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Combining Ability and Mean Performance of Some New Inbred Lines of Yellow Maize Through Line × Tester Method

Sultan, M. S.[1] ; S. E. Sadek[2] ; M. A. Abdel –Moneam[1] and M. S. Shalof [2]
[1] Agronomy Department, Faculty of Agriculture , Mansoura University, Egypt .
[2] Maize Research Department , Field Croup Institute , Agriculture Research Center, Egypt .

ABSTRACT

In Egypt, there are several maize production constraints, among which shortage of improved varieties is the major one. The objective of this study was to observe the mean performance of crosses and estimate combining abilities for grain yield and other agronomic traits in nine maize inbred lines and three testers using Line × Tester mating design. 27 yellow single crosses , 9 inbred lines , three testers and two standard checks (SC162 and SC168) were evaluated at two locations (Gemmeiza and Mallawy) under two density (24000 plant /fed and 30000 plant /fed). Analyses of variances showed significant mean squares for studied traits. Lines , tester and hybrids mean squares were highly significant and significant at combined data over two densities. Among the crosses, P_1 × Gm 174 , P_6 × Gm 1021 , P_7 × Gm 1021 and P_8 × Gm 1021 highest grain yield mean performance and highly significant and significant in studied traits at combined data over both densities and these crosses may be useful for improving grain yield of maize. GCA effects, Inbred lines P_6 **,** P_8 , P_2 **,** P_7**,** Gm 174 and Gm1021 had significant and highly significant positive GCA effects and were the best general combiners for grain yield, and hence were promising parents for hybrids as well as for inclusion in breeding programs for yield improvement. Inbred line Gm 1021 could be considered as a good general combiner for earliness and parental inbred lines P_1 , P_4 and Gm 1002 could be considered as a good general combiners for lateness for day to 50% tasseling, indicating that the line Gm 1021had general combinations that can enhance early maturity. P_1×Gm 174 , P_2×Gm 1002 **,** P_3×Gm 1002**,** P_4×Gm 174, P_5×Gm 1021 , P_6 ×Gm 1021, P_7×Gm 1002 and P_8×Gm 1002 had highly significant and significant positive SCA effects for grain yield trait**.** it could be concluded that the parental inbred line for that crosses could made themselves recombination's. The information of GCA and SCA effects for grain yield is very useful for maize breeders to determine which maize line should be selected to improve local lines and which parental lines should be used for making hybrids with greater grain yields.

Keywords: Maize, line × tester, general combining ability, specific combining ability.
Abbreviations: GCA general combining ability; SCA specific combining ability.

INTRODUCTION

Maize (*Zea mays L.*) is a diploid (2n= 20) crop and one of the oldest food grains in the world. It is a member of order Oales, family Poaceae, and sub family Panicoideae tribe maydeae. It is believed that the crop is originated. Maize is one of the most important strategic cereal crops in the world. It ranks third crop after wheat and rice in both terms of area and production in Egypt. The main objective of the maize breeding program in Egypt is to develop high yielding maize hybrids for commercial use to cover the increasing consumption of maize in human food, animal feeding and poultry industry. One of the most important criteria for identifying high yielding hybrids is the information about parents genetic structure and their combining ability (Ceyhan, 2003). The line × tester analysis method which suggested by Kempthorne (1957) is one of the powerful tools available to estimate general and specific combining ability effects and aids in selecting desirable parents and crosses. The effecteness of this method depends mainly upon the type of tester used in the evaluation. Nature and number of testers to be used in the line x tester model for evaluating inbred lines is still unsolved problem. The line × tester method using broad and narrow base testers is the most common procedure for the evaluating process. In this regard, the choice of a suitable tester is an important decision. There for , The obtained of this study high-yielding parental lines and early ripening, as well as plant height and low ear and making optional vaccinations for high yield hybridization and early ripening

MATERIALS AND METHODS

The experimental work of this study was carried out during 2015 and 2016 summer season at two location (Gemmeiza and Mallawy Station) under two densities (24000 planets per fad. and 30000 planets per fad.) at the Agriculture Research Center (A.R.C.), Egypt. Nine yellow maize inbred lines , three testers Gm 174 ,Gm1002 and Gm1021 , 27 yellow top single crosses and two yellow checks (single crosses 162 and 168) were planted by using Randomized Complete Block Design (R.C.B.D) with three replications was applied in two location (Gemmeiza and Mallawy) under two densities. Each replication contained 41 plots and each plot consisted of 1 row with 5 m long and spacing of 25 cm and 20 cm between plants within row and 70 cm between row (Plot size was: 5m×70cm = $3.5m^2$/plot, no. of row in Fadden = 4200/ 3.5 = 1200 row /plot and number of plant in Fadden =1200× 20=24000 plants / fadden and 1200×25 =30000 plants / fadden). The data were recorded from five plants taken randomly from each row. data were recorded on the following characters on plot basis [days to 50% tasseling , days to 50% silking , plant and ear height (cm) , ear position (%) and grain yield(ard./fed.)]. analysis of variance was performed for data collected from top crosses in each locations to test the significance of all genotypes. Homogeneity test revealed the validity of combined analysis of the two locations in the evaluation season for all the studied traits. All recorded data were examined according to analysis of variance procedures (ANOVA). The linear model utilized for individual analysis and least significant differences (LSD) at 5% and 1% significant level were calculated to evaluate the means. Line × tester analysis was performed according to (Kempthorne , 1957) to estimate the general and specific combining abilities and the interaction between line × testers variances. Data were tested for normality by statistical software. Then, data were analyzed using Agrobase 21 (2001) and Microsoft excel. Analysis of traits from the lines , testers and crosses was conducted using the line by tester - AGR 21 procedure developed , according to method line by tester , which included the parents , direct and crosses. The LSD test at 5% and 1% according to Steel and Torrie , (1980) was used for comparison the means of performance of the different genotypes .

