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GENOTYPIC CORRELATION AND COMBINING ABILITY OF SOME YELLOW MAIZE INBRED LINES VIA LINE BY TESTER ANALYSIS

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ABSTRACT

Twenty six inbred lines were top-crossed with two testers i.e. inbred lines Gm 1002 and Gm 1021 at Mallawy Agric Res. Station in 2009 season. The resulted 52 topcrosses along with two commercial check hybrids i.e. SC 162 and SC 166 were evaluated in replicated yield trails conducted at Sakha and Mallawy Agric. Res. Stations in 2010 season. Results showed highly significant differences between both locations. Mean squares due to lines, testers and lines x testers were significant or highly significant for all studied traits. Mean squares due to lines x locations, testers x locations and lines x testers x locations interactions were significant or highly significant for all studied traits, except for days to 50% silking. Five and six inbred lines possessed positive and significant or highly significant general combining ability effects (GCA) for ears per 100 plant and ear length, respectively. Six inbred lines had positive and significant or highly significant GCA effects for grain yield. For specific combining ability effects (SCA) six, two and three topcrosses had positive and significant SCA effects for ears per 100 plants, ear length and grain yield, respectively. σ^2_{GCA-L} was higher than σ^2_{GCA-T} for all studied traits, except ears per 100 plants, which indicated that most of GCA variance was due to lines. The ratio of $\sigma^2_{GCA}/\sigma^2_{SCA}$ was more than unit for days to 50% silking and plant and ear height, indicating that additive gene action played an important role in the inheritance of these traits, while $\sigma^2_{GCA}/\sigma^2_{SCA}$ was less than unity for ears per 100 plants, ear length and grain yield, indicating that non-additive genetic variance was more important in the expression of the latter traits. Positive and significant genotypic correlation was observed among grain yield and each of days to 50% silking, plant height and ear height. The highest grain yield was obtained by two topcrosses i.e. L-8 x Gm 1021 and L-17 x Gm 1021, which significantly outyielded the check hybrid SC 162 by 12.56 and 12.33%, respectively. These two promising single crosses have to be evaluated in the advanced stage for release as new commercial hybrids in Maize Research Programme.

Key words: ***Maize, Line x Tester, Combining ability, Genotypic correlation***

INTRODUCTION

Maize (*Zea mays* L.) is one of important cereal crops. Its cultivation extends over a wide range of geographical and environmental conditions ranging from 58°N to 40°S. Maize has been subjected to extensive genetic studies than any other crops (Hallauer and Miranda 1988). Maize breeders have used many biometrical techniques to study the quantitative traits including grain yield. Several types of hybrids are possible in maize; however the most common ones used for commercial production are derived from inbred lines. The top-cross procedure was suggested by Davis (1927) to evaluate the combining ability of inbred lines to determine the usefulness of the lines for hybrid development. Line x tester analysis is an extension of this method in which several testers are used (Kempthorne 1957) and it is provides information about general and specific combining ability of parents and at the same time it is helpful in estimating various typed of gene action (Singh and Chaudhary 1985). Rojas and Sprague (1952) compared the estimates of variances of GCA and SCA for yield and their interaction with locations. The concepts of GCA and SCA became useful for characterization of inbred lines in crosses and often have been included in the description of an inbred line (Hallauer and Miranda 1988). Many researchers (Dodiya and Joshi 2002, Parvez and Rather 2006 and El-Hifny *et al* 2010), indicated the importance of non-additive type of gene action in the inheritance of grain yield.

Genotypic correlation expresses the extent to which two traits are genetically associated. Genotypic correlations among and between pairs of agronomic traits provide scope for indirect selection in a crop breeding programme. Abo El-Saad *et al* (1994) found highly significant genotypic correlation coefficients between grain yield per plant, days to 50% silking and plant height. The main objectives of this study were to (1) identify the best inbred lines and crosses. (2) estimate the variance components for lines, testers and their interaction with locations. (3) determine the genotypic correlation coefficients among grain yield and other studied traits.

MATERIALS AND METHODS

Twenty six yellow maize inbred lines in the S_5 generation derived from composite SK-21 through selfing and or with selection in disease nursery field at Mallawy Agricultural Research Station were used in this study. In 2009 growing season the twenty six inbred lines were topcrossed to each of the two narrow base inbred testers i.e. Gm 1002 and Gm 1021 at Mallawy Agric. Res. Stn. The resulted 52 top-crosses along with two commercial single crosses i.e. SC 162 and SC 166 were evaluated in replicated yield trails conducted at Sakha and Mallawy Agric. Res. Stns in 2010 season. A randomized complete block design with four replications was used in each location. Plot size was one row, 6 m long and 70 cm wide; hills were spaced 25 cm along the row. All cultural practices for maize production were applied as recommended.

