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Combining Ability of Some Maize Top-Crosses

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Abstract

This investigation was conducted during 2013-2015 to determine the productivity and combining ability of some maize genotypes (74 top-crosses and two check hybrids). Genotypes evaluated at Experimental Farm, Faculty of Agriculture, Al-Azhar University at Assiut Branch. The obtained results revealed that highly significant differences were found among top-crosses and lines as well as, significant or highly significant differences between two testers and the interaction of lines x testers for all studied traits, except ear diameter for testers. Significant desirable GCA effects were found of some inbred lines for all studied traits. Line No.1 had the highest negative GCA effect for number of days to 50% tasseling. So, Line No.1 a good combiner for early tasseling. The highest GCA for grain yield/plant (28.37) was obtained from line No.2 The tester SC-10 was significantly the best general combiner for number of days to 50% tasseling, number of days to 50% silking, ear diameter and number of rows/ear while, the tester TWC-324 was significantly the best general combiner for plant height, ear length, 100-kernel weight and grain yield/plant. Significant desirable SCA effects were found of some top-crosses for all studied traits. Top cross (L8 x SC-10) gave the earliest tasseling (53 days). The highest grain yield /plant (241.37 g) was obtained from Top cross (L31 x TWC-324). 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 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. Contribution of lines was higher than testers for all studied traits. So, Lines played the major role in the inheritance of traits.

Keyword: *combining ability, gene action, proportion contribution*

Introduction

Maize is the third most cereal crop in the world, providing nutrient for humans and animals. The main objectives of maize breeding program are to develop new inbred lines and hybrids. 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). The line x tester analysis method is used to estimate favorable parents and crosses and their general and specific combining abilities (Kempthorne, 1957). 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 success to identify parental lines that combine well and produce productive crosses, mainly depend on gene action that controls the traits to be improved. 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.

The aim of the present investigation was to determine productive, combining ability and mode of gene action that control studied traits.

Materials and Methods

Thirty seven S_2 white maize lines were derived from IW-469 population. In 2013 summer season, 150 vigorous plants were selected before silking and self pollinated. After harvesting, 100 selfed ears (S_1's) which gave sufficient grains were grown in 2014 spring season and self pollinated. After harvesting, 70 selfed ears (S_2's) which gave sufficient grains were chosen. In 2014 summer season, top-crosses were formed between selected 70 S_2 lines and the two testers i.e., Single Crosses 10 (SC-10) and Three Way Cross 324 (TWC-324) in two isolated blocks and among them 37 S_2 lines were crossed successfully with the two testers and gave sufficient grains to be evaluated in the next season. In 2015 summer season, the 74 top-crosses and two checks i.e., SC-77 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% tasseling, 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 treatment means were compared statistically using the test of the Least Significant Differences (L.S.D). The combining ability effects and types of gene action were estimated according to Kempthorne (1957) and Singh and Shaudhary (1979).

Results and Disscusion

1- Analysis of variance and mean performance

The analysis of variance of all the studied traits (Table 1) revealed 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 significant or highly significant differences among lines and between the two testers for all the studied traits, except ear diameter for testers, indicating that great diversity among the lines and between the two testers. At the same time highly significant differences were found between lines x testers interaction for 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% tasseling	Days to 50% silking	Plant height	Ear height	Ear length	Ear diameter	Number of rows/ear	100-kernel weight	Grain yield/plant
Crosses	73	14.63**	14.05**	400.624**	222.86**	5.68**	0.13**	2.80**	37.46**	178.41**
Lines(L)	36	20.66**	19.68**	561.12**	303.37**	8.64**	0.20**	3.48**	54.28**	1101.52**
Testers(T)	1	35.86**	30.29**	583.78**	90.83*	5.09**	0.07	8.46**	33.20**	1483.89**
L x T	36	8.01**	7.95**	235.04**	146.02**	2.74**	0.06**	1.95**	20.76**	336.95**
Error	146	2.82	2.81	33.04	18.76	0.45	0.02	0.36	3.97	740.39

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

Mean performance values of the 74 top-crosses and the two checks i.e., SC-77 and TWC-324 for all the studied traits are presented in Table 2. The obtained results cleared that 26 and 24 top-crosses were significantly earlier tasseling than the two checks SC-77 and TWC-324, respectively. Regarding to number of days to 50% silking, 25 and 24 top-crosses were significantly earlier silking than the two respective checks, respectively. In respect of plant height, 11 and 20 top-crosses were significantly shorter than the two respective checks, respectively. Ear height revealed that 27 top-crosses were significantly lower ear placement than the two checks. Moreover, ear length 17 and 24 top-crosses were significantly longer than the respective two checks, respectively. Concerning to ear diameter, 19 and 28 top-crosses were significantly superior than the two ranked checks, respectively. Numbers of rows/ear exhibited that 31 and 26 top-crosses were significantly superior than the two proposed checks, respectively. Regarding to 100-kernel weight, 24 and 26 top-crosses were significantly heavier than the two same checks, respectively. Also, grain yield/plant, 60 and 43 top-crosses were significantly out-yielded the two respective checks, respectively. The obtained results exhibited the genetic variability among the studied top-crosses along with comparative cheeks. These results are supported with the findings of Soliman and Sadek (1999), Amer and El-Shenawei (2007), El-Beially *et al* (2007), El-Arif *et al* (2011), Chandel and Mankotia (2014), Tamirat *et al* (2014), Anupam *et al* (2015) and Shah *et al* (2015).

