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Diallel Analysis of Eight Yellow Maize Inbred Lines for Earliness and Grain Yield

El-Shahed, H. M.*; A. M. Abu Shosha; M. A. M. El-Ghonemy and R. H. A. Alsebaey

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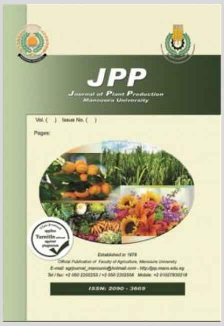
Maize Research Department, Field Crops Research Institute, ARC, Egypt



ABSTRACT

Combining ability for grain yield and other traits were evaluated in a half diallel fashion in maize. Eight yellow maize inbred lines were crossed in half diallel fashion excluding the reciprocals during the summer season of 2018 at Gemmeiza station, the resulting 28F_1 were evaluated along with check SC168 at two locations (Gemmeiza and Sids) in 2019 summer season. A randomized complete block design (RCBD) with four replications was used. Mean squares of GCA and SCA were highly significant for all the studied traits at combined data, except SCA for ear diameter. The non-additive gene effects were most responsible for controlling the inheritance of days to 50% silking, plant height, ear length and grain yield. While the additive gene effects had the important role in the inheritance of ear height and ear diameter. The parents; P_6 and P_7 were significant for general combiner for yield and p_4 for earliness. The crosses P_3 xP_7, P_5 x P_8 and P_6 x P_7 had desirable SCA effects for earliness. Meanwhile, the crosses P_2 xP_8, P_3 x P_6, P_4 x P_5 and P_5 x p_7 showed high SCA effect for grain yield. The single crosses; P_2 xP_7, P_2 x P_8, P_3 x P_6, P_5 x P_7, P_6 xP_7 and P_7 x P_8 had desirable mean values for earliness and grain yield.

Keywords: *Maize, half-diallel cross, combining ability, grain yield, earliness.*

INTRODUCTION

Maize (*Zea mays* L.) considered one of the most important and promising cereals crops in Egypt; Area devoted to maize cultivation is about 2.7 million faddan. Maize productivity increased form (1.5 ton/fed) in 1980 to (3.3 ton /fed) in 2020 season. Recently, national maize research program in Egypt has an optimistic plane to release early hybrids to save irrigation water in same time gave high grain yield. Diallel mating design has utility as a method to analyses crosses or parents with crosses for general combining ability (GCA) due to (additive type of gene action) and specific combining ability SCA (non- additive type of gene action) Griffing 1956. Hallauer and Miranda (1981) stated that both GCA and SCA effects should be taken into consideration when planning maize breeding programs to produce and release new inbred lines and crosses. Several investigators studied the general and specific combining ability and their role in the inheritance of grain yield, yield components and agronomic characters. Gado (2000) and Soliman *et al.* (2005) found that GCA (additive gene action) was more important in the inheritance of grain yield, days to mid silking, plant and ear heights. On the Contrary Sadek *et al.* (2001), Barakat and Osman (2008) and Irshad – El- Hag *et al.* (2010) reported that SCA (non- additive gene action) played the major role in the inheritance of grain yield and other agronomic traits. The present study was planned to obtain information on general and specific combining abilities for eight yellow inbred lines and their crosses for grain yield and other related traits and identify the best crosses compared to check hybrids.

MATERIALS AND METHODS

Eight yellow maize inbred lines (code, name and origin are presented in Table 1) which had earliness (95- 105 days) were crossed in a half diallel fashion excluding the reciprocals during the summer season 2018 at Gemmeiza Research Station, ARC, Egypt. The resulting 28 F_1 were evaluated along with check SC168 at two locations; Gemmeiza and Sids Stations. A randomized complete block design (RCBD) with four replications during 2019 summer season was used. Kernels were hand –sown at two grains per hill, then thinned at one plant per hell before the first irrigation. Each replication contained 30 plots and each plot consisted of one ridge with 6 m a long and spacing of 0.25 m between plants within ridge and 0.80 m between ridges. Data were taken on number of days to 50% silking, plant height (cm), ear height (cm), ear length (cm), ear diameter (cm) and grain yield, which was adjusted to 15.5 % grain moisture (estimated in kg/plot and converted to ard/fed). GCA and SCA combining abilities were estimates according to Griffings (1956). Diallel cross analysis designated as method 4 model 1 (fixed model) for each location. Combined analysis of variance over two locations was carried out whenever homogeneity of variance was detected (Snedecor and Cochran 1967). Least significant of difference (LSD) method was used to test differences between means at 5% and 1% level s of probability, as described by Snedecor and Cochran (1980).

