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Combining Ability of some White Maize Inbred Lines for Grain Yield and some Other Traits

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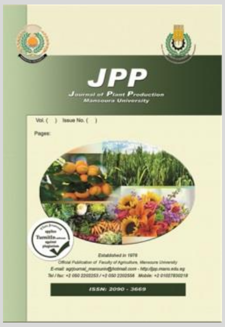

ABSTRACT

Fourteen white maize inbred lines derivative from diverse heterotic group by choice in field disease at Sids Agricultural Research Station were used in this study. In 2014 growing season, the fourteen white maize inbred lines were crossed with two testers Sids 7 and Sids 1157. In 2015 season 28 white single crosses and two checks (SC 10 and SC 128) were assess at two locations (Gemmeiza and Sids). Statistics were registered for five traits [days to 50% silking, plant and ear heights (cm.), ear length and grain yield (ard/fad)]. Collective analysis over two locations revealed that mean squares for crosses, lines, testers and lines × testers were significant and highly for all the studied traits, except lines × testers mean squares for days to 50% silking and ear length. Mean squares for crosses × locations interactions were highly and significantly for all the traits studied, except ear length. Mean squares due to lines × locations had significantly and high for days to 50% silking. Testers × locations interactions had highly and significant for all studied traits. The magnitude of σ^2 GCA was larger than that σ^2 SCA for all traits. For grain yield, two crosses (L7 × Sd 7 and L13 × Sd7) considerably out yielded the best commercial check SC 128. The best GCA effects were obtained from three inbreed lines (L5, L7 and L13) for grain yield. Two top crosses (L1 × Sd 1157 and L11 × Sd 7) had positively significant SCA effects for grain yield.

Keywords: Maize, GCA, SCA, Line × tester, Locations, Genotypic variances

INTRODUCTION

Maize (*Zea mays* L.) is one of the important food and forage crops with abundant natural variation and strategic cereal crops, It is one of the most important cereal crops and ranks after rice and wheat in production area in Egypt. The investigation of the maize breeding program in Egypt is to progress a high-yield maize hybrid for commercial use to get bigger consumption of corn in human food, animal feedstuff, and the poultry productiveness. Only of the greatest essential gauge for classifying high-yield maize crosses is evidence about the parent's genetic makeup and combining ability (Ceyhan, 2003). Top cross technique was first recommended by Davis (1927) to test the superiority of parental lines for hybrid development programs. Al-Naggar *et al.* (1997) used three way crosses, single crosses and inbred lines as testers to evaluate the combining ability and found that inbred lines with narrowest genetic base and lowest yield potential exhibited the highest genetic varieties test cross progenies for most of the studied. The use of an inbred as tester was suggested by Rassal and Eberhart (1975). One of the great implements obtainable to determine the effects of the combining ability to general and specific and aids to choice of desired parents and crosses depend on the line × tester analysis method proposed by Kempthorne (1957).

Line by tester analysis is an imperative method indiscriminately used to evaluate the inbred lines. The effectiveness of this method by determined primarily of the gender of tester used for the assessment. An appropriate laboratory should consist of simplicity of use and impart information that appropriately classifies the relative deserve of lines and take full advantage of genetic gain (Hallauer, 1975 and Menz *et al.* 1999). However, it is problematic to determine which testers have all these properties. Heterogeneous crosses have been used as a test widely by many educators such as, Horner *et al.* (1976), Musa and Ali (2012) and Ali (2013). The types of combining ability, general (GCA) and specific (SCA) were identified in quantifiable genetics. GCA is considered to be additive genetic effects while the SCA mirrors non-additive genetic for gene movements (Sprague and Tatum, 1942). Many researchers mentioned that the effects of additive genes conduct an actual role in inheriting the grain yield El-Badawy 2013 and the number of rows / ears. (Ali and others 2011). While El-Badawi (2013), Al-Hosary and Elgammaal (2013) referred that the non-additive genetic influences characterized the main function in the inheritage of grain yield and other agricultural characteristics.

The main points of this search were to:

Assessment combining ability, general (GCA) of parental lines, testers and SCA of crosses for grain yield and the other agronomical characteristics.