Table 2 . Mean performance of all the studied traits for 74 top-crosses of maize.

Lines	Number of days to 50% tasseling			Number of days to 50% silking			Plant height		
	S.C.10	TWC-324	Mean	S.C.10	TWC-324	Mean	S.C.10	TWC-324	Mean
L1	54.00	55.00	54.50	57.00	58.00	57.50	231.00	256.67	243.84
L2	57.00	57.67	57.34	60.33	60.00	60.17	276.46	264.67	270.57
L3	60.00	61.00	60.50	63.00	64.00	63.50	263.67	256.67	260.17
L4	61.00	57.00	59.00	63.67	60.33	62.00	253.33	240.67	247.00
L5	56.67	60.00	58.34	59.67	63.33	61.50	250.00	247.00	248.50
L6	59.67	57.00	58.34	62.67	60.00	61.34	246.00	246.67	246.34
L7	55.67	59.67	57.67	58.67	62.67	60.67	254.67	264.67	259.67
L8	53.00	56.67	54.84	56.67	59.67	58.17	254.67	262.33	258.50
L9	60.00	58.67	59.34	63.00	61.67	62.34	222.67	240.33	231.50
L10	56.00	60.33	58.17	59.00	63.33	61.17	250.67	247.00	248.84
L11	60.33	57.33	58.83	63.33	60.33	61.83	247.67	250.33	249.00
L12	56.67	59.33	58.00	59.67	62.33	61.00	257.67	255.67	256.67
L13	56.00	60.67	58.34	59.00	63.67	61.34	260.00	258.00	259.00
L14	58.67	59.33	59.00	61.67	62.33	62.00	240.00	235.33	237.67
L15	58.00	58.33	58.17	61.33	61.33	61.33	242.67	232.00	237.34
L16	54.67	56.67	55.67	58.00	59.67	58.84	266.00	270.67	268.34
L17	56.33	55.00	55.67	59.67	58.00	58.84	274.33	246.67	260.50
L18	55.00	58.67	56.84	58.00	61.67	59.84	241.33	234.00	237.67
L19	55.00	58.67	56.84	58.00	61.67	59.84	277.00	254.67	265.84
L20	60.67	59.67	60.17	63.67	62.67	63.17	249.00	250.67	249.84
L21	54.67	55.00	54.84	57.67	58.00	57.84	261.33	264.67	263.00
L22	55.00	56.67	55.84	58.00	59.67	58.84	254.67	242.00	248.34
L23	56.67	61.00	58.84	63.33	63.67	63.50	265.33	250.33	257.83
L24	60.00	59.00	59.50	62.67	62.00	62.34	255.67	266.33	261.00
L25	60.67	60.33	60.50	63.67	63.00	63.34	253.67	250.67	252.17
L26	59.33	61.00	60.17	62.33	64.33	63.33	257.67	234.33	246.00
L27	58.00	56.33	57.17	61.00	59.33	60.17	256.00	236.67	246.34
L28	61.00	62.00	61.50	64.33	64.67	64.50	262.00	264.33	263.17
L29	57.00	60.33	58.67	60.00	63.33	61.67	259.00	263.00	261.00
L30	56.33	54.66	55.50	59.33	57.67	58.50	262.00	249.33	255.67
L31	56.67	58.33	57.50	59.67	61.33	60.50	260.33	257.00	258.67
L32	57.33	55.67	56.50	60.67	58.67	59.67	262.33	256.67	259.50
L33	55.67	57.33	56.50	58.67	60.33	59.50	281.67	259.33	270.50
L34	57.33	55.00	56.17	60.67	58.00	59.34	244.33	254.33	249.33
L35	56.67	61.00	58.84	59.67	64.00	61.84	261.33	263.33	262.33
L36	60.33	60.67	60.50	63.33	63.67	63.50	250.33	274.00	262.17
L37	57.00	56.67	56.84	59.67	59.67	59.67	255.67	241.33	248.50
Mean	57.41	58.32	57.86	60.56	61.30	60.93	255.73	252.50	254.11
TWC-324	62.33			65.33			264.00		
S.C.77	61.66			65.00			259.66		
LSD 0.05	2.69			2.69			9.35		
LSD 0.01	3.55			3.55			12.36		

Table 2. Cont.

