Combining Ability And Type Of Gen Action Of Some New Yellow Maize Inbred Lines

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BSTRACT

Fifteen yellow maize inbred lines derived from different hetrotic group were used in this study. In 2016 growing season the fifteen inbred lines were top-crossed to each of two testers In 2017 season, 30 top-crosses along with four commercial check hybrids were evaluated in replicated yield trails conducted at Sakha and Mallawy. Data were recorded for days to 50% silking, plant and ear height and grain yield.

Combined analysis over the two locations showed that mean squares due to crosses, lines, testers and line x tester were significant for all the studied traits. Mean squares due to lines x testers were significant for all the studied traits, indicating that differed in their order of performance in crosses with each of the testers. Mean squares due to crosses x location, lines x location and tester x location interaction were significant for all the studied traits, except no of days to 50% silking of line x tester. Mean squares due to lines x testers x locations interaction were significant for all traits, except plant height. The magnitude of σ^2 GCA was larger than that obtained for σ^2 SCA for all the studied traits. For grain yield, six single crosses i.e. L-1 x Mall.5035, L-2 x Mall.5035, L-4 x Mall.5035, L-8 x Mall.5035, L-10 x Mall.5035 and L-11 x Mall.5035 significantly out-yielded the check hybrid SC-168. Only one cross L-3 x SC-162 significantly out-yielded the check hybrid TWC-360.The best GCA effects were obtained from five inbred lines i.e. L-1, L-2, L-4, L-8 and L-11 for grain yield exhibited positive and significant GCA effects. The top-crosses (L-1, L-8 and L-10 x Mall.5035 and L-3, L-5 and L-13 X SC-162) had positive and significant SCA effects.

Key words: Maize, top-cross, line x tester, combining ability

INTRODUCTION

Maize (*Zea mays* L.) is one of the three most important cereal crops in the world together with wheat and rice. The top-cross procedures suggested by *Davis (1927)* were used 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)*. Line x tester analysis 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)*. The concepts of general combining ability (GCA) and specific combining ability (SCA) defined by *Sprague and Tatum (1942)* have been used extensively in breeding of several economic crop species. For maize yield, they found that GCA was relatively more important than SCA for non selected inbred lines, whereas SCA was more important than GCA for previously selected lines. *Rojas and Sprague (1952)* compared estimates of the variances of GCA and SCA for yield and their interaction with locations and years. They stressed that the variance of SCA includes not only the non-additive deviations due to dominance and epistasis but also a considerable portion of the genotype x environment interaction. 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 Filho 1988)*. *Jayakumar and Sundaram (2007)* reported that the specific combining ability variances were higher than the general combining ability variances for days to 50% silking, number of grains per row and grain yield. *Almanie et al. (2006), Todkar and Navale (2006), Dar et al. (2007) and Abd El-Moula and Abd El-Aal (2009)* reported similar results.

The main objectives of this study were to (1) to identify the best inbred lines for general combining ability, (2) to identify the best crosses regarding the specific combining ability for grain yield and other traits and to (3) to determine the different types of gene action involved in manifestation of grain yield and other studied traits.

MATERIALS AND METHODS

Fifteen yellow maize inbred lines derived from different hetrotic group through selection in disease nursery field at Mallawy Agricultural Research Station were used in this study. In 2016 growing season the fifteen inbred lines were top-crossed to each of the two narrow base inbred testers i.e. Mall-5035 and SC-162 at Mallawy Agric. Res. Stn. In 2017 season, 30 top-crosses along with four commercial check hybrids i.e. SC 162, SC 168, TWC 352 and TWC 360 were evaluated in replicated yield trails conducted at Sakha and

Mallawy Agric. Res. Stns. A randomized complete block design with four replications was used in each location. Plot size was one row, 6 m long and 80 cm apart and hills were spaced 25 cm along the row. All cultural practice for maize production were applied as recommended. Data were recorded for days to 50% silking, plant and ear height (cm) and adjusted grain yield at 15.5% grain moisture and converted to ardab per fed (ardab = 140 kg). Analysis of variance was performed for the combined data over locations according to *Steel and Torrie (1980)*. Procedures of *Kempthorne (1957)* were performed to obtain valuable information about the combining ability of lines and testers as well as their topcrosses.