MATERIALS AND METHODS

The materials used in this study consisted of 16 inbreed lines of white corn delivered by the Maize Research Program, Field Crop Research Institute (FCRI), Agricultural Research Center (ARC) (Table 1). In 2014 summer season,

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The fourteen females were crossed with two testers; Sd 7 (T1) and Sd 1157 (T2) to produced 28 F_1 hybrids. summer season 2015, the 28 F_1 white single crosses and two commercial checks (SC10 and SC128) were estimated at the Gemmeiza and Sids Agricultural Research stations. F_1 top cross hybrids created from the above line × tester crossing program were rated in RCBD with four replications. thirty genotypes (28 top crosses and two checks) were assigned at random to experimental unit in each block. Each entry was planted in one row with a 6 meter long and 80 cm wide. Planted in hills spaced at a height of 25 cm and three grains per hill on one side of the row. After 21 days of planting plants are diluted to one plant per hill. Agricultural practices were followed as usual for the regular maize fields in the area. Statistics were noted for the number of days to 50% of silking (SK), plant and ear heights (PH&EH), ear length (EL), and grain yield (GY) adjusted to 15.5% grain moisture content (1 ardab = 140 kg and 1 fed. = 4200 m ^{2}). Statistical analysis of the variance of the combined data was accomplish on the two sites after the homogenization test across, Steele and Toure (1980). combined analysis was according to Kempthorne (1957).

Table 1. Origins of white maize inbred lines and testers

Inbred line number	origins
L-1 to L-9	G 2 Ev-8
L-10 to L-12	Syn-1 C-1
L-13 to L-14	G 2 Ev-10
Sd 7	American Early Dent
Sd 1157	Var. 5 W

RESULTS AND DISCUSSION

A. Analysis of variance

Analysis of variances were computed in Table 2. Mean squares for location were significantly and high for all studied traits, pointed to that performance of these traits could be changed from location to another. These results are in contract with El-Zeir (1990), Soliman *et al.* (1995), Shehata *et al.* (1997), Abd El-Azeem and Abd El-Moula (2009), Ibrahim *et al.* (2012), Aboyousef *et al.* (2016) and Moshera *et al.* (2016). Moreover, mean squares for crosses and the partitions lines, testers and line × tester were significantly and high for all traits studied, except line×tester of mean square for days to 50% silking and ear length. Mean squares for interaction between crosses×locations were high and significantly for all studied traits, except ear length. While mean squares for lines×locations were highly significant for days to 50% silking. Mean square due to testers × locations interaction were highly and significant for all studied traits, except ear length. Mean squares owing to L×T×Loc. were significantly for days to 50% silking and plant height, representative that a large amount variability in interaction of crosses and their partitions with locations. These results were obtained by Darwich *et al.* (2016) and Gamea (2015).

Table 2. Mean squares for grain yield and the other studied traits at combined data over two locations during summer season 2015.

S O V	d f	Mean Squares				
		Days to 50%silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Grain yield (ard fad^{-1})
Location (E)	1	1455.54**	102215.29**	64634.04**	130.235**	743.689**
Rep/Loc	6	3.0997	174.5164	303.8318	3.430	19.253
Crosses (C)	27	5.3457**	4175.078**	1423.750**	11.1625**	73.545**
Lines (L)	13	3.925**	2231.052**	1084.56**	10.9625**	105.061**
Testers (T)	1	81.3616**	75227.790**	21509.04**	129.6257**	87.737**
L x T	13	0.9192	653.5113**	217.934**	2.2499	40.937**
C x Loc	27	10.512**	621.3087**	155.799**	1.5720	47.947**
L x Loc	13	4.886**	207.3575	133.319	1.60615	19.798
T x Loc	1	191.2902**	9844.754**	627.790**	2.6578	957.376**
L x T x Loc	13	2.2325*	335.764**	141.973	1.4543	6.140
Pooled error	162	1.29	133.54	82.99	1.90	9.150
C V%		1.89	4.604	6.60	7.38	10.62

