II.7 COMBINING ABILITY ESTIMATES FOR GRAIN YIELD AND ITS COMPONENTS OF YELLOW MAIZE INBRED LINES

El-REFAEY, R.A.[1]., A.M. SHEHATA[2] and A.M. ABU SHOSHA[2]

1. Agronomy Dep., Fac. Agric., Tanta Univ. Egypt.
2. Maize Res. Dep., Field Crops Res. Inst., ARC, Giza, Egypt.

Abstract

Six yellow maize (Zea mays L.) inbred lines were crossed in a half diallel mating scheme at Gemmeiza Agric. Res. Stn. in 2009. In 2010, the resulting 15 crosses along with three check hybrids; SC 162, SC 164 and SC 166 were evaluated at Gemmeiza and Mallawy, where GCA and SCA effects were estimated. Location and crosses mean squares were significant for all traits except for no. of rows ear^{-1}. Significant cross x location interaction mean squares were recorded for all traits, except for ear diameter and no. of rows ear^{-1}. The mean squares associated with GCA and SCA were significant for all traits at both locations and also in the combined analysis, indicating that both additive and non-additive gene effects were involved in the inheritance of the traits. The ratio of GCA/SCA mean squares exceeded the unity for no. of rows ear^{-1} and no. of kernels row^{-1} at the two locations and their combined analysis. However, the same ratio was less than unity for ear diameter, 100-kernel weight and grain yield fed.$^{-1}$ at the two locations and their combined analysis, indicating that additive (a) and (aa) gene effects play an important role in the inheritance of the traits in the first case and non-additive was predominant in the second one. The ratio of GCA x L/SCA x L mean squares was less than unity for ear diameter, 100-kwt and grain yield fed.$^{-1}$, indicating that non-additive genes were more interacted with location than additive ones for the traits in question, while the same ratio exceeded the unity for no. of rows ear^{-1} and no. of kernels row^{-1}, indicating that additive (a) and (aa) changed with changing the environments. The parental genotype (P2) was a good general combiner for no. of kernels row^{-1} and 100-kwt at Gemmeiza, while P4 was considered as a good general combiner for no. of rows ear^{-1} and 100-kernel weight at Mallawy and for no. of kernels row^{-1} at Gemmeiza. The same parental genotype performed as a good general combiner for ear diameter, no. of rows ear^{-1} and grain yield fed.$^{-1}$ at Mallawy. The crosses; P1 x P3 and P5 x P6 had significant inter- and intra-allelic interactions for ear diameter at both locations and their combined data, no. of kernels row^{-1} at Gemmeiza and combined data and grain yield fed.$^{-1}$ at Mallawy. Moreover, the crosses; P1 x P2 , P2 x P4, P3 x P6 and P5 x P6 surpassed the three check hybrids with respect to grain yield.

Keywords: (*Zea mays* L.), GCA, SCA, gene effect, Diallel cross.

INTRODUCTION

Maize *(Zea mays* L.) is one of the major cereal crops in Egypt and the world. The grown area of maize in Egypt is about 1.6 million fedden in 2010 season with an average production of 24 ardab fed.$^{-1}$ (one feddan = 4200 m^2 and one ardab=140 kg) according to National Maize Program. It is used mainly for animal feed and domestic consumption. The main goal of the breeders is to develop new maize cultivars, which could be achieved by estimating heterosis and combining ability for maize genotypes under different environments. Sprague and Tatum (1942) were the first scientists defined general and specific combining ability. Hallauer and Miranda (1981) concluded that improving inbred lines increased grain yield and modified maturity.

Yield and yield components are of great importance for dealing with the inheritance of such traits to assist maize breeders and geneticists to plan convenient breeding programs for increasing yield potential. The diallel mating design has been used and abused more extensively than any other designs in maize and other plant species to determine the combining ability of various genotypes. After these steps of evaluation, the breeder can exploit both additive and non-additive gene action available, which helps to plan the suitable breeding program via the proper breeding method. Therefore, the main objectives of the present investigation were to study and determine: a) combining ability and interaction with environment, b) the type of gene action controlling the inheritance of the studied traits and c) identify the superior crosses, which surpass the check cultivars.