RESULTS AND DISCUSSION

Analysis of variance:

Combined analyses of variance across two locations for 30 top-crosses for the studied traits are presented in Table 1. Results showed significant differences between the two locations for all traits except for, days to 50% silking. These results revealed the presence of clear variations among the two locations in climatic and soil conditions. Mean squares due to crosses, lines and testers were highly significant for all the studied traits. Mean squares due to lines x testers were significant for all the studied traits, indicating that differed in their order of performance in crosses with each of the testers. Similar results were obtained by *Castellanos et al. (1998), Soliman and Sadek (1999), Soliman (2000), Venugopal et al. (2002), Amer et al. (2003), Abd El-Moula and Abd El-Aal (2009).*

Mean squares due to crosses x location and lines x location interaction were significant for all the studied traits. Mean squares due to testers x location interaction were significant or highly significant for plant and ear height and grain yield. Mean squares due to lines x testers x locations interaction were significant for days to 50% silking, ear height and grain yield. These results are in good agreement with obtained by *Shehata et al. (2001)* They found that the interaction of lines x testers x locations was insignificant for grain yield and yield components. *Mahmoud and Abd El-Azeem (2004), Abd El-Moula and Abd El-Aal (2009)* found that the interaction of lines x testers x locations was highly significant for grain yield.

The magnitude of mean squares due to testers were higher than of lines for all the studied traits, indicating that the tester contributed much more in the total variation for all the studied traits. Also the mean squares due to testers x locations were higher than of lines x locations for all the studied traits, except days to 50% silking, indicating that the testers were more affected by the environmental conditions than the lines. These results are in agreement with obtained by *Gado et al. (2000), El-Morshidy et al. (2003), Abd El-Moula and Ahmed (2006), Abd El-Moula and Abd El-Aal (2009) and Dar et al (2017)***.**

Mean performance:

Mean performance of the 30 top-crosses for all the studied traits are presented in Table 2. For days to 50% silking 14 single and 12 three-way crosses were significantly earlier than the earliest check hybrids SC-168 and TWC-352, respectively. The earliest crosses were L-2 x Mall.5035, L-2 x SC-162, while the latest crosses were L-8 x Mall-5035 and L-2 x SC-162. In general, the crosses involving inbred lines Mall.5035 as tester flowered earlier than those involving tester SC-162. Regarding plant height,crosses ranged from 228.62 for cross L-9 x Mall.5035 to 267.62 cm for cross L-12 x SC-162. There were 10 single crosses significantly shorter than check hybrid (S'C168).

AS For, ear height,the studied crosses ranged from 115.37 for cross L-5 x Mall.5035 to 149.00 cm for cross L-10 x SC-162. There were 9 single and 2 three-way crosses had significantly lower ear height than the check hybrids SC 168 and TWC-352, respectively. The crosses involving the inbred tester Mall.5035 had significantly short plant and low ear height comparing with the crosses, which involving the tester SC-162.

Concerning grain yield, results showed that the crosses involving Mall.5035 as a tester tended to have higher values of grain yield than those of SC-162 as a tester. Grain yield ranged from 26.43 and 26.20 for crosses L-13 x Mall.5035 and L-9 x SC-162 to 33.42 and 30.31 ard/ fedd. for crosses L-8 x Mall.5035 and L-3 x SC-162. There were six single crosses i.e. L-1 x Mall.5035, L-2 x Mall.5035, L-4 x Mall.5035, L-8 x Mall.5035, L-10 x Mall.5035 and L-11 x Mall.5035 significantly out-yielded the check hybrid SC-168. Only one cross L-3 x SC-162 significantly out-yielded the check hybrid TWC-360.

General and specific combining ability effects:

General combining ability effects are presented in Table 3. For days to 50% silking there were 6 inbred lines had significant GCA effects. Out of these inbred lines I.e; L-1, L-2 and L-7 exhibited negative and significant GCA effects. These inbred lines are considered best inbred lines for earliness. Concerning plant height, the inbred lines no. 4, 9 and 15 manifested negative and significant GCA effects. Regarding ear height, inbred lines L-1, L-2, L-4, L-5 and L-15 had negative and significant GCA effects. Five inbred lines i.e. L-1, L-2, L-4, L-8 and L-11 possessed positive and significant or highly significant GCA effects for grain yield, indicating that they have favorable genes and are best combiners for grain yield.