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

B. Mean performance of F_1 crosses (Line x Tester).

Data in Table 3 includes, mean performance of 28 crosses and two checks for five traits under combined data over two locations. For days to 50% silking, six crosses ; L2 × Sd 1157, L7 × Sd 1157 , L0 × Sd 1157, L11 × Sd 1157, L12 × Sd 1157 and L13 × Sd 1157 were significant earlier than the earliest check SC128. Ten crosses exhibited desirable significant for short plant height; L2 × Sd 1157, L4 × Sd 1157, L6 × Sd 1157, L8× Sd1157, L9× Sd 7, L10 × Sd 1157, L11 × Sd 1157, L12 × Sd 1157, L13 × Sd 1157 and L14 × Sd 1157. 8 crosses exhibited desirable significantly for low ear placement ; L2 × Sd 1157, L6 × Sd 1157, L7 × Sd 1157, L9 × Sd 1157, L11 × Sd 1157, L12 × Sd 1157, L13 × Sd 1157, and L14 × Sd 1157. For grain yield, when compared with the highest check (SC128) two crosses; L7 × Sd 7 and L13 × Sd 7 had significantly and higher than the best check (SC128) for grain yield.

C. Combining Ability Effects

For general combining ability effects: data in Table 4 showed that, significant negative GCA effects for females; L7, L10 and L11 and the tester; Sd 1157 for days to 50 % silking. For plant and ear heights, negative significant GCA effects was found by (L2, L0, L11, L12and L14) and (L2, L6, L11, L12 and L14), respectively and one tester: Sd 1157 for these traits. For ear length, positive significant GCA effects by 4 parents *i.e* L1, L5, L7, L9 and Sd 7 as tester. For grain yield had positive significant GCA effects were observed by three females (L5, L7and L13) and one mail (Sd 7). Once the best general combiners are identified, they can be crossed together to obtain the promising hybrid combinations.

Table 3. Mean performance of 28 white maize top crosses for all studied traits at combined data over two locations in growing summer season 2015.

	Days to 50 % silking		Plant height (cm)		Ear height (cm)		Ear length (cm)		Grain yieldN (ard fed^{-1})	
	Sd 7	Sd 1157	Sd 7	Sd 1157	Sd 7	Sd 1157	Sd 7	Sd 1157	Sd 7	Sd 1157
L1	61.1	60.5	280.0	248.1	157.5	135.6	19.3	19.5	23.55	30.26
L2	60.8	59.0	254.4	221.9	136.9	116.3	19.5	18.2	24.96	23.50
L3	61.0	59.6	267.5	239.4	146.3	135.6	19.3	18.1	30.54	26.93
L4	61.3	60.9	283.1	234.4	164.4	135.6	19.4	17.7	29.54	29.02
L5	61.0	60.0	286.9	246.3	165.0	142.5	19.9	19.4	29.02	31.91
L6	60.9	60.3	258.1	235.6	138.8	120.6	19.3	17.6	27.46	25.22
L7	60.6	58.8	282.5	245.0	153.1	128.1	21.0	18.4	34.68	30.57
L8	61.4	60.0	280.0	238.1	148.1	131.3	20.2	18.3	30.14	26.99
L9	61.0	59.8	295.0	232.5	153.8	124.4	21.3	18.5	29.38	28.25
L10	60.4	58.5	242.5	227.5	135.0	135.0	19.1	17.7	27.15	27.43
L11	60.1	59.3	261.3	213.1	138.8	118.8	18.8	17.1	29.00	23.40
L12	60.8	59.1	261.3	212.5	140.6	118.1	18.3	16.6	28.46	24.55
L13	60.5	59.5	266.3	234.4	148.8	128.8	18.5	17.3	34.93	32.52
L14	61.4	60.1	251.9	228.8	141.9	123.8	18.3	16.5	28.65	29.41
Cheeks SC 10	61.9		280.6		162.50		19.4		25.13	
Cheeks SC 128	60.6		250.00		139.4		20.9		30.34	
LSD 0.05	1.1		11.5		9.1		1.3		3.01	

Table 4. Estimates of general combining ability effects (GCA) for 14 inbreed lines and two testers at combined data over two locations.