MATERIALS AND METHODS

Six yellow (*Zea mays* L.) inbred lines with a wide range of diversity for several traits (Table 1) were crossed in a half diallel mating scheme in 2009 season at Gemmeiza Agric. Res. Station giving a total of 15 crosses as hybrid seeds. In 2010 season, these 15 crosses along with three commercial check hybrids; i.e., (S.C 162, S.C 164 and S.C 166); were evaluated in a randomized complete block design experiment with four replications at two locations i.e. Gemmeiza and Mallawy Agricultural Research Stations, representing Delta and Upper Egypt regions, respectively.

Table 1. Name and pedigree of the six yellow inbred lines.

No. of parent	Name	Pedigree
P_1	Gm. 101	Pool- 22 -622
P_2	Gm. 102	Pop. 146 -66
P_3	Gm. 104	Pop. 31-69
P_4	Gm. 207	(Comp # 21)
P_5	Gm. 215	(Comp # 45)
P_6	Gm. 230	(Gm.Y.Pop.)

The experimental plot was one ridge of 6-m length and 0.80 m width. Sowing was done in hills evenly spaced by 25 cm at the rate of two kernels per hill on one side of the ridge. Seedlings were thinned to one plant per hill. Agricultural practices were executed as recommended for maize cultivation. Data were recorded for ear diameter (cm), number of rows ear^{-1}, number of kernels row^{-1}, 100–kernel weight (g) and grain yield (ardab fed.$^{-1}$) adjusted to 15.5% moisture content. Analysis of variance for randomized complete block design was performed according to the method outlined by Snedecor and Cochran (1967) and used for each location, and then combined performance across locations.

The L.S.D. test at 0.05 and 0.01 level of probability according to Steel and Torrie (1980) was used for comparisons of the mean performance of different genotypes. General (GCA) and specific (SCA) combining ability effects were estimated according to Griffing (1956) model 1, method 4. Superiority percentage for all characteristics under study was computed for individual crosses as the percentage of increase of each cross relative to the three checks.

Superiority over check $[(F_1 - \text{check}) / \text{check}] \times 100$

The value of F_1-check compared with least significant difference (L.S.D) at 0.05 and 0.01 levels of probability to determine the level of significance where:

$$\textbf{L.S.D}_{\substack{0.05\\0.01}} = t_{\substack{0.05\\0.01}} \sqrt{\frac{2\text{M.S error}}{r}}$$

RESULTS AND DISCUSSION

The analysis of variance for the five studied traits in each location and their combined data are presented in Table 2. Results indicated that location mean squares were significant for all studied traits, except for no. of rows ear^{-1}, indicated overall differences between the two locations.

Significant differences were detected among crosses for all traits in each location as well as the combined data except for Gemmaiza location for no. of rows ear^{-1}, indicating wide diversity between the crosses used in this study. Significant crosses x locations interaction mean squares were obtained for all traits, except for ear diameter and number of rows ear^{-1}. These results indicated that the tested crosses changed its ranking from the first location to the second. These results were in harmony with those reported by Venugopal, *et. al.* (2002), Mosa (2003), Osman *et. al.* (2012), Abd El-Mottalb and Gamea (2014) and Mousa (2014).

Combining ability

Analysis of variance

Analysis of variance for combining ability as outlined by Griffng (1956) model-1, method 4 in each location and their combined data for studied traits are shown in Table 3. The mean squares associated with (GCA) and (SCA) were significant for all studied traits in both locations as well as the combined analysis. Insignificant mean squares of GCA were detected for ear diameter and grain yield at Gemmeiza, while insignificant mean squares of SCA were detected for no. of rows ear^{-1} at Gemmeiza and at Mallawy for no. of kernels row^{-1}. The ratio of GCA/SCA mean squares was less than unity for ear diameter, 100-kernel weight and grain yield (ard. fed.$^{-1}$) at the two locations and their combined data, indicating the importance of non-additive gene action in the inheritance of these traits. These results were in agreement with those reported by Venugopal, *et. al.* (2002), Mosa (2003), Mosa and Amer (2004), Singh and Roy (2007), Akbar *et. al.* (2008), Osman *et. al.* (2012), Abd El-Mottalb and Gamea (2014) and Mousa (2014). On the other hand, the ratio of GCA/SCA mean squares exceeded the unity for no. of rows ear^{-1} and no. of kernels row^{-1} at the two locations and their combined analysis. This would indicate that additive and additive x additive gene effects played an important role in the inheritance of the traits in view. Nigussie and Zelleke (2001), Yousif *et. al.* (2003), Abd El-Hadi *et. al.* (2005), Soliman *et. al.* (2005) and Motawei (2005) came up to the same conclusion. The ratio of GCA x location/SCA x location mean squares was less than unity for ear diameter, 100-kernel weight and grain yield (ard. fed.$^{-1}$), indicating that non-additive genes were more interacted with location than additive ones for the traits in question.