Table 1. Code, name and origin for eight yellow maize inbred lines.

Code	Name	Origin
P_1	Gm. 6042	Comp#45
P_2	Gz.666	Mo 17 x Sd7
P_3	Gm.42	Gm.Y.Pop.
P_4	Gm.2032	Pop. 31- 69 (Cimmyt)
P_5	Gm.36	Pool- 22 -622 (Cimmyt)
P_6	Gm.636	Pop- 24 -610 (Cimmyt)
P_7	Gm.6013	Pool- 18 -627 - M(Cimmyt)
P_8	Gm.40	Comp#21

RESULTS AND DISCUSSION

The analysis of variance for six traits a cross two locations is presented in Table 2. Mean squares due to locations were highly significant for all traits under this study, except days to 50% silking, meaning that the situations were differed from location to another. These results are agreement with Gamea *et*

* **Corresponding author.**
E-mail address: haythammostfa@yahoo.com
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al. (2018). Crosses mean squares were highly significant for all studied traits, indicating that there were differences among the crosses. These results are agreement with those of Mosa (2005), Mosa (2006) and Motawei (2006). The interaction between crosses with locations was highly significant for all traits, except for ear height, meaning that the crosses were affected by change of locations.

Table 2. Analysis of variance of RCBD for six traits combined across two locations.

S.O.V	d.f.	Days to 50 % silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard/fad)
Location (Loc.)	1	1.97	9014.47**	9321.54**	68.05**	29.68**	358.77**
Rep/loc.	6	5.47	706.28	437.46	2.15	1.65	39.29
Crosses (Cr.)	27	11.41**	2094.34**	834.83**	4.81**	0.33**	94.16**
Cr. x Loc.	27	2.99**	158.31**	63.90	7.52**	0.14**	31.47**
Error	162	1.39	89.85	61.23	1.26	0.06	6.38
CV %		2.08	4.82	7.66	5.78	5.45	10.67

**** significant at 0.01 level of probability.**

Mean performance:

Results in Table 3 cleared that, mean performance of 28 single crosses and one check for six traits across two locations are shown in table 3. For grain yield, mean of crosses ranged from 19.62 ard / fed for P_2 x P_5 to 33.06 ard /fed for P_3 x P_6.Three single crosses; P3 x P6 (33.06 ard /fed), P_5 x P_7 (32.15 ard /fed) and P_2 x P_8 (30.98 ard /fed) were significant out yielded over the highest check SC 168 (27.56 ard/fed). Also three single cross P_2 x P_7, P_6 x P_7 and P_7 x P_8 were not significant for grain yield compared to SC 168. For days to 50% silking all crosses were significant for earliness compared to SC 168, the best crosses from them P_3 x P_4 , P_3 x P_5, P_4 x P_8 and P_5 x P_8. These crosses could be harvested at (100 – 105) days from planting. The highest crosses for plant height were P_2 x P_7, P_3 x P_6 and P_6 x P_7, while, crosses P_3 x P_5, P_4 x P_6 and P_5 x P_8 had the lowest values, Also the highest crosses for ear height were P_3 x P_6, P_6 x P_7 and P_7 x P_8 on the other wise crosses P_1 x P_5 , P_3 x P_5 and P_5 x P_8 gave the lowest values. For ear length crosses P_2 x P_6, P_5 x P_7 and P_6 x P_7 increased significantly than the check SC 168 as well as cross P_3 x P_6 for ear diameter. From above crosses six crosses P_2 x P_7, P_2 x P_8, P_3 x P_6, P_5 x P_7, P_6 x P_7 and P_7 x P_8 had desirable values for grain yield and earliness. These crosses could be using in maize breeding programs for earliness and yield.