		Days to 50%silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Grain yield (ard fad^{-1})
Lines	L1	0.549	13.058**	8.594**	0.720*	- 1.572*
	L2	- 0.388	- 12.880**	- 11.406**	0.195	- 4.249**
	L3	0.049	2.433	2.969	0.057	0.257
	L4	0.799**	7.746**	12.031**	- 0.143	0.799
	L5	0.237	15.558**	15.781**	0.945**	1.985*
	L6	0.299	- 4.129	- 8.281**	- 0.218	- 2.137**
	L7	- 0.576*	12.746**	2.656	1.020**	4.146**
	L8	0.424	8.058**	1.719	0.557	0.089
	L9	0.112	12.746**	1.094	1.232**	0.338
	L10	- 0.826**	- 16.004**	- 2.969	- 0.268	- 1.193
	L11	- 0.576*	- 13.817**	- 9.219**	- 0.755*	- 2.283**
	L12	- 0.326	- 14.130**	- 8.594**	- 1.243**	- 1.973*
	L13	- 0.263	- 0.692	0.781	- 0.793*	5.243**
	L14	0.487	- 10.692**	- 5.156*	- 1.305**	0.550
LSD gi	0.05	0.565	5.749	4.531	0.687	1.504
	0.01	0.733	7.454	5.875	0.890	1.950
Tester	SD. 7	0.603**	18.326**	9.799**	0.761**	0.626*
	SD. 1157	- 0.603**	- 18.326**	- 9.799**	- 0.761**	- 0.626*
LSD gi	0.05	0.214	2.173	1.713	0.259	0.569
	0.01	0.277	2.817	2.221	0.336	0.737

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

For specific combining ability effects: data in Table 5 showed that significant desirable of SCA effects, one crosses ; L10×Sd 7 for plant and ear heights and two crosses (L1×Sd 1157 and L11×Sd 7) for grain yield, therefore these crosses may be exploited in maize breeding programs.

Table 5. Estimates of specific combining ability (SCA) effects of top crosses for days to 50% silking, plant and ear heights, ear length, and grain yield at combined data over two locations in 2015 growing season.

Lines	Days to 50% silking		Plant height (cm)		Ear height (cm)		Ear length (cm)		Grain yield (ard fed^{-1})	
	Sd 7	Sd 1157	Sd 7	Sd 1157	Sd 7	Sd 1157	Sd 7	Sd 1157	Sd 7	Sd 1157
L1	-0.290	0.290	-2.388	2.388	1.138	-1.138	-0.873	0.873	-3.980**	3.980**
L2	0.272	-0.272	-2.076	2.076	0.513	-0.513	-0.098	0.098	0.105	-0.105
L3	0.085	-0.085	-4.263	-4.263	-4.487	4.487	-0.161	0.161	1.179	-1.179
L4	-0.415	0.415	6.049	-6.049	4.576	-4.576	0.114	-0.114	-0.363	0.363
L5	-0.103	0.103	1.987	-1.987	1.451	-1.451	-0.498	0.498	-2.067	2.067
L6	-0.290	0.290	-7.076	7.076	-0.737	0.737	0.089	-0.089	0.494	-0.494
L7	0.335	-0.335	0.424	-0.424	2.701	-2.701	0.527	-0.527	1.429	-1.429
L8	0.085	-0.085	2.611	-2.611	-1.362	1.362	0.214	-0.214	0.949	-0.949
L9	0.022	-0.022	12.924**	-12.924**	4.888	-4.888	0.614	-0.614	-0.061	0.061
L10	0.335	-0.335	-10.826**	10.826**	-9.779**	9.779**	-0.061	0.061	-0.764	0.764
L11	-0.165	0.165	5.737	-5.737	0.201	-0.201	0.102	-0.102	2.177*	-2.177*
L12	0.210	-0.210	6.049	-6.049	1.451	-1.451	0.064	-0.064	1.327	-1.327
L13	-0.103	0.103	-2.388	2.388	0.201	-0.201	-0.161	0.161	0.580	-0.580
L14	0.022	-0.022	-6.763	6.763	-0.737	0.737	0.127	-0.127	-1.003	1.003
LSD Sij 0,05	0.800		8.131		6.410		0.969		2.127	
LSD Sij 0.01	1.037		10.542		8.310		1.256		2.758	