Table 2. Mean square of yellow crosses for the five studied traits under two locations and their combined,2010.

S.O.V.	d.f.		Ear Diameter			No. of Rows ear^{-1}			No. of Kernels row^{-1}		
	single	Comb	Gm.	Mal.	Comb	Gm.	Mal.	Comb	Gm.	Mal.	Comb
Loc.		1			13.068**			0.012			295.788**
Rep/Loc.		6			0.109*			1.050			2.190
Crosses	14	14	0.130*	0.087**	0.190**	1.779	1.684**	2.514**	33.910**	4.244**	18.483**
Crosses x Loc.		14			0.027			0.949			19.670**
Error	42	84	0.052	0.022	0.037	0.966	0.457	0.712	2.821	1.467	2.144

Table 2. Cont'd

S.O.V.	d.f.		100–kernel weight (g)			Grain yield		
	single	Comb	Gm.	Mal.	Comb.	Gm.	Mal.	Comb
Loc.		1			506.8**			47.6**
Rep/Loc.		6			5.0*			7.2
Crosses	14	14	46.6**	17.5**	20.2**	24.2**	68.7**	61.6**
Crosses x Loc.		14			43.9**			31.3**
Error	42	84	2.4	1.1	1.7	8.6	3.9	6.3

Gm.= Gemmeiza, Mal. = Mallawy, single = single analysis of variance, Comb = Combined analysis of variance.

On the other hand, the same ratio exceeded the unity for no. of rows ear^{-1} and no. of kernels row^{-1}, indicating the importance of additive and additive x additive gene effects with changing the environments for these traits. However, Dawood *et. al.* (1994) found that SCA x location interactions were higher than GCA x locations, indicating that non-additive gene action was more interacted with location than additive one. Mosa (2003) found that additive gene action was more interacted with locations than non-additive due to exceeding the ratio of GCA x location/SCA x location than unity. EL-Shenawy (2005) found that the ratio of SCA x location/GCA x location mean squares was more than unity for ear diameter indicating that non-additive genes were more interacted with environments than additive one for this trait, Motawei (2006) indicated that mean squares due to GCA x location were higher than those due to SCA x location interaction for all traits, indicating that additive gene effects was more affected by the environmental conditions than non-additive gene action and Mousa (2014) stated that the magnitude of SCA x location interaction was larger than GCA x location for all traits. (The ratio of GCA x loc.1/GCA x loc.2 mean squares was less than unity for grain yield (ard. fed.$^{-1}$), indicating that additive and additive x additive gene effects more interacted with Mallawy location than do with Gemmeiza location for these traits. The opposite case was observed for ear diameter, no. of rows ear^{-1}, no. of kernels row^{-1} and 100-kernel weight, where the same ratio was more than one, indicating that additive and additive x additive gene effects more interacted with Gemmeiza location than do with Mallawy one for the traits in consideration. The ratio of SCA x loc.1/SCA x loc.2 mean squares was less than unity for no. of rows ear^{-1} and grain yield (ard. fed.$^{-1}$), indicating that non-additive genes were more interacting with Mallawy than with Gemmeiza for the above-mentioned traits, while, ear diameter, no. of kernels row^{-1} and 100-kernel weight were more affected by non-additive genes at Gemmeiza than at Mallawy (where the same ratio exceeded the unity).

b. General combining ability effects ($\hat{g}_i$).

Considering ear diameter, desirable significant ($\hat{g}_i$) was detected for P_6 at Mallawy only (Table 4). The inbred lines; P_4 and P_6 exhibited desirable significant ($\hat{g}_i$) under Mallawy for number of rows ear^{-1}. For number of kernels row^{-1}, the highly significant ($\hat{g}_i$) was detected under Gemmeiza for the inbred lines (P_2 and P_4), while the inbred line (P_1) had high significant ($\hat{g}_i$) for the trait in view at Mallawy.