Lines	Ear height			Ear length			Ear diameter		
	S.C.10	TWC-324	Mean	S.C.10	TWC-324	Mean	S.C.10	TWC-324	Mean
L1	127.00	154.67	140.84	21.07	22.43	21.75	4.53	4.90	4.72
L2	151.00	142.67	146.84	21.57	20.57	21.07	5.20	5.10	5.15
L3	160.33	171.33	165.83	21.73	21.50	21.62	4.73	4.70	4.72
L4	163.33	142.67	153.00	20.03	19.67	19.85	5.50	5.00	5.25
L5	140.00	140.33	140.17	20.57	21.47	21.02	4.90	4.73	4.82
L6	146.67	145.00	145.84	21.57	20.73	21.15	4.70	4.80	4.75
L7	145.67	142.67	144.17	19.67	22.50	21.09	4.97	4.97	4.97
L8	138.67	148.00	143.34	18.53	21.77	20.15	4.97	5.10	5.04
L9	130.67	138.33	134.50	17.33	19.67	18.50	4.77	5.00	4.89
L10	149.00	151.00	150.00	22.27	21.23	21.75	4.83	4.77	4.80
L11	149.00	143.67	146.34	22.97	22.20	22.59	4.63	4.73	4.68
L12	149.67	144.33	147.00	19.67	20.40	20.04	5.07	4.87	4.97
L13	141.67	134.33	138.00	22.73	23.27	23.00	4.70	4.53	4.62
L14	134.67	140.67	137.67	21.77	22.07	21.92	4.40	4.63	4.52
L15	130.33	134.67	132.50	21.63	22.00	21.82	4.83	4.70	4.77
L16	148.00	141.33	144.67	22.67	21.43	22.05	4.57	4.53	4.55
L17	159.33	147.00	153.17	22.33	21.33	21.83	4.70	4.67	4.69
L18	140.33	135.67	138.00	19.43	20.33	19.88	4.70	4.70	4.70
L19	152.67	145.67	149.17	22.67	23.17	22.92	4.93	4.70	4.82
L20	142.00	150.33	146.17	19.67	20.33	20.00	4.73	5.03	4.88
L21	150.33	145.33	147.83	21.47	21.33	21.40	4.57	4.63	4.60
L22	136.67	125.67	131.17	20.30	22.30	21.30	4.60	4.80	4.70
L23	156.00	148.67	152.34	19.73	20.07	19.90	4.83	4.67	4.75
L24	159.67	163.33	161.50	23.23	20.43	21.83	5.20	4.73	4.97
L25	148.67	139.33	144.00	19.13	19.37	19.25	4.93	4.97	4.95
L26	146.33	141.00	143.67	18.30	16.90	17.60	5.10	4.90	5.00
L27	151.67	148.67	150.17	19.93	20.77	20.35	5.00	4.70	4.85
L28	135.00	145.00	140.00	20.67	19.77	20.22	4.97	4.73	4.85
L29	151.00	149.67	150.34	21.63	20.17	20.90	4.90	5.20	5.05
L30	137.67	149.33	143.50	2207	21.60	21.84	4.50	4.43	4.47
L31	149.00	138.00	143.50	21.90	21.60	21.75	4.87	4.93	4.90
L32	147.00	137.00	142.00	20.03	21.67	20.85	4.47	4.53	4.50
L33	160.67	143.33	152.00	21.23	21.73	21.48	4.63	4.70	4.67
L34	134.33	144.33	139.33	20.67	21.93	21.30	4.67	4.73	4.70
L35	145.33	138.00	141.67	18.00	19.40	18.70	5.20	4.80	5.00
L36	141.33	157.00	149.17	19.70	22.57	21.14	4.90	4.80	4.85
L37	144.33	139.67	142.00	20.93	22.43	21.68	4.63	4.63	4.63
Mean	145.81	144.53	145.17	20.78	21.14	20.96	4.82	4.78	4.80
TWC-324	155.33			19.63			4.47		
S.C.77	157.33			20.10			4.60		
LSD 0.05	7.16			1.08			0.23		
LSD 0.01	9.46			1.43			0.30		

Table 2. Cont.