Data were recorded on days to 50% silking, plant and ear height (cm), number of ears per 100 plants, ear length (cm) and grain yield, which was adjusted at 15.5% grain moisture and converted to ardab per fed (ardab = 140 kg). Analysis of variance was performed for the combined data across locations according to Steel and Torrie (1980). The procedures of Kempthorne (1957) was performed to obtain information about the combining ability of lines and testers as well as their topcrosses.

The data were subjected to analysis of variance and covariance to compute genotypic correlation coefficients among pairs of studied traits according to Kwon and Torrie (1964).

RESULTS AND DISCUSSION

Analysis of variance

Analysis of variance for all studied traits across two locations are presented in Table 1. Results showed highly significant differences between the two locations, indicating that the two locations differed in the environmental conditions. Mean squares due to crosses were highly significant for all studied traits. Mean squares due to lines, testers and lines x testers were significant or highly significant for all studied traits, indicating that the inbred lines behavior differed in their order of performance in crosses with each tester. Similar results were obtained by Castellanos *et al* (1998), Abd El-Moula *et al* (2004), Soliman and Osman (2006) and El-Hifny *et al* (2010).

Mean squares due to crosses x locations interaction were highly significant forall studied traits, except days to 50 % silking and ear length, indicating that the crosses differed in their order from location to another. Mean squares due to lines x locations, testers x locations and lines x testers x locations interaction were significant or highly significant for all studied traits, except for days to 50% silking. These results are in agreement with those obtained by Soliman *et al* (1995), who reported significant interaction of lines x locations and testers x locations for ear length, however El-Hefny *et al* (2010) found insignificant mean squares due to tester x locations and lines x testers x locations for days to 50% silking.

Mean performance

Mean performance of 52 topcrosses and two check hybrids for all studied traits across two locations are presented in Table 2. Data showed that most of top-crosses were significantly earlier than the earliest check hybrid (SC. 166). The earliest three top-crosses were L-24 x Gm 1002 (57.00), L-25 x Gm 1002 (57.25) and L-24 x Gm 1021 (57.88 days). For plant height, results showed that 24 out of 52 top-crosses were significantly shorter than the shortest check hybrid (SC 166). The shortest top-crosses were L-25 x Gm 1002, L-24 x Gm 1002 and L-26 x Gm 1002 with values of 219.00, 221.38 and 224.50 cm, respectively. The top-crosses involving inbred tester Gm 1002 had short plant height and lower ear height than the top-crosses involving the inbred tester Gm 1021. Mean ear height ranged from 114.88 for topcross L-25 x Gm 1002 to 164.75 cm for top-cross L-17 x Gm 1021

Table 1. Mean squares for grain yield and other studied traits, data are combined across two locations in 2010 season.

S.O.V	df	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ears/100 plants	Ear length (cm)	Grain yield (ard/fed)
Locations (Loc.)	1	6656.00**	34256.31**	39878.19**	2952.18**	91.31**	247.35**
Reps/loc.	6	38.12	398.83	262.47	67.80	1.77	30.11
Crosses	51	14.83**	1436.28**	879.27**	466.20**	6.21**	46.78**
Lines	25	27.04**	2251.38**	1310.48**	498.83**	8.46**	65.97**
Testers	1	23.09**	11246.56**	9075.12**	4233.00**	34.79**	105.62**
Lines x Testers	25	2.30*	228.80**	120.23**	282.72**	2.80**	25.25**
Loc. x Crosses	51	1.073	333.05**	311**	232.30**	1.99	19.36**
Loc. x Lines	25	0.66	435.35**	436.90**	238.45**	2.12**	19.97**
Loc. x Testers	1	3.85	3217.91**	2716.27**	1595.13**	9.39**	33.74*
Loc. x Lines x Testers	25	1.38	115.36*	89.69*	171.65**	1.56**	18.17**
Error	306	1.32	68.37	52.80	66.24	0.79	9.43
CV%		1.89	3.29	5.12	7.72	4.43	10.60

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

Table 2. Mean values of the studied traits of the top-crosses between 26 inbred lines and two testers across two locations.