Combining ability:

Analysis of combining ability for days to 50% silking, plant height, ear height, ear length, ear diameter and grain yield are presented in Table 4. The results showed that, mean squares of GCA and SCA were significant for all traits, except for SCA mean squares for ear diameter. This indicate importance of both additive and non-additive components of genetic variance in controlling these traits. This was confirmed by Abd El-Aty and Katta (2002) and Yousif *et al.* (2003). The interaction between GCA and SCA with locations were significant or highly significant for all traits, indicating that the additive and non-additive gene effects were affected by the environmental conditions. These results are in agreement with EL-Seidy *et al*. (2012). Regarding GCA / SCA ratio, Table 5 appeared that, the ratio was low than unity for all traits except for ear height and ear diameter, meaning that the non additive gene effects were most responsible for controlling the inheritance of these traits. Sultan *et al.* (2016) and Gamea *et al.* (2018) came the same conclusion. The ratio of GSA x L / SCA x L was low than unity for all trait except for ear height, indicate that the non-additive gene effects were more interacted with locations for these traits. This conclusion supports the findings by, Soliman *et al.* (2005) and Abdel-Moneam *et al* (2014,a, b and c).

Table 3. Mean performance of 28 F_1 crosses and check hybrid for gran yield and other traits combined across two locations.

Cross	Days to 50 % silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard/fed.)
P_1 x P_2	57.1	196.25	95.63	19.4	4.6	20.01
P_1 x P_3	57.1	182.50	93.13	18.9	5.0	22.97
P_1 x P_4	55.9	180.63	91.88	19.7	4.8	22.78
P_1 x P_5	57.0	163.13	83.75	18.9	4.8	19.83
P_1 x P_6	57.0	203.75	103.13	20.2	4.9	24.29
P_1 x P_7	58.1	181.25	96.25	18.0	4.5	23.26
P_1 x P_8	57.5	198.13	98.75	19.9	4.7	23.09
P_2 x P_3	56.6	216.25	110.63	20.3	4.7	23.74
P_2 x P_4	57.3	200.63	103.13	18.4	4.4	22.49
P_2 x P_5	57.0	200.00	95.00	19.6	4.6	19.67
P_2 x P_6	56.6	192.50	96.25	19.6	4.8	23.38
P_2x P_7	57.9	226.25	118.13	20.6	4.5	25.22
P_2x P_8	58.4	207.50	106.88	20.0	4.4	30.98
P_3 x P_4	54.9	191.25	101.25	18.3	4.9	22.17
P_3 x P_5	55.3	180.00	89.38	18.5	4.7	21.16
P_3 x P_6	59.1	221.25	122.50	19.8	5.1	33.06
P_3x P_7	55.9	201.88	106.25	19.5	4.6	24.44
P_3x P_8	55.8	197.50	101.88	20.3	4.9	23.54
P_4 x P_5	56.4	198.13	99.38	19.0	4.8	23.76
P_4 x P_6	56.0	180.00	98.75	19.3	4.9	22.92
P_4x P_7	55.9	198.75	104.38	18.9	4.5	23.67
P_4x P_8	55.3	190.63	104.38	17.7	4.5	19.75
P_5 x P_6	55.5	190.75	96.88	19.2	4.6	20.89
P_5 x P_7	59.6	198.13	109.38	20.5	4.8	32.15
P_5 x P_8	55.1	161.88	83.75	19.3	4.4	20.11
P_6 x P_7	56.1	225.63	121.25	20.5	4.8	25.78
P_6 x P_8	56.0	205.00	111.25	19.0	4.4	22.30
P_7 x P_8	57.4	215.63	118.75	19.4	4.5	25.16
Check SC168	62.5	220.00	128.13	19.2	27.57	27.57
L.S.D. 0.05	1.2	9.43	7.79	1.1	2.51	2.51

Table 4. Analysis of variance of combining ability for six traits combined across two location.

S.O.V	d.f.	Days to 50 % silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard/fad.)
Crosses	27	1.43**	261.79**	104.35**	0.60**	0.04**	11.77**
GCA	7	1.85**	582.97**	268.52**	0.75**	0.10**	11.79**
SCA	20	1.28**	149.38**	46.89**	0.55*	0.02	11.76**
GCA x Loc.	7	3.29**	654.05**	293.51**	3.20**	0.17**	28.16**
SCA x Loc.	20	1.78**	177.93**	59.71**	2.23**	0.04**	16.65**
Error term	162	0.35	22.46	15.31	0.31	0.02	1.59

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

Table 5. Estimates of ratio between GCA and SCA and their interaction with location.