Considering 100-kernel weight, desirable significant ($\hat{g}_i$) was detected for P_1 and P_2 at Gemmeiza and P_4 at Mallawy. For grain yield, the inbred line P_6 showed desirable and high significant ($\hat{g}_i$) under Mallawy and the combined analysis, while the inbred line P_2 was considered as good combiner at Mallawy for the trait in view.

Specific combining ability effects ($\hat{s}_{ij}$)

Specific combining ability effects ($\hat{s}_{ij}$) of the crosses for all traits at separate locations and their combined are presented in Table 5. For ear diameter, the crosses; (P_1 x P_3) and (P_5 x P_6) showed significant positive values of ($\hat{s}_{ij}$) at the two locations and the combined analysis. For no. of rows ear^{-1}, the crosses; (P_1 x P_3) and (P_4 x P_6) showed high significant positive values of ($\hat{s}_{ij}$) at Mallawy. The crosses; (P_1 x P_3), (P_1x P_6) (P_3 x P_4), (P_4 x P_5) and (P_5x P_6) showed significant positive values of ($\hat{s}_{ij}$) for no. of kernels row^{-1} at Gemmeiza and combined analysis. For 100-kernel weight, the cross; (P_1 x P_5) at the two locations and their combined data; the crosses; (P_1 x P_6), (P_2 x P_3) and (P_2 x P_4) at Gemmeiza and the combined analysis and the crosses; (P_1 x P_2), (P_3 x P_4) and (P_4 x P_6) at Mallawy exhibited significant ($\hat{s}_{ij}$) in positive direction for the trait in question. The cross; (P_1 x P_2) at the two locations and the crosses; (P_1 x P_4), (P_2 x P_4), (P_3 x P_6) and (P_5 x P_6) at Mallawy showed high significant ($\hat{s}_{ij}$) in positive direction for grain yield. These results were in good agreement with those obtained by Zelleke (2000), Barakat *et. al.* (2003) and Kabdal *et. al.* (2003), Osman *et. al.* (2012), Abd El-Mottalb and Gamea (2014), Mousa (2014) and Osman (2014).

Table 3. Analysis of variance for combining ability of yellow crosses for the five studied traits under two locations and their combined, 2010.

S.O.V.	d.f.		Ear diameter			No. of rows ear^{-1})			No. of kernels row^{-1}		
	single	Comb	Gm.	Mal.	Comb	Gm.	Mal.	Comb	Gm.	Mal.	Comb
G.C.A.	5	5	0.030	0.020**	0.023	0.658*	0.543**	0.453**	12.548**	1.666**	2.424**
S.C.A.	9	9	0.034*	0.023**	0.024**	0.326	0.353**	0.237**	6.216**	0.725	2.247**
G.C.A. x Loc.		5			0.027**			0.748**			11.79**
S.C.A. x Loc.		9			0.032**			0.442**			4.694**
Error term	42	84	0.013	0.006	0.009	0.242	0.114	0.178	0.705	0.367	0.536
G.C.A./ S.C.A			0.882	0.870	0.958	2.018	1.538	1.911	2.019	2.298	1.079
G.C.A x Loc/ S.C.A x Loc					0.844			1.692			2.512
G.C.AxLoc1/G.C.A x Loc2			1.5			1.212			7.532		
S.C.AxLoc1/S.C.A x Loc2			1.478			0.924			8.574		

Table 3. Cont'd

S.O.V.	d.f.		100–kernel weight (g)			Grain yield		
	single	Comb	Gm.	Mal.	Comb	Gm.	Mal.	Comb
G.C.A.	5	5	8.74**	2.82**	1.73**	4.32	7.57**	2.80**
S.C.A.	9	9	13.25**	5.23**	2.96**	7.02**	22.52**	4.42
G.C.A. x Loc.		5			9.83**			9.09**
S.C.A. x Loc.		9			15.53**			19.11**
Error term	42	84	0.58	0.28	0.43	2.15	0.99	1.57
G.C.A./ S.C.A			0.66	0.54	0.58	0.63	0.34	0.62
G.C.A x Loc/ S.C.A x Loc					0.63			0.48
G.C.AxLoc1/ G.C.A x Loc2			3.10			0.57		
S.C.AxLoc1/ S.C.A x Loc2			2.53			0.31		

Table 4. Estimates of general combining ability effects of six yellow maize inbred lines for the five traits at two locations and their combined data, 2010.