Inbred lines	Days to 50% silking		Plant height (cm)		Ear height (cm)		Ears/100 plants		Ear length (cm)		Grain yield (ard/fed)	
	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021
L-1	62.63	61.50	239.75	255.63	135.75	150.50	105.81	107.41	19.48	20.83	31.16	29.43
L-2	61.63	62.13	268.88	264.25	149.88	149.88	97.38	100.30	20.35	21.73	30.19	26.24
L-3	60.13	61.63	254.25	260.75	139.75	150.88	104.96	103.91	20.25	20.53	30.02	29.59
L-4	60.25	61.63	264.38	260.25	148.13	147.50	98.51	101.04	20.90	20.53	27.92	29.51
L-5	60.75	61.75	261.75	264.50	149.50	148.75	103.28	98.16	19.96	20.18	31.48	27.37
L-6	61.25	61.88	253.13	262.88	143.75	152.63	103.46	98.20	19.75	20.58	24.16	28.25
L-7	61.63	61.88	258.75	266.13	146.38	156.25	99.39	98.24	20.98	20.53	25.05	29.00
L-8	61.00	62.25	255.50	261.75	141.63	150.38	102.88	130.53	19.18	19.70	29.94	33.41
L-9	62.00	62.00	263.63	275.38	152.13	162.75	100.56	113.93	19.70	19.83	29.84	27.89
L-10	60.88	60.75	264.38	270.63	152.13	156.25	100.06	121.48	19.88	19.88	30.36	30.96
L-11	61.25	61.88	243.75	255.88	134.75	147.63	100.04	113.56	18.68	20.38	27.21	31.47
L-12	61.75	61.75	253.50	264.63	140.25	150.63	100.56	106.25	21.35	23.08	28.95	32.29
L-13	59.63	59.87	230.00	238.13	125.50	135.13	102.76	109.14	20.18	21.30	27.75	30.68
L-14	60.88	61.63	244.88	254.63	136.88	143.88	101.01	107.04	18.88	20.30	28.45	28.94

Table 2. Continued

Inbred lines	Days to 50% silking		Plant height (cm)		Ear height (cm)		Ears/100 plants		Ear length (cm)		Grain yield (ard/fed)	
	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021
L-15	60.00	61.13	234.50	256.63	127.75	144.88	105.89	115.94	18.88	18.55	32.00	31.04
L-16	60.38	61.50	237.13	253.88	133.38	145.50	102.28	108.63	19.98	18.83	27.71	31.29
L-17	63.63	63.00	259.25	273.38	150.25	164.75	112.71	131.58	20.15	20.15	32.06	33.34
L-18	62.13	62.13	234.75	245.88	133.38	141.50	102.50	102.31	19.33	19.33	28.82	32.06
L-19	62.25	62.25	233.50	240.88	129.25	138.00	100.60	104.18	19.05	19.50	28.11	31.65
L-20	61.75	61.13	239.38	240.63	133.13	133.75	100.46	105.18	19.12	19.27	26.27	29.42
L-21	61.88	61.13	243.75	258.00	140.38	150.13	101.20	110.90	20.23	20.23	30.06	31.62
L-22	60.88	61.25	244.38	258.25	137.13	150.00	102.56	95.71	20.28	21.40	26.90	28.47
L-23	58.25	58.88	244.38	247.50	134.00	137.75	101.10	103.93	19.25	20.15	29.02	28.46
L-24	57.00	57.88	221.38	240.75	120.63	135.13	104.23	122.18	19.73	20.05	23.88	24.19
L-25	57.25	59.25	219.00	245.88	114.88	133.25	100.88	106.60	18.65	21.15	25.88	25.15
L-26	59.63	60.75	224.50	245.75	119.75	136.13	102.04	106.69	18.83	20.15	27.15	24.87
Check hybrids												
SC 162	65.00		268.88		151.88		118.80		24.53		29.68	
SC 166	63.88		259.63		147.13		117.42		22.98		35.23	
LSD 0.05	1.13		8.10		7.12		7.98		0.87		3.01	

Regarding ears per 100 plants, two top-crosses i.e. L-8 x Gm 1021 and L-17 x Gm 1021 were significantly surpassed the best check hybrid by 30.6 and 31.6%, respectively. For ear length, the best five top-crosses which had longer ears but didn't surpass the checks were L-12 x Gm 1021, L-22 x Gm 1021, L-12 x Gm 1002, L-13 x Gm 1021 and L-25 x Gm 1021 and their ear length were 23.08, 21.40, 21.35, 21.30 and 21.15 cm, respectively. The top-crosses involving the tester Gm 1021 tended to be longer ears than those of the tester Gm 1002. Concerning grain yield, two top-crosses i.e. L-8 x Gm 1021 and L-17 x Gm 1021 significantly outyielded the check hybrid SC 162 by 12.56 and 12.33%, respectively.

General combining ability effects (GCA)

Estimates of general combining ability effects of the 26 inbred lines and two testers across locations for all studied traits are presented in Table 3. For days to 50% silking, five inbred lines (L-13, L-23, L-24, L-25 and L-26) possessed negative (desirable) and highly significant GCA effects and are considered good combiners for earliness. Regarding plant and ear height, nine inbred lines (L-13, L-15, L-18, L-19, L-20, L-23, L-24, L-25 and L-26) had negative (desirable) and significant or highly significant GCA effects, indicating that these inbred lines are considered good combiners for both shortness and low ear placement.

Estimates of GCA effects for ears per 100 plants showed that five inbred lines i.e. L-8, L-10, L-15, L-17 and L-24 possessed positive (favorable) and significant or highly significant GCA effects and are considered good combiners for this trait. Six inbred lines (L-2, L-4, L-7, L-12, L-13 and L-14) had positive and significant or highly significant GCA effects for ear length and are considered good combiners for this character.

