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COMBINING ABILITY OF SEVEN WHITE INBRED LINES OF MAIZE IN A DIALLEL CROSS OVER TWO LOCATIONS

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ABSTRACT

All possible cross combinations were made without reciprocals among seven inbred lines of maize at Sids Agricultural Research Station. The seven inbred lines, 21 F_1 diallel crosses and two check cultivars were evaluated at Sakha and Sids Agricultural Research Stations in 2003 growing season.

Combined analysis of variance showed highly significant mean squares due to locations and genotypes for all studied traits. The variances due to general (GCA) and specific (SCA) combining abilities were highly significant for all studied traits. Ratios of GCA/SCA mean squares higher than unity were detected for ear position and resistance to late wilt disease, indicating that the largest part of the total genetic variability associated with these two traits was a result of additive type of gene action, while, the lower ratio than unity detected for grain yield (ard/fed.) and the remaining traits suggests that non-additive played the major role in their inheritance. The interaction between locations and both GCA and SCA was highly significant for all studied traits except locations x SCA for ear position, resistance to late wilt disease and grain yield (ard/fed.).

The inbred lines, L-9, Gm-21 and L-5 are considered the best general combiners for high yield, earliness and shortness, respectively. The highest desirable SCA effects was detected in the crosses; L-7 x Sd 34, L-13 x Gm-21 and L-19 x Sd-34 for grain yield, L-5 x L-7 for earliness and ear position, L-5 x L-9 for resistance to late wilt. These crosses could be used as superior and promising hybrids in maize breeding program.

Key words: ***Maize, Zea mays, GCA, SCA, Resistance to late wilt***

INTRODUCTION

Many investigators use diallel analysis to study combining ability in maize to develop new single crosses characterized by high yielding ability. Conventional diallel analysis is limited to partitioning the genotypic variation into general (GCA) and specific (SCA) combining ability. In this connection, Sprague and Tatum (1942) mentioned that the estimates of GCA are considered as a measure of additive type of gene action and those of SCA are considered as a measure of non-additive type of gene action. Lee Mason and Zuber (1976) found that general combining ability effects were relatively more important than specific combining ability effects for grain yield. El-Hosary (1988b), Nawar *et al* (1988) and Gomaa and Shaheen (1994) reported that the GCA/SCA ratio was higher than the unity. Moreover, El-Sherbieny *et al* (1996) reported that the magnitude of additive was greater than that of dominance genetic variance with regard of yield. On the other hand, Nawar *et al* (1980), Sedhom (1992), El-Shamarka (1995), El-Shenawy *et al* (2002) and Ibrahim (2005) found that the non-additive were more important than additive variances in the inheritance of grain yield, silking date and plant and ear heights.

The aims of this investigation were: 1) to study the relative importance of general and specific combining abilities and their interaction with environments for grain yield and some other traits in maize, 2) to identify the superior parental lines and crosses for their use in hybrid maize breeding programs.

MATERIALS AND METHODS

Seven white-maize inbred lines, i.e. L-5, L-7, L-9, L-13, L-19, Gm-21 and Sd-34 were used to establish the experimental materials for this study. The first five inbreds are in the S_6 generation, while the latter two inbreds are completely homozygous and already involved in the commercial single and 3-way crosses.

These inbred lines were obtained by Maize Research Program and had high combining ability. All possible cross combinations were made without reciprocals among the seven inbred lines in 2002 growing season at Sids Research Station.

The seven parents, 21 F_1 crosses and two check cultivars, SC10 and SC 124 were evaluated in 2003 growing season at two locations i.e. Sakha and Sids Agricultural Research Stations. Randomized complete block design with four replications was used. Plot size was one ridge, 6 m long and 80 cm width and hills were spaced at 25 cm. All cultural practices were applied as recommended. Data were recorded for days to 50 % silking, plant height (cm), ear position (%), late wilt disease (%) and grain yield (ard/fed.) adjusted to 15.5 % grain moisture.

General and specific combining ability estimates were calculated by using Griffing's (1956) diallel cross analysis designated as method II Model I for each location. The combined analysis of the two locations was carried out whenever homogeneity of variance was detected.

RESULTS AND DISCUSSION

Mean performances of parents and F_1 crosses for five studied traits over two locations are shown in Table (1). There are significant differences between the parents and F_1's for grain yield. The mean values for parents ranged from 4.4 (ard/fed.) for inbred Sd-34 to 12.2 (ard/fed.) for L-19, while the mean value for the crosses ranged from 20.6 (ard/fed.) for cross L-5 x L-19 to 31.2 (ard/fed.) for cross L-7 x Sd-34.