Parent	Ear diameter			No. of rows ear^{-1}			No. of kernels row^{-1}			100–kernel weight (g)			Grain yield		
	Gm.	Mal.	Comb.	Gm.	Mal.	Comb.	Gm.	Mal.	Comb.	Gm.	Mal.	Comb.	Gm.	Mal.	Comb.
P_1	-0.08	-0.01	-0.05	-0.23	-0.49**	-0.36	-0.77*	0.93**	0.08	2.09**	-0.04	1.02**	-1.79	-0.49	-1.15*
P_2	0.04	0.04	0.04	0.38	0.03	0.21	1.60**	-0.78**	0.41	1.55**	-1.17**	0.19	-0.17	1.25**	0.54
P_3	-0.13	-0.13**	-0.13	-0.67**	-0.32*	-0.49*	-2.96**	0.40	-1.28**	-1.59**	-0.67**	-0.98**	-0.42	0.49	0.04
P_4	0.08	0.02	0.05	0.19	0.42**	0.31	1.79**	0.29	1.04**	-1.09**	1.21**	0.06	0.61	-1.00*	-0.19
P_5	0.04	0.02	0.03	0.37	-0.04	0.16	-0.33	-0.38	-0.36	-1.14**	0.46	-0.34	0.90	-1.91**	-0.50
P_6	0.05	0.07*	0.06	-0.05	0.39*	0.17	0.67	-0.46	0.10	-0.13	0.21	0.04	0.88	1.66**	1.27*
LSD5% (gi)	-	0.07	-	0.45	0.31	0.38	0.77	0.56	0.66	0.70	0.49	0.59	-	0.92	1.14
LSD1% (gi)	-	0.09	-	0.61	0.42	0.51	1.04	0.75	0.88	0.94	0.65	0.79	-	1.23	1.50
LSD5% (gi - gj)	-	0.11	-	070	0.48	0.59	1.20	0.87	1.03	1.09	0.75	0.92	-	1.42	1.76
LSD1% (gi - gj)	-	0.14	-	0.94	0.65	0.78	1.61	1.16	1.36	1.46	1.01	1.22	-	1.90	2.33

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

Table 5. Estimates of specific combining ability effects of yellow maize crosses for five studied traits at two locations and their combined performance, 2010.