Concerning grain yield, six inbred lines i.e. L-8, L-10, L-12, L-15, L-17 and L-21 had positive (desirable) and significant or highly significant GCA effects with values of 2.69**, 1.68*, 1.64*, 2.54**, 3.72** and 1.86*, respectively. These lines were considered as good combiners for grain yield.

Concerning testers, the inbred tester Gm 1021 had positive (favorable) and significant or highly significant GCA effects for ears per 100 plants, ear length and grain yield, indicating that it may have favorable genes and is a good combiner for theses traits. On the other hand, the inbred tester Gm 1002 possessed negative (desirable) and highly significant GCA effects and is considered as a good combiner for earliness, shortness and low ear position

Table 3. General combining ability effects ($\hat{g}_i$) for the studied traits, in the combined analysis across locations.

Inbred line	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ears/100 plants	Ear length (cm)	Grain yield (ard/fed)
L-1	1.04**	-3.37	1.11	1.23	0.13	1.31
L-2	0.85**	15.50**	7.86**	-6.55**	1.02**	-0.76
L-3	-0.15	6.44**	3.30	-0.94	0.37	0.83
L-4	-0.02	11.25**	5.80**	-5.61**	0.69**	-0.26
L-5	0.23	12.06**	7.11**	-4.67*	0.05	0.44
L-6	0.48	6.94**	6.17**	-4.55*	0.14	-2.77**
L-7	0.73*	11.38**	9.30**	-6.57**	0.73**	-1.95*
L-8	0.60	7.56**	3.99	11.31**	-0.58**	2.69**
L-9	0.98**	18.44**	15.43**	1.86	-0.26	-0.12
L-10	-0.21	16.44**	12.18**	5.38**	-0.15	1.68*
L-11	0.54	-1.25	-0.82	1.41	-0.50*	0.36
L-12	0.73*	8.00	3.43	-1.98	2.19**	1.64*
L-13	-1.27**	-17.00**	-11.70**	0.56	0.72**	0.23
L-14	0.23	-1.31	-1.64	-1.36	-0.43*	-0.28
L-15	-0.46	-5.50**	-5.70**	5.53**	-1.26**	2.54**
L-16	-0.09	-5.56**	-2.57	0.06	-0.62	0.52

Table 3. Continued

Inbred lines	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ears/100 plants	Ear length (cm)	Grain yield (ard/fed)
L-17	2.29**	15.25**	15.49**	16.76**	0.13	3.72**
L-18	1.10**	-10.75*	-4.57*	-2.98	-0.70**	1.46
L-19	1.23**	-13.87**	-8.39**	-3.00	-0.75**	0.90
L-20	0.41	-11.06*	-8.57**	-2.57	-0.82**	-1.14
L-21	0.48	-0.19	3.24	0.66	0.20	1.86*
L-22	0.04	0.25	1.55	-6.25**	0.82**	-1.29
L-23	-2.46**	-5.12*	-5.82**	-2.87	-0.32	-0.24
L-24	-3.59**	-20.00**	-14.14**	7.81**	-0.13	-4.94**
L-25	-2.71**	-18.62**	-17.95**	-1.65	-0.12	-3.47**
L-26	-0.96**	-15.94**	-14.07**	-1.02	-0.53*	-2.97**
SE (g_i)	**0.29**	**2.07**	**1.82**	**2.03**	**0.22**	**0.77**
SE (g_i-g_j)	**0.41**	**2.92**	**2.57**	**2.88**	**0.31**	**1.09**
Testers						
Gm 1002	-0.24**	-5.20**	-4.67**	-3.19**	-0.29**	-0.50*
Gm 1021	0.24**	5.20**	4.67**	3.19**	0.29**	0.50*
SE (g_i)	**0.08**	**0.57**	**0.50**	**0.56**	**0.06**	**0.21**
SE (g_i-g_j)	**0.11**	**0.81**	**0.71**	**0.80**	**0.09**	**0.30**

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

Specific combining ability effects (SCA)

Estimates of specific combining ability effects of the 52 top crosses for all studied traits across locations are presented in Table 4. Data showed that only the topcross (L-1 x Gm 1021) had negative and significant SCA effects for days to 50% silking, while for plant height, four topcrosses i.e. L-2 x Gm1021, L-4 x Gm1021, L-15 x Gm1002 and L-25 x Gm1002 possessed negative and significant or highly significant SCA effects. These crosses were considered as good combinations for short plants. Regarding ear height, one topcross (L-5 x Gm1021) had negative and significant SCA effects. For ears per 100 plants, six topcrosses i.e. L-5 x Gm 1002, L-6 x Gm 1002, L-8 x Gm 1021), L-10 x Gm 1021, L-17 x Gm 1021 and L-24 x Gm 1021 had positive and significant or highly significant SCA effects. These topcrosses are considered as good combinations for prolificacy. For ear length, two topcrosses (L-16 x Gm 1002 and L-25 x Gm 1021) had positive and highly significant SCA effects.