Lines	Number of rows/ear			100-kernel weight			Grain yield/plant		
	S.C.10	TWC-324	Mean	S.C.10	TWC-324	Mean	S.C.10	TWC-324	Mean
L1	12.47	12.47	12.47	36.10	39.50	37.80	200.97	240.90	220.94
L2	14.43	14.90	14.67	45.27	42.97	44.12	239.43	229.10	234.27
L3	12.23	12.47	12.35	47.47	45.77	46.62	223.77	203.43	213.60
L4	14.03	13.90	13.97	41.40	42.67	42.04	235.10	226.97	231.04
L5	15.40	13.67	14.54	41.10	44.50	42.80	241.10	225.90	233.50
L6	13.30	12.70	13.00	40.73	40.67	40.70	202.77	230.23	216.50
L7	14.03	14.33	14.18	42.20	46.17	44.19	226.03	213.97	220.00
L8	13.30	15.33	14.32	40.70	41.27	40.99	199.63	220.70	210.17
L9	14.57	13.20	13.89	33.40	43.37	38.39	195.97	214.03	205.00
L10	15.70	13.67	14.69	41.63	43.87	42.75	228.97	212.10	220.54
L11	12.87	12.77	12.82	35.90	43.60	39.75	198.67	196.77	197.72
L12	14.00	13.00	13.50	44.10	35.00	39.55	228.97	199.57	214.27
L13	13.00	13.67	13.34	43.17	43.27	43.22	212.30	237.03	224.67
L14	11.77	13.73	12.75	37.70	46.43	42.07	190.97	202.33	196.65
L15	15.00	12.67	13.84	37.80	37.90	37.85	207.30	213.56	210.43
L16	14.33	12.77	13.55	37.33	39.90	38.62	196.43	198.57	197.50
L17	12.77	13.67	13.22	37.50	36.97	37.24	204.20	186.90	195.55
L18	14.00	12.67	13.34	41.20	39.67	40.44	222.87	185.13	204.00
L19	13.33	12.47	12.90	40.57	38.47	39.52	215.10	209.87	212.49
L20	13.83	14.13	13.98	35.50	38.63	37.07	172.53	220.47	196.50
L21	15.00	13.43	14.22	33.43	38.47	35.95	181.97	195.87	188.92
L22	15.43	13.43	14.43	39.50	40.43	39.97	186.10	204.37	195.24
L23	13.10	12.47	12.79	39.30	35.50	37.40	175.63	197.23	186.43
L24	13.33	14.00	13.67	44.77	45.37	45.07	240.53	204.43	222.48
L25	14.23	14.00	14.12	38.60	34.97	36.79	194.20	196.13	195.17
L26	14.10	14.53	14.32	35.83	34.57	35.20	201.53	162.23	181.88
L27	14.80	12.90	13.85	36.73	37.40	37.07	187.97	192.67	190.32
L28	14.43	15.30	14.87	41.70	37.67	39.69	195.00	197.97	196.49
L29	14.67	13.10	13.89	45.97	47.87	46.92	215.77	232.23	224.00
L30	13.70	13.10	13.40	36.47	35.00	35.74	185.43	187.90	186.67
L31	14.13	12.90	13.52	38.73	42.07	40.40	218.30	241.37	229.84
L32	14.23	11.77	13.00	38.50	37.57	38.04	201.77	200.10	200.94
L33	13.67	13.67	13.67	39.07	43.33	41.20	178.43	195.10	186.77
L34	12.00	12.90	12.45	37.10	34.55	35.83	195.43	178.5	186.97
L35	15.00	12.87	13.94	42.57	39.17	40.87	191.30	226.90	209.10
L36	13.50	14.30	13.90	39.43	41.57	40.50	191.10	219.10	205.10
L37	12.00	11.90	11.95	39.23	39.50	39.37	189.10	164.10	176.60
Mean	13.83	13.37	13.60	39.67	40.42	40.04	204.67	207.13	205.90
TWC-324	11.90			34.93			190.67		
S.C.77	11.90			34.70			182.13		
LSD 0.05	0.96			3.22			8.48		
LSD 0.01	1.26			4.26			11.21		

II- **Combining ability**

A- General combining ability

Estimates of general combining ability effects for all the studied traits of the 37 S_2 white maize lines and the two testers i.e., S.C-10 and TWC-324 are presented in Table 3.

A.1- General combining ability for the two testers

The obtained results cleared that the tester SC-10 was significantly the best general combiner for number of days to 50% tasseling, number of days to 50% silking, ear diameter and number of rows/ear. Meanwhile, the tester TWC-324 was significantly the best general combiner for plant height, ear length, 100-kernel weight and grain yield/plant.

A.2- General combining ability for the inbred lines

The obtained results in Table 3 exhibited that the line number 1 was significantly the highest desirable general combiner for number of days to 50% tasseling and number of days to 50% silking with values of - 3.41 and - 3.43, respectively Also, line no.21 was ranked second order after line no.1. The line number 9 with value - 22.62 and the line number 22 with value - 14.00 were significantly the most superior general combiners for plant height and ear height, respectively. The line number 13 with value 2.07 and the line number 4 with value 0.45 were significantly the highest desirable general combiners for ear length and ear diameter, respectively. The line number 28 with value 1.30 was significantly the highest desirable general combiner for number of rows/ear. The line number 29 with value 6.87 and the line number 2 with value 28.37 were significantly the most superior general combiners for 100-kernel weight and grain yield/plant, respectively.