S.O.V	Days to 50 % silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard/fad.)
GCA / SCA	0.26	0.73	1.30	0.31	3.50	0.16
GCA x Loc. /SCA x Loc.	0.33	0.67	1.04	0.25	0.99	0.29

General combining ability (GCA) effects:

Data in Table 6 showed that, the inbred lines P_4 for days to 50% silking and P_1 and P_5 for plant and ear heights had negative values and desirable significant of GCA effects for these traits, while, the inbred lines P_3 for ear diameter and P_6 and P_7 for grain yield had positive values and desirable significant of GCA effects.

Table 6. Estimates of general combining ability (GCA) effects for the eight inbred lines for the six studied traits combined across two locations.

Parent		Days to 50 % silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard/fad.)
P_1		0.474*	-11.776**	-8.828**	-0.129	0.093	-1.568**
P_2		0.661**	10.516**	1.693	0.378	-0.13	-0.024
P_3		-0.380	2.391	1.589	-0.014	0.191**	0.906
P_4		-0.901**	-6.047**	-2.057	-0.726**	0.002	-1.350**
P_5		-0.172	-14.047**	-9.661**	-0.106	-0.015	-1.346**
P_6		-0.089	7.099**	5.755**	0.303	0.127	1.163*
P_7		0.661**	11.870**	9.818**	0.290	-0.097	2.339**
P_8		-0.255	-0.005	1.693	0.004	-0.170**	-0.120
LSD $_{gi}$	0.05	0.448	3.602	2.973	0.426	0.097	0.960
	0.01	0.581	4.670	3.855	0.552	0.126	1.244
LSD $(_{gi-gj})$	0.05	0.678	5.445	4.495	0.644	0.147	1.451
	0.01	0.879	7.060	5.828	0.835	0.190	1.881

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

Specific combining ability (SCA) effects:

The estimates of specific combining ability effects for 28 crosses are presented in Table 7. For days to 50% silking, the single crosses; P_3 x P_7, P_5 x P_8, and P_6 x P_7 had negative and desirable significant of SCA effects towards earliness. For plant and ear heights, five crosses P_1 x P_7, P_2 x P_6, P_3 xP_7, P_4 x P_6 and P_5 x P_8 exhibited negative and desirable significant of SCA effects for short plant and low ear position. Regarding to ear length and ear diameter, three single crosses P_1 x P_4 and p_3 x p_8 and P_5 x P_7 and one single cross P_3 x P_8 for ear diameter showed positive values and significant of SCA effects for these traits, respectively. four single crosses; P_2 xP_8, P_3 x P_6, P_4 x P_5 and P_5 x P_7 had positive values and desirable significant of SCA effects for grain yield.

Table 7. Estimates of specific combining ability (SCA) effects for 28 F_1 crosses for the six studied traits combined across two locations.

Cross			Days to 50 % silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard/fad.)
P_1 x P_2			-0.711	0.899	0.551	-0.251	-0.077	-2.065
P_1 x P_3			0.330	-4.726	-1.845	-0.376	0.035	-0.028
P_1 x P_4			-0.399	1.836	0.551	1.212*	0.049	2.039
P_1 x P_5			-0.003	-7.664	0.030	-0.209	0.074	-0.922
P_1 x P_6			-0.086	11.815**	3.988	0.599	0.016	1.032
P_1 x P_7			0.289	-15.455**	-6.949*	-1.580*	-0.161	-1.172
P_1 x P_8			0.580	13.295**	3.676	0.606	0.063	1.117
P_2 x P_3			-0.357	6.732	5.134	0.550	-0.024	-0.802
P_2 x P_4			0.789	-0.455	1.280	-0.629	-0.152	0.205
P_2 x P_5			-0.190	6.920	0.759	-0.066	0.064	-2.623*
P_2 x P_6			-0.649	-21.726**	-13.408**	-0.458	0.156	-1.420
P_2x P_7			-0.149	7.253	4.405	0.571	0.055	-0.759
P_2x P_8			1.268*	0.378	1.280	0.282	-0.022	7.464**
P_3 x P_4			-0.545	-1.705	-0.491	-0.337	0.044	-1.051
P_3 x P_5			-0.899	-4.955	-4.762	-0.783	-0.181	-2.060
P_3 x P_6			2.893**	15.149**	12.946**	0.092	0.102	7.323**
P_3x P_7			-1.107*	-8.997*	-7.366*	-0.112	-0.199	-2.470*
P_3x P_8			-0.315	-1.497	-3.616	0.966*	0.224*	-0.911
P_4 x P_5			0.747	21.607**	8.884**	0.446	0.108	2.790**
P_4 x P_6			0.289	-17.664**	-7.158*	0.338	0.058	-0.553
P_4x P_7			-0.586	-3.685	-5.595	-0.083	-0.069	-0.984
P_4x P_8			-0.295	0.065	2.530	-0.947	-0.037	-2.446*
P_5 x P_6			-0.940	1.086	-1.429	-0.375	-0.167	-2.591*
P_5 x P_7			2.435	3.690	7.009*	0.971*	0.189	7.495**
P_5 x P_8			-1.149*	-20.685**	-10.491**	0.016	-0.087	-2.089
P_6 x P_7			-1.149*	10.045*	3.467	0.480	0.081	-1.383
P_6 x P_8			-0.357	1.295	1.592	-0.676	-0.245*	-2.408*
P_7 x P_8			0.268	7.149	5.030	-0.247	0.103	-0.726
L S D	Sij	0.05	0.992	7.971	6.580	0.943	0.215	2.124
		0.01	1.286	10.334	8.531	1.222	0.278	2.754
	Sij-SIK	0.05	1.515	12.176	10.051	1.440	0.328	3.245
		0.01	0.992	15.786	13.031	1.867	0.425	4.207