Cross	Ear diameter			No. of rows ear^{-1}			No. of kernels row^{-1}			100–kernel weight (gm)			Grain yield		
	Gm.	Mal.	Comb.	Gm.	Mal.	Comb.	Gm.	Mal.	Comb.	Gm.	Mal.	Comb.	Gm.	Mal.	Comb.
$P_1 * P_2$	-0.08	0.09	0.01	0.23	-0.08	0.08	0.35	0.08	0.21	-3.82**	2.98**	-0.42	2.88*	4.31**	-0.26
$P_1 * P_3$	0.25**	0.27**	0.26**	0.83	1.18**	1.00**	2.16**	0.14	1.15*	-3.75**	0.73	-1.51**	-3.14**	0.59	0.61
$P_1 * P_4$	-0.16	-0.19**	-0.17*	-0.48	-0.51	-0.50	-1.59*	0.60	-0.49	-0.60	-3.65**	-2.13**	-0.32	2.60**	-0.29
$P_1 * P_5$	-0.13	-0.14*	-0.13	-0.46	-0.35	-0.40	-2.46**	-1.57	-2.02**	2.78**	1.10**	1.94**	0.54	-4.03**	-0.22
$P_1 * P_6$	0.11	-0.04	0.04	-0.13	-0.24	-0.18	1.54*	0.75	1.15*	5.39**	-1.15**	2.12**	0.03	-3.47**	0.16
$P_2 * P_3$	0.08	-0.09	-0.01	-0.33	-0.15	-0.24	1.04	-0.65	0.20	4.74**	-1.65**	1.54**	1.88	-2.80**	0.28
$P_2 * P_4$	0.11	0.12*	0.11	0.51	-0.09	0.21	-1.71*	-0.19	-0.95	3.36**	-1.28**	1.04*	1.85	2.89**	-0.01
$P_2 * P_5$	-0.10	-0.09	-0.09	-0.57	0.18	-0.20	-0.09	0.59	0.25	-3.06**	-0.28	-1.67**	-4.14**	-0.28	-0.34
$P_2 * P_6$	-0.01	-0.04	-0.02	0.16	0.14	0.15	0.41	0.17	0.29	-1.22*	0.23	-0.50	-2.46*	-4.12**	0.32
$P_3 * P_4$	0.04	-0.06	-0.01	-0.09	-0.44	-0.27	2.10**	0.38	1.24*	-0.48	1.73**	0.62	-1.26	-1.44	0.04
$P_3 * P_5$	-0.13	-0.01	-0.07	-0.17	0.03	-0.07	-2.78**	0.10	-1.34*	1.28*	0.48	0.88	0.36	-2.80**	-0.59
$P_3 * P_6$	-0.24**	-0.11	-0.17*	-0.24	-0.61*	-0.43	-2.53**	0.03	-1.25*	-1.78**	-1.28**	-1.53**	2.16	6.45**	-0.34
$P_4 * P_5$	0.11	0.09	0.10	0.53	0.24	0.38	2.98**	0.52	1.75**	-0.45	-0.15	-0.30	1.35	0.96	0.78
$P_4 * P_6$	-0.10	0.04	-0.03	-0.46	0.80**	0.17	-1.78**	-1.31	-1.54**	-1.83**	3.35**	0.76	-1.63	-5.02**	-0.52
$P_5 * P_6$	0.24**	0.14*	0.19**	0.67	-0.09	0.29	2.35**	0.37	1.36*	-0.55	-1.15**	-0.85	1.89	6.16**	0.38
LSD 5% (Sij)	0.18	0.12	0.15	-	0.53	0.65	1.32	-	1.13	1.19	0.82	1.01	2.29	1.56	-
LSD1% (Sij)	0.24	0.16	0.19	-	0.71	0.86	1.76	-	1.49	1.59	1.10	1.33	3.07	2.09	-
LSD 5% (Sij - Sik)	0.28	0.19	0.23	-	0.84	1.03	2.08	-	1.78	1.88	1.30	1.59	3.63	2.46	-
LSD1% (Sij - Sik)	0.38	0.25	0.31	-	1.12	1.36	2.78	-	2.36	2.52	1.74	2.11	4.86	3.29	-
LSD 5% (Sij - Ski)	0.23	0.15	0.19	-	0.68	0.84	1.69	-	1.46	1.54	1.06	1.30	2.96	2.01	-
LSD1% (Sij - Ski)	0.31	0.20	0.25	-	0.91	1.11	2.27	-	1.93	2.06	1.42	1.72	3.96	2.69	-

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

4 – Superiority percentage

The superiority over the three checks (S.C. 162, S.C. 164 and S.C. 166) relative to the average of the two locations is presented in Table 6. For ear diameter, three crosses out of fifteen ones i.e., (P_2 x P_4), (P_4 x P_5) and (P_5 x P_6) exhibited their superiority relative to the check cultivar (S.C.162), where the values of these crosses were significant in positive direction. With regard to no. of rows ear^{-1}, the cross; (P_4 x P_5) was significant in positive superiority percentage over the three checks, while the crosses; (P_2 x P_4), (P_2 x P_6), (P_4 x P_6) and (P_5 x P_6) was significantly increased in rows ear^{-1} than the check cultivar (S.C.162). For no. of kernels row^{-1}, all the significant values of superiority percentage were in negative direction, which means that no. of kernels row^{-1} of the cross-plant was significantly less than that of the check cultivars. Concerning 100-kernel weight, the crosses; (P_1 x P_5) and (P_1 x P_6) exhibited its superiority over the check cultivars (S.C.162 and S.C.166) for the trait in view. For grain yield, the results pointed out that, the crosses; (P_1 x P_2), (P_2x P_4), (P_3 x P_6) and (P_5 x P_6) had its superiority percentage over the three checks, where its values were highly significant in positive direction and the crosses; (P_1x P_4), (P_2 x P_3) and (P_4 x P_5) significantly exceeded grain yield than the two checks i.e., (S.C.164) and (S.C.166). However, all crosses had superior percentage in grain yield over the check cultivar (S.C.164). Results were in good agreement with those reported by EL-Kielany (1999), Rana and Kumar (2001), Hammouda (2002), Singh *et. al.* (2002), Unay *et. al.* (2004), EL-Hosary and EL-Badawy (2005), Mousa (2014) and Osman (2014). They compared their crosses with check cultivars and came up to the same conclusions.