10 lines out of 37 possessed significant desirable GCA effects for number of days to 50% tasseling, ear height, ear diameter, number of rows/ear and 100-kernel weight. As well as, 9, 14, 15 and 16 lines possessed significant desirable GCA effects for number of days to 50% silking, plant height, ear length and grain yield/plant, respectively. These results are supported with the findings of Gado (2000), Mahmoud and Abd El-Azeem (2004), Osman and Ibrahem (2007), Senthil and Bharathi (2011), Chandel and Mankotia (2014), Shah *et al* (2015).

Table 3. Estimates of general combining ability effects for all the studied traits of 37 S_2 lines and 2 testers.

Lines	Number of days to 50% tasseling	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	-3.41**	-3.43**	-1.28	-4.34*	0.82**	-0.08	-1.11**	-2.25**	15.04**
L2	-0.58	-0.76	16.55**	1.66	0.13	0.35**	1.09**	4.07**	28.37**
L3	2.58**	2.57**	6.05**	20.66**	0.68*	-0.08	-1.22**	6.57**	7.70**
L4	1.09	1.07	-7.12**	7.83**	-1.08**	0.45**	0.39	1.99*	25.14**
L5	0.42	0.57	-5.61*	-5.00**	0.08	0.01	0.96**	2.75**	27.60**
L6	0.42	0.41	-7.78**	0.66	0.22	-0.05	-0.57*	0.65	10.60**
L7	-0.25	-0.26	5.54*	-1.00	0.15	0.16**	0.61*	4.14**	14.10**
L8	-3.08**	-2.76**	4.38	-1.84	-0.78**	0.23**	0.74**	0.94	4.27*
L9	1.42*	1.40*	-22.62**	10.67**	-2.43**	0.08	0.31	-1.66*	-0.90
L10	0.25	0.24	-5.28*	4.83**	0.82**	-0.00	1.11**	2.70**	14.64**
L11	0.92	0.91	-5.12*	1.16	1.65**	-0.12*	-0.76**	-0.30	-8.18**
L12	0.09	0.07	2.55	1.83	-0.90**	0.16**	-0.02	-0.35	8.37**
L13	0.42	0.41	4.88*	-7.17**	2.07**	-0.19**	-0.02	3.17**	18.77**
L14	1.08	1.07	-16.45**	-7.50**	0.98**	-0.29**	-0.82**	2.02*	-9.25**
L15	0.25	0.41	-16.78**	-12.67**	0.88**	-0.04	0.26	-2.20**	4.54*
L16	-2.25**	-2.09**	14.22**	-0.50	1.11**	-0.25**	-0.02	-1.43	-8.40**
L17	-2.25**	-2.09**	6.38**	8.00**	0.90**	-0.12*	-0.36	-2.81**	-10.35**
L18	-1.08	-1.09	-16.45**	-7.17**	-1.05**	-0.10	-0.24	0.39	-1.90
L19	-1.08	-1.09	11.72**	4.00*	1.98**	0.01	-0.67**	-0.53	6.59**
L20	2.25**	2.24**	-4.28	1.00	-0.93**	0.08	0.41	-2.98**	-9.40**
L21	-3.08**	-3.09**	8.88**	2.66	0.47	-0.20**	0.64**	-4.10**	-16.98**
L22	-2.08**	-2.09**	-5.78*	-14.00**	0.37	-0.10	0.86**	-0.08	-10.66**
L23	2.92**	2.57**	3.72	7.16**	-1.03**	-0.05	-0.80**	-2.65**	-19.46**
L24	1.59*	1.41*	6.88**	16.33**	0.90**	0.16**	0.10	5.02**	16.59**
L25	2.59**	2.41**	-1.95	-1.17	-1.68**	0.15**	0.54*	-3.26**	-10.73**
L26	2.25**	2.41**	-8.12**	-1.50	-3.33**	0.20**	0.74**	-4.85**	-24.01**
L27	-0.75	-0.76	-7.78**	5.00**	-0.58*	0.05	0.28	-2.98**	-15.58**
L28	3.59**	3.57**	9.05**	-5.17**	-0.67*	0.05	1.30**	-0.36	-9.41**
L29	0.75	0.74	6.88**	5.16**	-0.03	0.25**	0.31	6.87**	18.10**
L30	-2.41**	-2.43**	1.55	-1.67	0.90**	-0.34**	-0.17	-4.81**	-19.23**
L31	-0.41	-0.43	4.55	-1.67	0.82**	0.10	0.06	0.35	23.94**
L32	-1.41*	-1.26	5.38*	-3.17	-0.08	-0.30**	-1.57**	-2.01*	-4.96*
L33	-1.41*	-1.42*	16.38**	6.83**	0.55*	-0.14*	0.10	1.15	-19.13**
L34	-1.75*	-1.60*	-4.78*	-5.84**	-0.63*	-0.10	-1.12**	-4.21**	-18.90**
L35	0.92	0.91	8.22**	-3.50*	-2.23**	0.20**	0.36	0.82	3.20
L36	2.59**	2.57**	8.05**	4.00*	0.20	0.05	0.33	0.45	-0.80
L37	-1.08	-1.26	-5.62*	-3.17	0.75**	-0.17**	-1.62**	-0.68	-29.30**
S.E lines 0.05	1.36	1.36	4.65	3.50	0.54	0.11	0.48	1.61	4.24
0.01	1.79	1.79	6.14	4.63	0.72	0.15	0.64	2.13	5.61
Testers									
S.C.10	-0.40**	-0.37*	1.62**	0.64	-0.15*	0.02*	0.20**	-0.38*	-1.23*
TWC324	0.40**	0.37*	-1.62**	-0.64	0.15*	-0.02*	-0.20**	0.38*	1.23*
S.E testers 0.05	0.30	0.30	1.04	0.78	0.12	0.02	0.11	0.36	0.95**
0.01	0.40	0.40	1.37	1.03	0.16	0.03	0.14	0.48	1.25*