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

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تحليل الدياليل لثمانية سلالات صفراء من الذرة الشامية للتبكير ومحصول الحبوب

هيثم مصطفي الشاهد*، احمد مصطفي أبو شوشة ، محمد أحمد محمد الغنيمي و رفيق حليم عبد العزيز السباعي

قسم بحوث الذرة الشامية –معهد بحوث المحاصيل الحقلية –مركز البحوث الزراعيـة – مصر

تم حساب القدرة على الائتلاف لمحصول الحبوب وبعض الصفات الأخرى في تصميم الدياليل النصف دائري في الذرة الشامية في محطة البحوث الزراعية بالجميزة ، تم تهجين ثماني سلالات في نظام التهجين النصف دائري في الموسم الصيفي 2018 م. وفي الموسم الصيفي 2019 م تم تقيم ثماني وعشرون هجين فردي الناتجة من التهجين بالإضافة إلى هجين المقارنة هـ ف 168 في موقعين بمحطة البحوث الزراعية بالجميزة وسدس باستخدام تصميم القطاعات العشوائية في أربع مكررات. كان التباين الراجع إلى القدرة العامة والقدرة الخاصة على التآلف عالي المعنوية لجميع الصفات محل الدراسة للتحليل التجميعي لكلا الموقعين فيما عدا تباين القدرة الخاصة على التآلف لصفة قطر الكوز. كان التباين غير المضيف الأكثر مسئولية عن التحكم في وراثة صفات عدد الأيام حتى ظهور 50% من النورة المؤنثة، وطول النبات، طول الكوز ومحصول الحبوب بينما كان للتباين المضيف الدور الأكبر لصفتي ارتفاع الكوز وقطر الكوز. كانت تأثيرات القدرة العامة على التآلف للآباء (P_6 جميزة 636 ، P_7 جميزة 6013) معنوية لمحصول الحبوب وكانت السلالة (P_4 جميزة 2032) معنوية وأفضل الآباء قدرة عامة على التآلف لصفة طول الكوز. أظهرت الهجن (P_3 جميزة 42 × P_7 جميزة 6013) ، (P_5 جميزة 36 × P_8 جميزة 40) ، (P_6 جميزة 636 × P_8 جميزة 40) ، (P_6 جميزة 636 × P_7 جميزة 6013) قدرة خاصة على الائتلاف للتبكير بينما كانت الهجـن (P_2 جيـــزة 666 × P_8 جميزة 40)، (P_3 جميزة 42 × P_6 جميـــزة 636)، (P_4 جميـــزة 2032 × P_5 جميزة 36) ، (P_5 جميزة 36 × P_7 جميزة 6013) لها قدرة خاصة على الائتلاف عالية ومعنوية لصفة محصول الحبوب. وكانت الهجن (P_3 جميزة 42 × P_7 جميزة 6013) والهجين (P_3 جميزة 42 × P_8 جميزة 40) ، (P_3 جميزة 42 × P_6 جميزة 636) ، (P_5 جميزة 36 × P_7 جميزة 6013)، (P_6 جميزة 636 × P_7 جميزة 6013) ، (P_7 جميزة 6013 × P_8 جميزة 40) أظهرت متوسطات مرغوبة للتبكير ومحصول الحبوب.