Regarding grain yield, the best SCA effects were detected from the topcrosses L-2 x Gm 1002, L-5 x Gm 1002 and L-26 x Gm 1002, which had positive and significant SCA effects and are considered as good combinations for high grain yield.

Variance components

Estimates of combining ability variances σ^2_{GCA-L} for lines, σ^2_{GCA-T} for testers, σ^2_{SCA} for testcrosses and their interactions with environments are presented in Table 5. Results showed that σ^2_{GCA-L} was higher than σ^2_{GCA-T} for all studied traits, except ears per 100 plants, indicating that most of GCA variance was due to lines.

The ratio of σ^2GCA/σ^2SCA was more than unity for days to 50% silking, plant height and ear height, indicating that additive gene action played an important role in the inheritance of these traits, while $\sigma^2_{GCA}/\sigma^2_{SCA}$ was less than unity for ears per 100 plant, ear length and grain yield, indicating that non-additive genetic variance was more important in the expression of the latter traits. Similar results were obtained by Abd El-Moula *et al* (2004) and Soliman and Osman (2006), who indicted that additive gene effect was more important in the inheritance of days to 50% silking.Dodiya and Joshi (2002), Kumar *et al* (2005) and Parvez and Rather (2006) found preponderance of SCA variance for ear length and grain yield indicating greater role of non-additive component in the inheritance of these traits. Motawei *et al* (2005) and Osman and Ibraim (2007) indicated that the additive type of gene action was more important than non-additive in the inheritance of plant and ear height.

Table 4. Specific combining ability effects ($\hat{S}_{ij}$) of 52 topcrosses for grain yield and the other studied traits, in the combined analysis across locations.

Inbred lines	Days to 50% silking		Plant height (cm)		Ear height (cm)		Ears/100 plants		Ear length (cm)		Grain yield (ard/fed)	
	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021
L-1	0.80*	-0.80*	-2.74	2.74	-2.70	2.70	2.39	-2.39	-0.39	0.39	1.37	-1.37
L-2	-0.01	0.01	7.51**	-7.51**	4.67	-4.67	1.73	-1.73	-0.40	0.40	2.48*	-2.48*
L-3	-0.51	0.51	1.95	-1.95	-0.89	0.89	3.71	-3.71	0.15	-0.15	0.72	-0.72
L-4	-0.39	0.39	7.26*	-7.26*	4.98	-4.98	1.93	-1.93	0.48	-0.48	-0.29	0.29
L-5	-0.26	0.26	3.82	-3.82	5.05*	-5.05*	5.75*	-5.75*	0.18	-0.18	2.56*	-2.56*
L-6	-0.14	0.14	0.32	-0.32	0.23	-0.23	5.82*	-5.82*	-0.12	0.12	-1.54	1.54
L-7	0.11	-0.11	1.51	-1.51	-0.27	0.27	3.76	-3.76	0.51	-0.51	-1.47	1.47
L-8	-0.39	0.39	2.07	-2.07	0.30	-0.30	-10.64**	10.64**	0.03	-0.03	-1.23	1.23
L-9	0.24	-0.24	-0.68	0.68	-0.64	0.64	-3.49	3.49	0.23	-0.23	1.48	-1.48
L-10	0.30	-0.30	2.07	-2.07	2.61	-2.61	-7.51**	7.51**	0.29	-0.29	0.21	-0.21
L-11	-0.08	0.08	-0.86	0.86	-1.77	1.77	-3.57	3.57	-0.56	0.56	-1.62	1.62
L-12	0.24	-0.24	-0.36	0.36	-0.52	0.52	0.35	-0.35	-0.57	0.57	-1.17	1.17
L-13	0.11	-0.11	1.14	-1.14	-0.14	0.14	0.002	-0.002	-0.27	0.27	-0.96	0.96
L-14	-0.14	0.14	0.32	-0.32	1.17	-1.17	0.18	-0.18	-0.42	0.42	0.26	-0.26