B- Specific combining ability

Estimates of specific combining ability effects of the 74 top-crosses for all the studied traits are presented in Table 4. The obtained results revealed that 2 top-crosses possessed significant negative desirable SCA effects for number of days to 50% tasseling and number of days to 50% silking. As well as, 11 and 10 top-crosses possessed significant negative desirable SCA effects for plant height and ear height, respectively. On the other hand, 9, 8, 7, 6 and 25 top-crosses possessed significant positive desirable SCA effects for ear length, ear diameter, number of rows/ear, 100-kernel weight and grain yield/plant, respectively. These results are supported with the findings of El-Zeir *et al* (2000), Mostafa (2000), Abd El-Moula (2005), Sunil *et al* (2012), Chandel and Mankotia (2014),Shah *et al* (2015).

Table 4. Estimates of specific combining ability effects for all the studied traits of 74 top-crosses.

Lines	Number of days to 50% tasseling		Number of days to 50% silking		Plant height	
	S.C.10	TWC-324	S.C.10	TWC-324	S.C.10	TWC-324
L1	-0.10	0.10	-0.13	0.13	-14.45**	14.45**
L2	0.07	-0.07	0.54	-0.54	4.38	-4.38
L3	-0.10	0.10	-0.13	0.13	1.88	-1.88
L4	2.40*	-2.40*	2.04*	-2.04*	4.71	-4.71
L5	-1.27	1.27	-1.46	1.46	-0.12	0.12
L6	1.73	-1.73	1.70	-1.70	-1.95	1.95
L7	-1.60	1.60	-1.63	1.63	-6.62*	6.62*
L8	-1.43	1.43	-1.13	1.13	-5.45	5.45
L9	1.07	-1.07	1.04	-1.04	-10.45**	10.45**
L10	-1.08	1.08	-1.80	1.80	0.21	-0.21
L11	1.90	-1.90	1.87	-1.87	-2.95	2.95
L12	-0.93	0.93	-0.96	0.96	-0.62	0.62
L13	-1.93*	1.93*	-1.96*	1.96*	-0.62	0.62
L14	0.07	-0.07	0.04	-0.04	0.71	-0.71
L15	0.23	-0.23	0.37	-0.37	3.71	-3.71
L16	-0.60	0.60	-0.46	0.46	-3.95	3.95
L17	1.07	-1.07	1.20	-1.20	12.21**	-12.21**
L18	-1.43	1.43	-1.46	1.46	2.05	-2.05
L19	-1.43	1.43	-1.46	1.46	9.54**	-9.54**
L20	0.90	-0.90	0.87	-0.87	-2.45	2.45
L21	0.23	-0.23	0.20	-0.20	-3.29	3.29
L22	-0.43	0.43	-0.46	0.46	4.71	-4.71
L23	0.23	-0.23	0.20	-0.20	5.88	-5.88
L24	0.90	-0.90	0.70	-0.70	-6.95*	6.95*
L25	0.57	-0.57	0.70	-0.70	-0.12	0.12
L26	-0.43	0.43	-0.63	0.63	10.05**	-10.05**
L27	1.23	-1.23	1.20	-1.20	8.05*	-8.05*
L28	-0.10	0.10	0.20	-0.20	-2.88	2.88
L29	-1.27	1.27	-1.30	1.30	-3.62	3.62
L30	1.23	-1.23	1.20	-1.20	4.71	-4.71
L31	-0.43	0.43	-0.46	0.46	0.05	-0.05
L32	1.23	-1.23	1.37	-1.37	1.21	-1.21
L33	-0.43	0.43	-0.47	0.47	9.54**	-9.54**
L34	1.57	-1.57	1.70	-1.70	-6.62*	6.62*
L35	-1.77	1.77	1.80	-1.80	-2.62	2.62
L36	0.23	-0.23	0.20	-0.20	-13.45**	13.45**
L37	0.58	-0.58	0.37	-0.37	5.55	-5.55
S.E. 0.05	1.92		1.92		6.57	
0.01	2.54		2.53		8.68	

Table 4. Cont.