Table 1: Mean squares for grain yield and the other studied traits, From combined analysis across two locations in 2017 season.

S.O.V	DF	Days to 50% silking	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)
Location (Loc)	1	322.02m.s.	191365.53**	65175.10**	51.89*
Rep/loc.	6	155.76	775.38	264.02	5.88
Crosses	29	8.95**	1224.23**	628.49**	24.29**
Lines	14	11.63**	600.94**	542.92**	24.26**
Testers	1	35.27**	22951.70**	7537.60**	73.60**
Line x tester	14	4.38**	295.55**	220.568**	20.81**
Loc. x Crosses	29	4.82**	287.89**	143.60**	20.233**
Loc. x Lines	14	6.49**	264.51**	150.94**	18.11**
Loc. x testers	1	0.07	2166.01**	561.20**	43.54**
Loc. x Lines x tester	14	3.49*	177.14	106.46*	20.69**
Error	174	1.76	108.01	61.27	3.45
CV%		2.11	4.20	6.02	6.33

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

Table 2: Mean grain yield and other studied traits of the crosses between 15 inbred lines and two testers evaluated Across locations during 2017 season.

Inbred lines	Days to 50% silking		Plant height (cm)		Ear height (cm)		Grain yield (ard/fed)	
	Mall.5035	SC162	Mall.5035	SC162	Mall.5035	SC162	Mall.5035	SC162
L-1	60.87	62.62	244.25	250.00	123.00	125.87	31.90	28.57
L-2	60.75	62.12	234.62	257.25	120.87	129.00	31.42	30.02
L-3	63.12	63.62	241.50	264.50	125.50	138.37	29.01	30.31
L-4	61.37	63.75	233.75	239.12	119.87	118.37	31.19	29.29
L-5	62.00	64.12	236.12	255.25	115.37	133.62	27.43	29.07
L-6	62.75	62.75	247.50	265.25	124.25	142.00	29.95	29.55
L-7	61.75	62.37	229.37	265.75	116.25	137.12	27.78	28.43
L-8	64.87	64.25	244.87	257.00	132.00	138.25	33.42	28.13
L-9	63.12	62.37	228.62	249.87	126.50	136.25	27.91	26.20
L-10	63.50	64.12	237.00	268.75	127.12	149.00	32.62	28.97
L-11	63.00	64.87	241.00	262.50	128.00	134.00	31.48	29.51
L-12	63.87	63.50	241.37	267.62	130.00	146.37	29.72	26.67
L-13	61.87	63.00	236.12	255.00	129.62	143.75	26.43	29.62
L-14	62.87	62.37	240.37	251.12	128.25	128.12	28.97	29.57
L-15	62.37	63.75	226.75	247.62	116.62	131.25	29.02	27.72
Mean	62.54	63.31	237.55	257.11	124.21	135.42	29.88	28.77
Check SC 162	67.12		272.25		145.62		26.11	
SC 168	64.75		248.37		132.87		28.96	
TWC 352	63.50		243.87		132.75		23.25	
TWC 360	64.87		251.00		136.12		28.89	
LSD 0.05%	0.94		7.31		5.80		1.34	

Data showed that the tester inbred lines Mall.5035 were more favorable effect than SC-162 for earliness, plant height, ear height and grain yield. The tester inbred line Mall.5035 had positive and highly significant GCA effects and could be considered as good combiners for grain yield.

Specific combining ability effects of 30 topcrosses for all the studied traits are presented in table 4. Results showed that, one cross (L-7 x Mall.5035) for plant height and crosses (L-4 x SC-162), (L-10 x Mall.5035) and (L-14 x SC-162) for ear height had negative and significant SCA effects . For grain yield, there are six crosses (L-1, L-8 and L-10 x Mall.5035 and L-3, L-5 and L-13 X SC-162) had positive and significant or highly significant SCA effects with values of 1.109, 2.091, 1.275, 1.202, 1.374 and 2.147, respectively.