Table 4. Continued

Inbred lines	Days to 50% silking		Plant height (cm)		Ear height (cm)		Ears/ 100 plants		Ear length (cm)		Grain yield (ard/fed)	
	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021	Gm 1002	Gm 1021
L-15	-0.33	0.33	-5.86*	5.86*	-3.89	3.89	-1.84	1.84	0.50	-0.50	0.99	-0.99
L-16	-0.33	0.33	-3.18	3.18	-1.39	1.39	0.01	-0.01	0.86**	-0.86**	-1.28	1.28
L-17	0.55	-0.55	-1.86	1.86	-2.58	2.58	-6.24*	6.24*	0.29	-0.29	-0.14	0.14
L-18	0.24	-0.24	-0.36	0.36	0.61	-0.61	3.28	-3.28	0.29	-0.29	-1.12	1.12
L-19	0.24	-0.24	1.51	-1.51	0.30	-0.30	1.40	-1.40	0.06	-0.06	-1.26	1.26
L-20	0.55	-0.55	4.57	-4.57	4.36	-4.36	0.83	-0.83	0.21	-0.21	-1.07	1.07
L-21	0.61	-0.61	-1.93	1.93	-0.20	0.20	-1.66	1.66	0.29	-0.29	-0.27	0.27
L-22	0.05	-0.05	-1.74	1.74	-1.77	1.77	6.61	-6.61	-0.27	0.27	-0.28	0.28
L-23	-0.08	0.08	3.64	-3.64	3.11	-3.11	1.78	-1.78	-0.16	0.16	0.78	-0.78
L-24	-0.20	0.20	-4.49	4.49	-2.58	2.58	-5.79*	5.79*	0.13	-0.13	0.35	-0.35
L-25	-0.70	0.70	-8.24**	8.24**	-4.52	4.52	0.33	-0.33	-0.96**	0.96**	0.87	-0.87
L-26	-0.45	0.45	-5.43	5.43	-3.52	3.52	0.86	-0.86	-0.37	0.37	1.65*	-1.65*
SE												
S_{ij}	0.41		2.92		2.57		2.88		0.31		1.09	
$S_{ij}-S_{kl}$	0.57		4.13		3.63		4.07		0.44		1.54	

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

Table 5. Genetic parameters for grain yield and the other studied traits of 52 topcrosses and two testers across the two locations in 2010 season.

Parameters	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ears/100 plants	Ear length (cm)	Grain yield (ard/fed)
σ^2_{GCA-L}	1.546	126.410	74.391	13.507	0.354	2.548
σ^2_{GCA-T}	0.100	52.970	43.052	18.992	0.154	0.386
σ^2_{GCA}	0.195	42.937	32.015	11.947	0.131	0.463
σ^2_{SCA}	0.122	20.053	8.428	27.061	0.252	1.977
$\sigma^2_{GCA}/\sigma^2_{SCA}$	1.598	2.141	3.799	0.441	0.520	0.234
$\sigma^2_{GCA-L \times E}$	-0.089	39.997	43.402	8.350	0.070	0.224
$\sigma^2_{GCA-T \times E}$	0.024	29.832	25.256	13.687	0.075	0.150
$\sigma^2_{GCA \times E}$	0.016	30.558	26.552	11.947	0.075	0.155
$\sigma^2_{SCA \times E}$	0.014	11.749	9.222	26.352	0.194	2.185
$\sigma^2_{GCA \times E}/\sigma^2_{SCA \times E}$	1.143	2.601	2.879	0.453	0.387	0.071

All negative estimates of variance were considered zero.

El-Hifny *et al* (2010) found that non-additive genetic variance was more important for grain yield inheritance than additive one. The magnitude of $\sigma^2_{SCA \times E}$ interaction was higher than $\sigma^2_{GCA \times E}$ for ears per 100 plants, ear length and grain yield , indicating that non-additive type of gene action was more affected than additive by environment. These results are of good agreement with those obtained by Soliman *et al* (2001), Abd El-Moula *et al* (2004), Amr and El-Shenawy (2007) and El Hifny *et al* (2010). On the other hand, $\sigma^2_{GCA \times E}$ was higher than $\sigma^2_{SCA \times E}$ interaction for days to 50% silking, plant height and ear height, indicating that the additive type of gene action was more affected than non-additive type by environment for these traits. Similar results were obtained by Abd El-Moula and Ahmed (2006), and Abd El-Moula and Abd El-Aal (2009) who found that additive type of gene action was more affected than non-additive type of gene action by environment for days to 50% silking and plant and ear height.

Genotypic correlation

Estimates of genotypic correlations among grain yield and other studied traits are presented in Table 6. Data showed positive and significant genotypic correlations among grain yield and each of days to 50% silking, plant height and ear height. Positive but non-significant genotypic correlations among grain yield and each of ears/100 plants and ear length were detected. Similar results were obtained by El-Sherbieny *et al* (1994) and Muhammad and Saleem (2001). Sadek and Abdel-Azeem (2005) found positive and highly significant correlations among grain yield and each of plant height, ear height and ear length.

Table 6. Genotypic correlations among grain yield and other studied traits over locations.