Lines	Ear height		Ear length		Ear diameter	
	S.C.10	TWC-324	S.C.10	TWC-324	S.C.10	TWC-324
L1	-14.47**	14.47**	-0.53	0.53	-0.20*	0.20*
L2	3.53	-3.53	0.65	-0.65	0.33**	-0.33**
L3	-6.14*	6.14*	0.27	-0.27	-0.01	0.01
L4	9.69**	-9.69**	0.33	-0.33	0.23**	-0.23**
L5	-0.81	0.81	-0.30	0.30	0.07	-0.07
L6	0.19	-0.19	0.57	-0.57	-0.07	0.07
L7	0.86	-0.86	-1.27**	1.27**	-0.02	0.02
L8	-5.31*	5.31*	-1.47**	1.47**	-0.08	0.08
L9	-4.47	4.47	-1.02**	1.02**	-0.13	0.13
L10	-1.64	1.64	0.67	-0.67	0.02	-0.02
L11	2.03	-2.03	0.53	-0.53	-0.07	0.07
L12	2.03	-2.03	-0.22	0.22	0.08	-0.08
L13	3.03	-3.03	-0.12	0.12	0.07	-0.07
L14	-3.64	3.64	0.01	-0.01	-0.13	0.13
L15	-2.81	2.81	-0.03	0.03	0.05	-0.05
L16	2.69	-2.69	0.77*	-0.77*	-0.01	0.01
L17	5.53*	-5.53*	0.65	-0.65	-0.01	0.01
L18	1.69	-1.69	-0.30	0.30	-0.02	0.02
L19	2.86	-2.86	-0.09	0.09	0.10	-0.10
L20	-4.81	4.81	-0.18	0.18	-0.17*	0.17*
L21	1.86	-1.86	0.22	-0.22	-0.05	0.05
L22	4.86	-4.86	-0.85*	0.85*	-0.12	0.12
L23	3.03	-3.03	-0.02	0.02	0.07	-0.07
L24	-2.47	2.47	1.55**	-1.55**	0.22**	-0.22**
L25	4.03	-4.03	-0.03	0.03	-0.03	0.03
L26	2.03	-2.03	0.85*	-0.85*	0.08	-0.08
L27	0.86	-0.86	-0.27	0.27	0.13	-0.13
L28	-5.64*	5.64*	0.65	-0.65	0.10	-0.10
L29	0.03	-0.03	0.88*	-0.88*	-0.17*	0.17*
L30	-6.47*	6.47*	0.38	-0.38	0.02	-0.02
L31	4.86	-4.86	0.30	-0.30	-0.05	0.05
L32	4.36	-4.36	-0.67	0.67	-0.05	0.05
L33	8.03**	-8.03**	-0.10	0.10	-0.05	0.05
L34	-5.64*	5.64*	0.51	-0.51	-0.05	0.05
L35	3.03	-3.03	-0.54	0.54	0.18*	-0.18*
L36	-8.47**	8.47**	-1.28**	1.28**	0.33**	-0.33**
L37	1.69	-1.69	-0.60	0.60	-0.02	0.02
S.E. 0.05	4.95		0.77		0.16	
0.01	6.54		1.01		0.21	

Table 4. Cont.

Lines	Number of rows/plant		100-kernel weight		Grain yield/plant	
	S.C.10	TWC-324	S.C.10	TWC-324	S.C.10	TWC-324
L1	-0.20	0.20	-1.32	1.32	-18.73**	18.73**
L2	-0.43	0.43	1.53	-1.53	6.40*	-6.40*
L3	-0.32	0.32	1.23	-1.23	11.40**	-11.40**
L4	-0.13	0.13	-0.25	0.25	5.30	-5.30
L5	0.67	-0.67	-1.32	1.32	8.83**	-8.83**
L6	0.10	-0.10	0.41	-0.41	-12.50**	12.50**
L7	-0.35	0.35	-1.60	1.60	7.27*	-7.27*
L8	-1.22**	1.22**	0.10	-0.10	-9.30**	9.30**
L9	0.48	-0.48	-4.60**	4.60**	-7.80*	7.80*
L10	0.82*	-0.82*	-0.74	0.74	9.67**	-9.67**
L11	-0.15	0.15	-3.47**	3.47**	2.18	-2.18
L12	0.25	-0.25	4.78**	-4.78**	15.93**	-15.93**
L13	-0.53	0.53	0.33	-0.33	-11.13**	11.13**
L14	-1.18**	1.18**	-3.98**	3.98**	-4.45	4.45
L15	0.97**	-0.97**	0.33	-0.33	-1.90	1.90
L16	0.58	-0.58	-0.90	0.90	0.17	-0.17
L17	-0.65	0.65	0.65	-0.65	9.88**	-9.88**
L18	0.47	-0.47	1.15	-1.15	20.10**	-20.10**
L19	0.23	-0.23	1.43	-1.43	3.85	-3.85
L20	-0.35	0.35	-1.19	1.19	-22.73**	22.73**
L21	0.58	-0.58	-2.14	2.14	-5.72	5.72
L22	0.80*	-0.80*	-0.09	0.09	-7.90*	7.90*
L23	0.12	-0.12	2.28*	-2.28*	-9.57**	9.57**
L24	-0.53	0.53	0.08	-0.08	19.28**	-19.28**
L25	-0.08	0.08	2.20	-2.20	0.27	-0.27
L26	-0.42	0.42	1.01	-1.01	20.88**	-20.88**
L27	0.75*	-0.75*	0.05	-0.05	-1.12	1.12
L28	-0.63	0.63	2.40*	-2.40*	-0.25	0.25
L29	0.58	-0.58	-0.57	0.57	-7.00*	7.00*
L30	0.10	-0.10	1.11	-1.11	-0.001	0.001
L31	0.42	-0.42	-1.29	1.29	-10.30**	10.30**
L32	0.03	-0.03	0.85	-0.85	2.07	-2.07
L33	-0.20	0.20	-1.75	1.75	-7.10*	7.10*
L34	-0.65	0.65	1.65	-1.65	9.67**	-9.67**
L35	0.87*	-0.87*	2.08	-2.08	-16.57**	16.57**
L36	-0.60	0.60	-0.69	0.69	-12.77**	12.77**
L37	-0.15	0.15	0.25	-0.25	13.73**	-13.73**
S.E. 0.05	0.69		2.28		6.00	
0.01	0.91		3.01		7.93	