Table 1. Mean performance of seven parental lines, their 21 F_1's and two check cultivars for grain yield and other traits evaluated at Sakha and Sids in 2003 season (Data are combined over locations).

Genotypes	50 % silking (days)	Plant height, cm	Ear position (%)	Late wilt (%)	Grain yield (ard/fed.)
Parents :					
L-5	69.9	161.3	52.9	36.5	5.6
L-7	73.4	177.3	53.9	9.2	8.0
L-9	69.5	173.8	59.2	21.2	11.8
L-13	70.6	155.5	62.1	4.3	8.2
L-19	70.0	167.6	61.3	13.1	12.2
Gm-21	68.1	172.0	44.3	0.8	9.2
Sd-34	74.9	185.6	50.5	21.8	4.4
F_1 crosses:					
L-5 x L-7	62.3	228.9	54.2	6.2	26.0
L-5 x L-9	61.1	232.6	58.4	1.1	28.5
L-5 x L-13	62.3	235.4	60.7	2.1	23.0
L-5 x L-19	63.5	222.9	57.4	5.0	20.6
L-5 x Gm-21	60.3	225.5	54.7	5.3	24.8
L-5 x Sd-34	62.5	245.6	52.9	12.2	25.0
L-7 x L-9	63.8	240.4	61.2	11.8	29.0
L-7 x L-13	63.6	236.4	61.0	2.0	26.8
L-7 x L-19	65.5	235.5	61.0	3.1	26.5
L-7 x Gm-21	62.9	222.8	55.2	3.5	29.0
L-7 x Sd-34	66.8	255.3	59.1	8.3	31.2
L-9 x L-13	61.4	235.0	62.7	11.7	27.8
L-9 x L-19	61.9	231.5	62.2	6.0	29.1
L-9 x Gm-21	61.1	220.0	55.0	9.9	30.6
L-9 x Sd-34	65.1	244.1	58.5	10.3	28.7
L-13 x L-19	64.9	243.8	51.3	0.5	24.8
L-13 x Gm-21	61.1	234.1	57.6	1.1	30.6
L-13 x Sd-34	63.9	246.3	58.9	10.9	22.3
L-19 x Gm-21	63.6	238.0	55.0	1.0	27.8
L-19 x Sd-34	64.6	250.6	57.2	1.5	29.3
Gm-21x Sd-34	64.9	230.4	50.9	4.7	23.9
Checks:					
SC-10	66.1	268.3	54.5	0.7	28.5
SC124	63.8	238.3	55.1	0.5	29.6
Mean	65.1	221.8	56.9	7.5	22.8
$LSD_{0.05}$	1.7	9.0	3.8	7.3	3.4
C.V. %	2.6	4.1	6.8	47.3	15.3

The high yielding crosses, L-7 x Sd-34, L-9 x Gm-21, L-13 x Gm-21 and L-19 x Sd 34 gave yields of 31.2, 30.6, 30.6 and 29.3 (ard/fed.), respectively.

Days to 50 % silking showed differences among parents, Gm-21 was the earliest parent (68.1 days) and inbred Sd-34 showed the latest parent (74.9 days). In general, the F_1 crosses were earlier than their parents by about one week on average. The crosses L-5 x Gm- 21, L-7 x Gm-21 and L-13 x Gm-21 were the earliest.

The analysis of variance for combining ability combined over two locations (Sakha and Sids) for the five studied traits is presented in Table (2). Mean squares due to locations were highly significant for all studied traits, 50 % silking, plant height, ear position, late wilt % and grain yield (ard/fed.). Genotypes and genotypes x locations mean squares were highly significant for all traits except genotypes x locations for ear position, indicating that the performance of genotypes differed from location to another. The variance associated with both general and specific combining abilities was highly significant for all traits, indicating that both additive and non-additive types of gene action were involved in the inheritance of these traits. These results are in agreement with those obtained by El-Hosary (1988a), Amer (2002) and Ibrahim (2005). The ratios of GCA/SCA computed for ear position and late wilt disease, were high and largely exceed the unity revealing the importance of additive than non-additive gene action. These results are in agreement with those obtained by Mahmoud (1989).

For the remaining three traits, GCA/SCA ratios indicated that the non-additive gene action types played the more important role than additive ones in the inheritance of these traits. These results are similar with those of Talleei and Kochaksaraei (1999), Geetha and Jayaraman (2000), El-Shenwawy *et al* (2002) and Ibrahim (2005).