Variance components:

Estimates of combining ability variances σ^2GCA for lines, σ^2SCA for line x tester and their interactions with environments are presented in Table 5. The results showed that, σ^2 GCA-T was higher than σ^2 GCA-L for days to 50% silking, plant and ear height, indicating that most of GCA variance was due to testers for these traits. The magnitude of σ^2 GCA (average) was larger than that obtained for σ^2 SCA for days to 50% silking, plant height, ear height and grain yield, indicating that the additive gene action played an important role in the inheritance of these traits. Khalil *et al (2016) illustrated that the additive gene effects played the major role in the inheritance of days to 50% silking and grain yield. Jayakumar and Sundaram (2007)* reported that the specific combining ability variances were higher than the general combining ability variances for days to 50% silking, number of grains per row and grain yield. *Almanie et al. (2006), Todkar and Naval (2006), Dar et al. (2007) and Abd El-Moula and Abd El-Aal (2009)* reported similar results.

Furthermore, the magnitude of σ^2 GCA x E interaction was higher than σ^2 SCA x E for plant height, indicating that the non-additive type of gene action was more affected than the additive type of gene action by environment in this traits. These results are in a good agreement with those obtained by *El-Itriby et al (1990), El-Zeir et al (2000) and Soliman et al (2001)*. On the other side, the magnitude of σ^2 SCA x E interaction was higher than σ^2 GCA x E for days to 50% silking, ear height and grain yield indicating that the additive type of gene action were more affected by environment than non-additive ones. These results are in a good agreement with those obtained by *Sadek et al. (2000), Soliman et al. (2001), Abd El-Moula et al. (2004) and Amer and El-Shenawy (2007)***.** They found that the magnitude of σ^2 SCA x E interaction was higher than that of σ^2GCA x E interaction.

Table 3:General combining ability effects ($\hat{g}_i$) for grain yield and the other studied traits, from combined 1 analysis across two locations in 2017 season.

Inbred lines	Days to 50% silking	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)
L-1	-1.175**	-0.204	-5.383**	0.909*
L-2	-1.488**	-1.392	-4.883*	1.388**
L-3	0.450	5.671*	2.117	0.329
L-4	-0.362	-10.892**	-10.696**	0.913*
L-5	0.137	-1.642	-5.321**	-1.078*
L-6	-0.175	9.046**	3.304	0.419
L-7	-0.862*	0.233	-3.133	-1.223**
L-8	1.637**	3.608	5.304**	1.448*8
L-9	-0.175	-8.079**	1.554	-2.276**
L-10	0.887*	5.546*	8.242**	1.466**
L-11	1.012**	4.421	1.179	1.163*
L-12	0.762*	7.171*	8.367**	-1.136*
L-13	-0.487	-1.767	6.867**	-1.305**
L-14	-0.300	-1.579	-1.633	-0.057
L-15	0.137	-10.142**	-5.883**	-0.959*
SE (g_i)	0.331	2.598	1.956	0.464
SE(g_i-g_i)	0.117	0.918	0.691	0.164
Mall.5035	-0.383*	-9.779**	-5.604**	0.554**
SC-162	0.383*	9.779**	5.604**	-0.554**
SE (g_i)	0.121	0.948	0.714	0.169
SE(g_i-g_i)	0.015	0.122	0.092	0.021

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

Table 4: Specific combining ability effects ($\hat{S}_{ij}$) of 30 topcrosses for grain yield and the other studied traits, from combined analysis across two locations in 2017season.

Inbred lines	Days to 50% silking		Plant height (cm)		Ear height (cm)		Grain yield (ard/fed)	
	Mall.5035	SC-162	Mall.5035	SC-162	Mall.5035	SC-162	Mall.5035	SC-162
L-1	-0.492	0.492	6.904	-6.904	4.167	-4.167	1.109*	-1.109*
L-2	-0.304	0.304	-1.533	1.533	1.542	-1.542	0.146	-0.146
L-3	0.133	-0.133	-1.721	1.721	-0.834	0.834	-1.202*	1.202*
L-4	-0.804	0.804	7.092	-7.092	6.354*	-6.354*	0.392	-0.392
L-5	-0.679	0.679	0.217	-0.217	-3.521	3.521	-1.374*	1.374*
L-6	0.388	-0.388	0.904	-0.904	-3.271	3.271	-0.353	0.353
L-7	0.071	-0.071	-8.408*	8.408*	-4.833	4.833	-0.877	0.877
L-8	0.696	-0.696	3.717	-3.717	2.479	-2.479	2.091**	-2.091**
L-9	0.758	-0.758	-0.846	0.846	0.729	-0.729	0.298	-0.298
L-10	0.071	-0.071	-6.096	6.096	-5.333*	5.333*	1.275*	-1.275*
L-11	-0.554	0.554	-0.971	0.971	2.604	-2.604	0.432	-0.432
L-12	0.571	-0.571	-3.346	3.346	-2.583	2.583	0.973	-0.973
L-13	-0.179	0.179	0.342	-0.342	-1.458	1.458	-2.147**	2.147**
L-14	0.633	-0.633	4.404	-4.404	5.667*	-5.667*	-0.856	0.856
L-15	-0.304	0.304	-0.658	0.658	-1.708	1.708	0.094	-0.094
SE sij	0.469		3.674		2.767		0.656	
SE sij-sik	0.234		1.837		1.383		0.328	