II - Genetic variance components

Estimation of the general combining ability variances of S_2 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 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 Sadek *et al* (2001), El-Shenawy *et al* (2003), Abd El-Azeem *et al* (2004), El-Beially *et al* (2007), Barakat and Abd El-Moula (2008), Mosa (2010), El-Arif *et al* (2011), Chandel and Mankotia (2014).

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

Parameters	Tasseling date	Silking date	Plant height	Ear height	Ear length	Ear diameter	Number of rows/ear	100-kernel weight	Grain yield /plant
σ^2GCA-L	2.108	1.955	54.347	26.225	0.983	0.023	0.255	5.587	123.917
σ^2GCA-T	0.251	0.201	3.142	-0.497	0.021	0.001	0.059	0.112	-3.635
σ^2GCA(average)	0.040	0.037	0.999	0.464	0.018	0.0004	0.005	0.101	2.179
σ^2SCA	1.730	1.713	67.333	42.420	0.763	0.013	0.530	5.597	237.617

All negative estimates of variance were considered equal zero.

V-Proportion contribution

Proportion contribution of the lines, testers and their interaction for all the studied traits are presented in Table 6. The obtained results concluded 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 (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% tasseling	69.64	3.36	27.00
Days to 50% silking	69.08	2.95	27.90
Plant height	69.07	2.00	28.93
Ear height	67.13	0.56	32.31
Ear length	75.01	1.23	23.79
Ear diameter	75.87	0.74	22.76
Number of rows/ear	61.29	4.14	34.34
100-kernel weight	71.46	1.21	27.33

Grain yield/ear	66.43	0.42	33.15

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القدرة على الأئتلاف لبعض الهجن القميه للذرة الشاميه

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الملخص

أجريت هذه الدراسه خلال الفترة من ٢٠١٣-٢٠١٥ بهدف تحديد الانتاجية والقدره على التآلف فى بعض الطرز الوراثية للذرة الشامية. تم تقيم الطرز الوراثية بمزرعة كلية الزراعة - جامعة الأزهر فرع أسيوط - تصميم القطاعات الكامله العشوائيه فى ثلاث مكررات.

أوضحت نتائج التحليل وجود اختلافات معنويه او عاليه المعنويه لكلا من الهجن والسلالات والكشافين وتفاعل السلالات x الكشافين لكل الصفات المدروسه ما عدا صفه قطر الكوز للكشافين.

وجدت قيم معنويه ومرغوبه للقدره العامه والقدره الخاصه على التألف فى جميع الصفات المدروسه. السلالة رقم ١ والكشاف SC-10 لهما قدرة تآلف عاليه بالنسبة للتبكير فى نثر حبوب اللقاح. بينما السلالة رقم ٢ والكشاف TWC-324 لهما قدرة تآلف عامة جيده لمحصول حبوب النبات.

الهجين القمى (L8 x SC-10) أعطى أبكر نباتات (٥٣ يوم) من الزراعة حتى نثر حبوب اللقاح بينما أعلى محصول حبوب للنبات (٢٤١.٣٧ جم) تم الحصول عليه من الهجين القمى (L31 x TWC- 324).

اظهرت النتائج ان الفعل الغير مضيف للجينات لعب الدور الرئيسى فى توريث كل الصفات المدروسه.

لعبت السلالات الدور الرئيسى فى توريث جميع الصفات المدروسة.