The interactions between location and both general and specific combining ability were highly significant for most traits, indicating that the magnitude of all types of gene action differ from location to another.

The magnitude of the interaction for GCA x location was higher than that of SCA x location for all studied traits. This means that SCA was more stable than GCA at different locations. These results are in harmony with those previously reached by Matzinger *et al* (1959), El-Hosary (1989), El-Zeir *et al* (1999) and Ibrahim (2005).

Table 2. Combined analysis of variance for grain yield and other traits of the seven inbred lines and their 21 F_1 crosses.

SOV	df	Mean squares				
		Days to 50 % silking (days)	Plant height (cm)	Ear position (%)	Late wilt (%)	Grain yield (ard/fed.)
Locations	1	4428.6**	172549.5*	1611.4**	358.6**	2892.3**
Reps./Loc	6	36.5**	1128.1**	86.8**	1.2	38.2**
Genotypes	27	120.4**	7379.8**	151.5**	9.1**	594.1**
Geno. x Loc.	27	17.2**	277.1**	19.7	4.8**	27.5**
GCA	6	98.2**	1734.7**	554.8**	16.5**	141.8**
SCA	21	126.8**	8992.7**	36.3**	7.0**	723.3**
GCA x Loc	6	25.8**	395.5**	34.3*	9.8**	60.0**
SCA x Loc	21	14.7**	243.3**	15.5	3.4	18.2
Error	162	2.9	86.7	15.7	1.0	12.8
GCA/SCA	--	0.774	0.193	15.284	2.357	0.196
GCA x Loc /SCA x	--	1.755	1.626	2.213	2.882	3.296

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

Estimates of GCA effects for the parental inbred lines of each studied trait are presented in Table (3). The inbred line L-9 showed highly significant and positive GCA effect for grain yield, it was considered the best general combiner for this trait. The inbred lines Gm-21 and L-5 exhibited significant negative (desirable) GCA effects for days to 50 % silking, plant height and ear position. For late wilt resistance Gm-21 was the most desirable general combiner. The two inbred lines Gm-21 and L-5 were considered the best combiners for earliness and shortness.

Table 3. Estimates of the relative general combining ability effects (g_i) of parental inbreds in the F_1 generation for grain yield and other traits (Data are combined over locations).

Inbred	Days to 50 % silking (days)	Plant height (cm)	Ear position (%)	Late wilt (%)	Grain yield (ard/fed.)
L-5	-1.034*	-4.796	-1.434	0.582	-2.166*
L-7	1.175*	1.899	0.303	-0.072	0.677
L-9	-0.839	-0.601	2.180	0.414	2.084*
L-13	-0.284	-1.629	3.254**	-0.447	-0.757
L-19	0.341	0.107	2.201	-0.328	0.455
Gm-21	-1.200*	-4.643	-4.424**	-0.596*	0.726
Sd-34	1.841**	9.663**	-2.081	0.446	-1.030
Standard error					
S.E. g_i	0.528	2.873	1.224	0.306	1.103
S.E. (g_i- g_j)	0.806	4.389	1.870	0.467	1.685

The estimates of specific combining ability effects for the F_1 crosses based on combined data for five traits are shown in Table (4). Significant desirable SCA effects were obtained for the crosses, L-7 x Sd-34, L-13 x Gm-21, L-19 x Sd-34 and L-5 x L-9 for grain yield (ard/fed.), L-5 x L-7 and L-5 x Sd-34 for earliness and L-5 x L-9 for late wilt disease resistance. The two crosses L-5 x L-7 and L-13 x L-19 exhibited negative desirable SCA effects for ear position. These crosses could be used as superior and promising hybrids in maize breeding programs.

Table 4. Estimation of specific combining ability effects (S_{ij}) of 7 x 7 diallel crosses for grain yield and other traits (Data are combined over locations).