Table 6. Superiority percentages of yellow maize crosses relative to check hybrids (S.C. 162, 164 and S.C. 166) for studied traits, based on average performance across locations, 2010.

Cross	Ear diameter			No. of rows ear^{-1}			No. of kernels row^{-1}			100–kernel weight (g)			Grain yield (ard. fed.$^{-1}$)		
	S.C 162	S.C 164	S.C 166	S.C 162	S.C 164	S.C 166	S.C 162	S.C 164	S.C 166	S.C 162	S.C 164	S.C 166	S.C 162	S.C 164	S.C 166
$P_1 * P_2$	2.06	-1.98	0.00	3.58	-0.33	0.67	-9.06**	-7.77**	-10.25**	0.68	-6.15**	-0.80	17.60**	38.50**	25.82**
$P_1 * P_3$	3.71	-0.40	1.62	5.16	1.19	2.21	-10.81**	-9.54**	-11.98**	-5.46**	-11.87**	-6.85**	-1.89	15.56**	4.97
$P_1 * P_4$	-1.44	-5.35*	-3.43	0.34	-3.44	-2.47	-9.22**	-7.93**	-10.41**	-4.30*	-10.79**	-5.70**	6.06	24.91**	13.47**
$P_1 * P_5$	-1.03	-4.95 **	-3.03	0.00	-3.77	-2.81	-16.06**	-14.87**	-17.17**	5.60**	-1.56	4.05*	-5.55	11.24*	1.05
$P_1 * P_6$	3.09	-0.99	1.01	1.51	-2.32	-1.34	-7.59**	-6.28**	-8.80**	7.11**	-0.15	5.54**	0.98	18.93**	8.04
$P_2 * P_3$	0.00	-3.96	-2.02	0.48	-3.31	-2.34	-12.26**	-11.01**	-13.41**	0.57	-6.25**	-0.91	7.18	26.24**	14.67**
$P_2 * P_4$	6.19**	1.98	4.04	9.08**	4.97	6.02	-9.53**	-8.24**	-10.71**	2.03	-4.89**	0.53	16.62**	37.35**	24.77**
$P_2 * P_5$	1.65	-2.38	-0.40	5.30	1.32	2.34	-9.99**	-8.71**	-11.18**	-6.41**	-12.76**	-7.78**	-1.12	16.45**	5.78
$P_2 * P_6$	3.71	-0.40	1.62	7.71**	3.64	4.68	-8.83**	-7.53**	-10.02**	-2.22	-8.85**	-3.65*	1.38	19.40**	8.46
$P_3 * P_4$	0.00	-3.96	-2.02	1.03	-2.78	-1.81	-8.36**	-7.06**	-9.56**	-2.27	-8.90**	-3.70*	1.31	19.32**	8.39
$P_3 * P_5$	-1.44	-5.35**	-3.43	1.38	-2.45	-1.47	-17.63**	-16.46**	-18.71**	-2.68	-9.28**	-4.10*	0.62	18.50**	7.65
$P_3 * P_6$	-3.09	-6.93**	-5.05**	-1.03**	-4.77	-3.81	-16.34**	-15.16**	-17.44**	-8.17**	-14.39**	-9.51**	27.10**	49.70**	35.99**
$P_4 * P_5$	5.77 **	1.58	3.64	9.98**	5.83*	6.89*	-5.02**	-3.67*	-6.27**	-3.06	-9.63**	-4.48*	8.42	27.69**	15.99**
$P_4 * P_6$	3.71	-0.40	1.62	8.60**	4.50	5.55	-11.63**	-10.37**	-12.79**	0.73	-6.10**	-0.75	-1.42	16.11**	5.47
$P_5 * P_6$	7.84 **	3.56	5.66 **	8.40**	4.30	5.35	-8.13**	-6.82**	-9.33**	-4.60*	-11.07**	-6.00**	24.13**	46.20**	32.80**
LSD 0.05	0.19			0.84			1.46			1.30			2.49		
LSD 0.01	0.25			1.11			1.93			1.72			3.29		