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

D - Variance Components:-

Estimates of GCA and SCA variances for lines, testers, crosses and their interactions with locations for the studied traits were offer in Table 6. Results revealed that values of σ2GCA of testers was higher than σ2GCA of lines all traits under this study, indicated that most of GCA variance was for testers. Values of σ^2GCA were larger than those of σ^2SCA for all traits, manifested that the additive gene effects were more essential than the non-additive in heritage of these traits. These results agreed with those reported by Todkar and Navale (2006), Dar *et al.* (2007), Abd El-Moula and Abd El-Aal (2009), Mousa and Abd El-Azeem (2009), Ibrahim *et al.* (2010) and Ibrahim *et al.* (2012). Furthermore, the magnitude of σ^2GCA average × location interaction was higher than σ^2SCA × Loc. for all traits, except for ear height, representative that the type of additive gene action was more effected by environmental conditions (locations) than non-additive gene. These results are in harmony with those achieved by Soliman and Sadek (1999), Abd El-Azeem and Abd El-Moula (2009), Abd El-Mottalb(2015) and Abd El-Mottalb (2017).

Table 6. Estimates of Variance for general (δ^2 GCA), specific (δ^2 SCA) combining ability and their interaction with locations for five traits at combined data over two locations.

Parameter	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Grain yield (ard fed^{-1})
σ^2 GCA-L	0.02	106.00	54.70	0.54	3.15
σ^2 GCA-T	-0.97	580.85	185.76	1.13	-8.08
σ^2 GCA (average)	-0.85	521.65	169.38	1.05	-6.67
σ^2 SCA	-0.16	40.97	9.50	0.10	4.35
σ^2 GCA L × Loc.	0.33	-14.80	-1.08	0.02	1.71
σ^2 GCA T × Loc.	3.38	169.98	8.68	0.02	16.99
σ^2 GCA × Loc.	3.00	146.9	7.46	0.2	15.08
σ^2 SCA × Loc.	0.24	48.05	14.74	-0.11	-0.75

All negative estimates of variance were considered zero

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القدرة على الإئتلاف فى بعض سلالات الذرة الشامية البيضاء لمحصول الحبوب وبعض الصفات الأخري

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تم اجراء التهجين بين 14 سلاله من الذرة الشامية البيضاء مرباه تربية داخليه بمحطة البحوث الزراعية بسدس مع كشافين هما السلالة سدس 7 والسلالة سدس 1157 فى موسم 2014 م وتم تقييم 28 هجينا قميا مع هجينين مقارنه هما هجين فردى 10 وهجين فردى 128 فى محطتى البحوث الزراعية بالجميزة وسدس فى موسم 2015م . تم آخذ القراءات التالية عدد الأيام حتى ظهور 50% من الحراير وارتفاع النبات والكوز وطول الكوز ومحصول الحبوب أردب / فدان . أظهر تحليل التباين التجميعي اختلافات عالية المعنوية ناتجة من الهجن والسلالات والكشافات لكل الصفات محل الدراسة. كما أظهر تباين تفاعل السلالات × الكشافات إختلافات معنوية لكل الصفات محل الدراسة . كان تباين التفاعل بين السلالات × المواقع معنويا عدد الايام من الزراعه حتي 50% من النوره المؤنثه . وكان تباين تفاعل الكشافات × المواقع معنويا لكل الصفات تحت الدراسة فيما عدا طول الكوز . كما أظهر التفاعل الثلاثي المشترك بين السلالات والكشافات والمواقع إختلافات معنوية لصفة عدد الأيام حتى ظهور 50% من الحراير وصفة ارتفاع النبات . كان تباين القدرة العامة على التآلف أكبر من تباين القدرة الخاصة على التآلف فى كل الصفات محل الدراسه. تفوق إثنان من الهجن القمية معنويا في صفه محصول الحبوب عن أعلى هجن المقارنة هجين فردى 128 وهما (السلالة رقم 7 × سدس -7) و (السلالة رقم 13 × سدس -7) . أظهرت السلالات أرقام 5 ، 7 ، 13 أفضل قدرة عامة على التآلف لصفة المحصول . وقد أظهرت الهجن القمية (السلالة رقم - 1 × سدس -1157) و (السلالة رقم - 11 × سدس -7) تأثيرات موجبة ومعنويه وذلك بالنسبة للقدرة الخاصة على التآلف لصفة محصول الحبوب .