Crosses	Days to 50 % silking (days)	Plant height (cm)	Ear position (%)	Late wilt (%)	Grain yield (ard/fed.)
L-5 x L-7	-3.009*	12.205	-1.727	-0.390	5.141
L-5 x L-9	-2.118	18.455*	0.545	-2.126*	6.289*
L-5 x L-13	-1.549	22.233**	1.734	-0.902	3.613
L-5 x L-19	-0.924	7.997	-0.463	-0.547	0.038
L-5 x Gm-21	-2.632	15.372	3.499	-0.278	3.942
L-5 x Sd-34	-3.424*	21.191**	-0.706	-0.370	5.848
L-7 x L-9	-1.701	19.510*	1.634	0.141	3.950
L-7 x L-13	-2.382	16.538*	0.385	-0.473	4.605
L-7 x L-19	-1.132	13.927	1.388	-0.317	3.030
L-7 x Gm-21	-2.215	5.927	2.188	0.126	5.259
L-7 x Sd-34	-1.382	24.122**	3.733	-0.141	9.277**
L-9 x L-13	-2.618	17.663*	0.183	0.691	4.160
L-9 x L-19	-2.743	12.427	0.685	-0.103	4.260
L-9 x Gm-21	-1.951	5.677	0.160	0.615	5.542
L-9 x Sd-34	-0.993	15.497	1.255	-0.427	5.345
L-13 x L-19	-0.299	25.705**	-1.301	-0.455	2.764
L-13 x Gm-21	-2.507	20.830**	1.674	-0.087	8.318**
L-13 x Sd-34	-2.799	18.649*	0.381	0.572	1.787
L-19 x Gm-21	-0.632	22.969**	0.102	-0.219	4.331
L-19 x Sd-34	-2.674	21.288**	-0.016	-1.185	7.574*
Gm-21x Sd-34	-0.882	5.788	0.297	-0.180	1.853
Standard error					
S_{ij}	1.535	8.357	3.560	0.890	3.208
S_{ij} - S_{ik}	2.281	12.415	5.289	1.322	4.675
S_{ij} - S_{kl}	2.133	11.613	4.947	1.236	4.457

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القدرة على الائتلاف لسبعة سلالات بيضاء من الذرة الشامية فى نظام الهجن الدائرية فى موقعين

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تم عمل كل الهجن الممكنة عدا العكسية بين سبعة سلالات من الذرة الشامية بمحطة البحوث الزراعية بسدس وفى موسم ٢٠٠٣ تم تقييم عدد سبعة سلالات وعدد ٢١ هجين من الهجن الدائرية للجيل الأول وهجينين فرديين للمقارنة فى محطتى بحوث سخا وسدس-مركز البحوث الزراعية . وكانت البيانات المجمعة على صفات عدد الأيام لظهور ٥٠ % من الحراير، ارتفاع النبات، موقع الكوز، نسبة الإصابة بمرض الذبول المتأخر ومحصول الحبوب (اردب/فدان). وتم تحليل البيانات وراثيا باستخدام الطريقة الثانية والنموذج الأول لجريفنج (١٩٥٦). وقد أوضحت نتائج التحليل التجميعى عبر المواقع وجود فروق عالية المعنوية بين المواقع وكذلك بين التراكيب الوراثية تحت الدراسة لكل الصفات المدروسة كذلك كان التباين الراجع لكلا من القدرة العامة والخاصة على الائتلاف عالى المعنوية لكل هذه الصفات. وكانت نسبة التباين الراجع للقدرة العامة على الائتلاف الى القدرة الخاصة على الائتلاف اكبر من الواحد لصفتى موقع الكوز والإصابة بمرض الذبول المتأخر مما يشير الى دور الفعل الجينى المضيف فى وراثة هاتين الصفتين بينما كانت النسبة اقل من الواحد لصفة المحصول وباقى الصفات المدروسة وهذا يوضح دور الفعل الجينى الغير مضيف والذى يلعب الدور الرئيسى فى وراثة هذه الصفات. كان تفاعل كلا من القدرة العامة والخاصة على الائتلاف مع المواقع معنويا لكل الصفات عدا تفاعل القدرة الخاصة على الائتلاف مع المواقع حيث كان غير معنويا لصفات موقع الكوز والإصابة بمرض الذبول المتأخر ومحصول الحبوب (أردب/فدان).

أظهرت السلالة ٩، جميزة ٢١، السلالة ٥ افضل قدرة عامة على الائتلاف لصفات محصول الحبوب، التبكير فى التزهير، والطول المنخفض للنبات، على التوالى مما يساعد على استخدامها كمختبرات جيدة فى برنامج التربية لهذه الصفات. كما أظهرت بعض الهجن تأثيرا عالياً ومرغوباً للقدرة الخاصة على الائتلاف ومنها (سلالة ٧ x سدس٣٤)، (سلالة ١٣ x جميزة ٢١)، (سلالة ١٩ x سدس٣٤) لصفة محصول الحبوب، الهجين (سلالة ٥ x سلالة ٧) لصفتى التبكير وموقع الكوز كما اظهر الهجين (سلالة ٥ x سلالة ٩) افضل تأثير مرغوب للقدرة الخاصة على الائتلاف للمقاومة لمرض الذبول المتأخر. هذه الهجن يمكن الاستفادة منها فى برنامج التربية كهجن مبشرة.