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

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٢-٧ تقدير القدرة على التآلف لمحصول الحبوب ومكوناته في سلالات من الذرة الشامية الصفراء المرباة داخليا

رمضان علي الرفاعي[١] ، عبد الحميد مصطفي شحاته[٢] ، أحمد مصطفى أبــوشوشــه[٢]

١. *قسم المحاصيل – كلية الزراعــة – جامعـــة طنطا، مصـــــر.*
٢. *قسم بحوث الذرة الشامية – معهد المحاصيل الحقلية – مركز البحوث الزراعية – الجيزة – مصر*

تم التهجين بين ست سلالات من الذرة الشامية الصفراء مرباة داخليا بنظام التهجين النصف دائري في الموسم ٢٠٠٩ بمزرعة محطة البحوث الزراعية بالجميزة حيث تم الحصول على ١٥ هجينا. و في موسم ٢٠١٠ تم تقييم الهجن الناتجة و معها ثلاثة هجن فرديه صفراء وهى هجين فردي ١٦٢، هجين فردي ١٦٤ وهجين فردي ١٦٦ في موقعين هما محطة البحوث الزراعية بالجميزة بوسط الدلتا ومحطة البحوث الزراعية بملوي بمصر الوسطى باستخدام تصميم القطاعات كاملة العشوائية في أربعة مكررات. وتم تقدير القدرة العامة والخاصة على التآلف طبقا لنموذج جريفنج الموديل الأول الطريقة الرابعة. كان متوسط مجموع مربعات الانحرافات للمواقع والهجن عالي المعنوية لجميع الصفات ماعدا عدد الصفوف بالكوز وكان متوسط مجموع مربعات الانحرافات للتفاعل بين الهجن والمواقع معنويا لجميع الصفات عدا قطر الكوز وعدد الصفوف بالكوز. كان متوسط مربعات الانحرافات لكل من القدرة العامة والخاصة على التآلف معنويا لجميع الصفات في كلا الموقعين والتحليل الضام بينهما بما يشير إلى أن كلا من الجينات المضيفة وغير المضيفة تؤثر في توريث الصفات المدروسة. كانت النسبة بين متوسط مجموع مربعات الانحرافات للقدرة العامة على التآلف إلي القدرة الخاصة على التآلف يزيد عن الواحد الصحيح لصفات عدد الصفوف بالكوز وعدد الحبوب بالصف في كلا الموقعين والتحليل الضام بينهما، بينما كانت نفس النسبة أقل من الواحد الصحيح لصفات قطر الكوز ووزن المائة حبة ومحصول الحبوب للفدان في كلا الموقعين والتحليل الضام بينهما مما يدل على أن الجينات المضيفة والمضيفة × المضيفة كانت تلعب دورا هاما في توريث الصفات في الحالة الأولى بينما الجينات غير المضيفه كانت الأكثر تأثيرا في توارث صفات الحالة الثانية. كانت السلالة رقم ٢ ذات قدرة ائتلافية عامة عالية لصفات عدد الحبوب بالصف ووزن المائة حبة في الجميزة بينما كانت السلالة رقم ٤ ذات قدرة ائتلافية عامة عالية لصفات عدد الصفوف بالكوز ووزن المائة حبة في ملوي وعدد الحبوب بالصف في موقع الجميزة. كانت الهجن (١ × ٣) و (٥ × ٦) ذات قدرة ائتلافية خاصة معنوية لصفة قطر الكوز في كلا الموقعين والتحليل المشترك بينهما ولصفة عدد الحبوب بالصف لموقع الجميزة والتحليل المشترك ولصفة محصول الحبوب للفدان في ملوي. أظهر الهجين (١ × ٥) قدرة ائتلافية خاصة معنوية لصفة وزن المائة حبة في كلا الموقعين والتحليل المشترك بينهما والهجين بين السلالتين (١ × ٦) لصفتي عدد الحبوب بالصف ووزن المائة حبة في الجميزة والتحليل المشترك. تفوقت الهجن (١ × ٢) ، (٢ ×٤) ،(٣ × ٦) و (٥ × ٦) معنويا على الهجن الفردية الثلاثة المستخدمة للمقارنة لصفة محصول الحبوب للفدان.