Characters	Days to 50 % silking	Plant height (cm)	Ear height (cm)	Ears/100 plants	Ear length (cm)	Grain yield (ard/fed)
Days to 50 % silking	-	0.641**	0.735**	0.346	0.445**	0.753**
Plant height (cm)	0.641**	-	0.999**	0.126	0.485**	0.464**
Ear height (cm)	0.735**	0.999**	-	0.134	0.441**	0.566**
Ears/100 plants	0.346	0.126	0.134	-	0.018	0.307
Ear length (cm)	0.445**	0.485**	0.441**	0.018	-	0.118
Grain yield (ard/fed)	0.753**	0.464**	0.566**	0.307	0.118	-

Genotypic correlation among days to 50% silking and other studied traits were positive and highly significant, except ears/100 plant, which was positive and non-significant. Data in Table 6 also showed that genotypic correlations among plant height and each of ear height, ear length and grain yield were positive and highly significant. Genotypic correlation between ears/100 plants and ear length was Low and positive (0.018), while genotypic correlation between ears/100 plants and grain yield was medium and positive (0.307).

REFERENCES

Abd El-Moula, M. A.; A. A. Barakat and A. A. Ahmed (2004). Combining ability and type of gene action for grain yield and other attributes in maize (*Zea mays* L.). Assiut J.of Agric. Sci. 35 (3): 129-142.

Abd El-Moula, M.A. and A.A. Ahmed (2006). Evaluation of new maize inbred lines *via* line x tester analysis. Minia J. of Res. and Develop. 26(2): 265-284.

Abd El-Moula, M. A. and A. M. M. Abd El-Aal (2009). Evaluation of some new yellow maize inbred lines *via* top cross analysis. Egypt. J. of Appl. Sci. 24 (12A): 148-166.

Abo El-Saad, S.F.A., M.M.A. Regheb and A.A.A. Aziz (1994). Genetic variance and correlation studies in a yellow maize population. Bull. Fac. Agric., Univ. Cairo 45: 811–816.

Amer E.A. and A.A. El-Shenawy (2007). Combining ability for new twenty one yellow maize inbred lines. J. of Agric. Sci., Mansoura Univ. 32 (9): 7053 – 7062.

Castellanos, J.S.; A.R. Hallauer; and H.S. Cordova (1998). Relative performance of testers to identify elite lines of corn (*Zea mays* L.). Maydica 43(3): 217-226.

Davis, R.L. (1927). Report of the plant breeding. Ann. Rep., Puerto Rico Agric. Exp. Stat., P: 14-15.

Dodiya, N.S. and V.N. Joshi (2002). Heterosis and combining ability for quality and yield in early maturing single crosses of maize. Crop Res. 26: 114-118.

El-Hifny, M. Z., E. A. Hassaballa, M. A. Abd El-Moula and Kh. A. M. Ibrahim (2010). Combining ability and types of gene action in yellow maize (*Zea mays* L.). Assiut J. of Agric. Sci. 41(1): 1-27.

El-Sherbieny, H.Y.Sh, S. E. Sadek, A.A. Abd El-Azize and H.El. Gado (1994). Correlation and path coefficient analysis in fourteen white maize (*Zea mays* L.). J. Agric. Sci. Mansoura Univ. 19(12): 4133-4142.

Hallauer, A.R. and J.B. Miranda Filho (1988). Quantitative Genetics in Maize Breeding. 2nd ed. Iowa State University Press. Ames, IA, USA.

Kempthorne, O. (1957). An Introduction to Genetic Statistics. John Wiley and Sons Inc., NY, USA.

Kwon, S.H. and J.H. Torrie (1964). Heritability and inter-relationship among traits of two soybean populations. Crop Sci. 4: 196–8.

Kumare, R., M. Singh, M. Narwal and S. Sharma (2005). Gene effects for grain yield and its attributes in maize. Natural J. Plant Improvement 7: 105-107.

Motawei, A.A.; A.A. El-Shenawy and Fatma A.E. Nofal (2005). Estimation of combining ability for two sets of yellow maize topcrosses. Assiut J. of Agric. Sci. 36 (3): 91-107.

Muhammad, Y. and M. Saleem (2001). Correlation analysis of S_1 families of maize for grain yield. Int. J. of Agric. & Biol. 3(4): 387-388.

Osman, M.M.A. and M.H.A. Ibrahim (2007). A study on combining ability of new yellow maize inbred lines using line x tester analysis. J. of Agric. Sci. Mansoura Univ. 32(2): 815-830.

Parvez Sofi and A.G. Rather (2006). Genetic analysis of yield traits in local and cimmyt inbred line crosses using line x tester analysis in maize (*Zea mays* L.). Asian J. of plant Sci. 5 (6): 1039-1042.

Rojas, B.A. and G.F. Sprague (1952). A comparison of variance components in corn yield trails III. General and specific combining ability and their interactions with locations and years. Agron. J. 44: 462-466.

Sadek, S.E. and M. El-M. Abdel-Azeem (2005). Correlation and path coefficient analysis in nine yellow maize (*Zea mays* L.) genotypes. Assiut J. of Agric. Sci. 36(5): 1-13.

Singh, R.K. and B.D. Chaudhary (1985). Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers. New Delhi, 3rd Ed.