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

Table 5: Genetic parameters for grain yield and the other studied traits of 30 top-crosses and two testers across the two locations.

Parameters	Days to 50% silking	Plant height (cm)	Ear height (cm)	Grain yield (ard/fed)
σ^2_{GCA-L}	0.294	13.628	17.367	-1.139
σ^2_{GCA-T}	0.290	172.227	57.186	0.250
$\sigma^2_{GCA\ (average)}$	0.290	153.568	52.501	0.0.086
σ^2_{SCA}	0.055	14.801	14.264	0.015
$\sigma^2_{GCA-L\ x\ E}$	0.319	10.921	5.560	-0.323
$\sigma^2_{GCA-T\ x\ E}$	-0.065	17.283	7.579	0.381
$\sigma^2_{GCA\ (average)\ x\ E}$	-0.019	30.533	7.341	0.298
$\sigma^2_{SCA\ x\ E}$	0.545	17.290	11.298	4.310

All negative estimates of variance were considered equal zero.

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الملخص العربي

القدرة على التآلف وطرز فعل الجين فى بعض السلالات الجديدة من الذرة الشامية الصفراء

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تم إجراء التهجين بين 15 سلالة من الذرة الشامية الصفراء مرباة تربية داخلية بمحطة البحوث الزراعية بملوى مع كشافين عبارة عن السلالة النقية ملوي 5035 و هجين فردي –162فى موسم 2016 . تم تقييم 30 هجين قمى مع اربعة هجن مقارنة وهما الهجين الفردى 162 والهجين الفردى 168 والهجين الثلاثي 352 والهجين الثلاثي 360فى محطتى البحوث الزراعية بسخا وملوى فى الموسم الزراعى 2017.

تم اخذ القراءات على صفات عدد الايام حتى ظهور 50% من الحراير و ارتفاع النبات والكوز ومحصول الحبوب (اردب/فدان). اظهر التحليل المشترك اختلافات معنوية ناتجة بين الهجن والسلالات والكشافات لكل الصفات محل الدراسة. كما اظهر تباين تفاعل السلالات مع الكشافات اختلافات معنوية لصفات عدد الايام حتى ظهور % من الحراير، ارتفاع النبات، ارتفاع الكوز ومحصول الحبوب . كان تباين التفاعل بين كل من الهجن ، السلالات والكشافات x المواقع معنويا لجميع الصفات ماعدا صفة عدد الأيام حتى ظهور 50% من الحراير. اظهر التفاعل المشترك بين السلالات والكشافات والمواقع اختلافات معنوية لجميع الصفات ما عدا صفة ارتفاع النبات .كان تباين القدرة العامة على التآلف اكبر من تباين القدرة الخاصة على التآلف فى جميع الصفات. تفوق 6هجن قمية على هجين المقارنة 168 وهى (السلالة–1 ، 2 ، 4، 8، 10 و 11 x ملوي 5035) و الهجين الثلاثي (السلالة–3 x هجين فردي 162) تفوق معنويا على هجين المقارنة 360. أظهرت السلالات 1 ، 2 ،4، 8 و 11 أفضل قدرة عامة على التآلف حيث كانت موجبة ومعنوية فى صفة محصول الحبوب. أما بالنسبة للقد رة الخاصة على التآلف فقد أظهرت الهجن القمية (السلالة– 1 و 8 و 10 x ملوي 5035) والهجن (السلالة–3 و 5 و 13 x هجين فردي 162) تأثيرات موجبة ومعنوية.