويا اعلى قدرة خاصه على التآلف لصفه محصول الحبوب. لعب الفعل الغير مضيف للجينات الدور الرئيسى فى توريث كل الصفات. لعبت السلالات الدور الرئيسى فى توريث كل الصفات.