Soliman, F.H. S.; A.A. El-Shenawy; F.A. El-Zeir and E. A. Amer (1995). Estimates of combining ability and type of gene action in topcrosses of yellow maize. Egypt. J. Appl. Sci. 10 (8): 312-329.

Soliman, M.S. M.; A.A. Mahmoud; F.A. El-Zeir; A. A. I. Gaber and F.H.S. Soliman (2001). Utilization of narrow base tester for evaluating combining ability of newly developed maize inbred lines (*Zea mays* L.). Egypt. J. Pl. Breed. 5: 61-76.

Soliman, M.S.M. and M.M.A. Osman (2006). Type of gene action for grain yield using testcross analysis in new developed maize inbred lines. J. of Agric. Sci. Mansoura Univ. 31(5): 2615-2630.

Steel, R.G. and J. Torrie (1980). Principles and Procedures of Statistics. Mc Graw-Hill Book Company, New York, USA.

الارتباط الوراثي و القدرة على التآلف لبعض سلالات الذرة الشامية الصفراء من خلال تحليل السلالة x الكشاف

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تم التهجين بين ٢٦ سلالة صفراء مرباة داخليا مع سلالتين كشافتين وهما جميزة-١٠٠٢ و جميزة-١٠٢١ في محطة البحوث الزراعية بملوى في الموسم الزراعي ٢٠٠٩. في الموسم الزراعي ٢٠١٠ تم زراعة ٥٢ هجين قمي مع هجيني مقارنة وهما هـ.ف ١٦٢ وهـ.ف ١٦٦ بمحطتي البحوث الزراعية بسخا وملوى. كانت الاختلافات بين الموقعين عالية المعنوية. كانت متوسطات مربعات الانحرافات بين

السلالات والكشافات وتفاعل السلالة x الكشاف معنويه أو عالية المعنوية لكل الصفات المدروسة، أما متوسطات مربعات الانحرافات الراجعة لتفاعل السلالة x المواقع و الكشاف x المواقع و السلالة x الكشاف x المواقع كانت معنوية أو عاليه المعنوية لكل الصفات المدروسة ما عدا صفة عدد الأيام حتى ظهور ٥٠% من الحراير. بالنسبة لتأثيرات القدرة العامة على التآلف كانت هناك ٥ سلالات بالنسبة لعدد الكيزان لكل ١٠٠ نبات و ٦ سلالات بالنسبة لطول الكوز أعطت تأثيرات للقدرة العامة موجبة ومعنوية أما بالنسبة لمحصول الحبوب (إردب/الفدان) فكانت هناك ٦ سلالات (السلالات أرقام ٨ و ١٠ و ١٢ و ١٥ و ١٧ و ٢١) أعطت تأثيرات قدرة التآلف عامه موجبة ومعنوية. أما بالنسبة للقدرة الخاصة على التالف كان هناك ٦ هجن بالنسبة لعدد الكيزان لكل ١٠٠ نبات و ٢ هجين بالنسبة لطول الكوز ٣ هجن بالنسبة لمحصول الحبوب (إردب/فدان) أعطوا تأثيرات موجبة ومعنوية.

كان تباين القدرة العامة للتآلف بالنسبة للسلالات اكبر من تباين القدرة العامة للكشافات لكل الصفات المدروسة ما عدا عدد الكيزان لكل ١٠٠ نبات مما يشير إلى أن معظم تباين القدرة العامة على التالف يرجع إلى السلالات. النسبة بين تباين القدرة العامة والخاصة للتآلف كانت اكبر من الوحدة بالنسبة لصفات عدد الأيام حتى ظهور ٥٠% من الحراير وارتفاع الكوز والنبات مما يشير إلى أن فعل الجين المضيف يتحكم في توريث تلك الصفات ومن ناحية أخرى كانت تلك النسبة اقل من الوحدة بالنسبة لصفات عدد الكيزان لكل ١٠٠ نبات و طول الكوز ومحصول الحبوب (إردب/فدان) مما يشير إلى أن فعل الجين غير المضيف كان الأكثر أهمية في التعبير عن الصفات الأخيرة. كان هناك ارتباط وراثي موجب ومعنوي بين محصول الحبوب وكلا من عدد الأيام حتى ظهور ٥٠% من الحراير و وارتفاع النبات والكوز بينما كان هذا الارتباط موجب وغير معنوي بين محصول الحبوب وكلا من عدد الكيزان/١٠٠ نبات وطول الكوز. أعطى الهجينين الفرديين (السلالة ٨ x جميزة ١٠٢١) و (السلالة ١٧ x جميزة ١٠٢١) أعلى محصول حبوب حيث أنهم تفوقوا معنويا عن هجين المقارنة هـ ف ١٦٢ بمقدار ١٢.٥٦ و١٢.٣٣% على الترتيب. هذه الهجن مبشرة و سوف يتم إعادة تقيمها في المراحل المتقدمة لبرنامج الذرة الشامية.