For combined analyses

$$X_{lijk} = \mu + L_i + R_s / L_i + g_i + g_j + S_{ij} + (Lg_i)_{li} + (Lg_j)_{lj} + (LS_{ij})_{ilj} + \ell_{isij}$$

μ = over all genotype mean
L_i = locations effects.
R_s/L_i = replications within locations effects.
g_i = G.C.A. effect of the i the male parents (testers).
g_j = G.C.A. effect of the j the female parents (inbred line)
S_{ij} = S.C.A. effect of the ij the cross combinations.
$(Lg_i)_{li}$ = interaction of location x males (testers) effects.
$(Lg_j)_{lj}$ = interaction of location x female (inbred lines) effects.

$(LS_{ij})_{ilj}$ = interaction of between location, males and female effects.
ℓ_{isij} = the error associated with the each observation

Table 1. Names and the pedigree of the studied twelve yellow inbred lines .

No.	Inbred line	Pedigree	Notes
1	line 10	EG-38-B5-2-77-1-1-1	Line
2	line 11	EG-29-B5-2-57-2-1-1	Line
3	line 12	Gm.Y.Pop.F14	Line
4	line 17	EG-28-B5-2-131-2-3-1	Line
5	line 20	EG-28-B5-2-127-1-1-1	Line
6	line 21	Gm. y. Pop. F 21	Line
7	line 26	EG-29-B5-2-186-1-1-1	Line
8	line 32	Sc.2-F47-48/A2- 2003	Line
9	line 48	EG-26-B5-1-49-1-1-1	Line
10	line Gm. 174	EG-40-B5-2-104-2-1-1	Tester
11	line Gm.1002	Sub trop. _ y. I.G. S. Pop. _ IITA_ N.M.B.P.	Tester
12	line Gm.1021	IL. Sd – 121 × Pop. (DMR- ESR)	Tester

Gm.1002 and Gm.1021 were developed at Gemmeiza Agricultural Research Station during the period of 1983 to 1992 by S. E. Sadek at al, N. M.B. P._ F.C.R.I._ A.R.C. , Egypt

RESULTS AND DISCUSSION

Analysis of variance

Mean squares were significant for all of the studied traits. Lines , testers and hybrids mean squares were highly significant and significant for the six traits over combined data under two densities except :

For silking date in crosses ×loc., testers × loc and lines× testers × loc. in their combined data ; lines × loc. in $L_1L_2D_2$, $L_1D_1D_2$ and $L_2D_1D_2$, rep × loc. in $L_1D_1D_2$; crosses in $L_1L_2D_2$; lines in $L_1L_2D_2$ and lines ×testers in $L_1L_2D_2$;

For tasseling date in crosses ×loc. and lines× testers × loc. in combined data , lines × loc. in $L_1L_2D_2$ and $L_1D_1D_2$; testers × loc. in $L_1L_2D_1$, $L_1L_2D_2$and $L_1D_1D_2$, crosses in $L_1L_2D_2$ and lines in $L_1L_2D_2$;

For grain yield had non-significant for rep. × loc. in $L_1L_2D_1$, $L_1L_2D_2$, $L_1D_1D_2$and $L_2D_1D_2$. These results agree with those obtained by Sultan,*el.al.*,2010 , Moosavi *et.al.*,2012 and Kamara, *et.al.,*2014.

Table 2. Mean squares of analysis of variance for days to50 % tasseling and50 % silking at combined over locations and over two densities.

S.O.V.	df Comb	Days to50 % tasseling				Days to50 % Silking			
		$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
Location	1	9.20**	162.50**	38.60**	6.17*	33.85**	55.54**	6.84**	18.06**
Rep.	5	61.60**	37.29**	9.23**	11.83**	15.73**	18.32**	2.61	18.54**
Rep.× Location	4	9.15*	5.98*	1.90	13.25**	11.20**	9.01**	1.55	18.66**
Genotypes	38	22.64**	19.97**	14.76**	31.08**	22.96**	18.07**	13.11**	31.40**
Parents	11	19.10**	11.92**	10.07**	28.07**	19.97**	11.33**	8.87**	28.58**
Crosses	26	7.06*	2.50	4.23*	5.76*	7.13*	2.13	3.63*	6.53*
Par. vs. crosses	1	466.80**	562.60**	340.25**	722.47**	467.27**	506.69**	306.18**	709.06**
Lines	8	4.72*	1.59	2.39	7.12*	3.92*	1.35	2.66*	6.74**
Testers	2	24.13**	6.41*	15.90**	11.88**	24.03**	9.64**	18.38**	14.27**
Lines × testers	16	6.09*	2.46	3.69	4.31*	6.62*	1.57	2.28	5.45*
crosses × location	26	2.10	0.60	0.50	1.80	2.60	0.90	0.90	1.70
line × location	8	4.70*	1.30	0.50	2.30	5.00*	1.80	0.60	2.10
tester× location	2	0.00	0.70	1.10	2.40	0.50	0.80	0.60	1.70
line× tester × loc.	16	1.10	0.20	0.40	1.50	1.70	0.50	1.00	1.60
par× loc	11	8.43**	4.06*	2.68	2.68	5.89*	4.62*	1.98	2.37
p.vs. cr. ×location	1	64.13**	0.18	23.51**	7.48*	45.04**	5.85*	6.72*	2.89
Error	152	2.87	1.51	1.83	1.83	2.69	1.65	1.74	1.89

***, ** significant at 0.05 and 0.01 level of probability , respectively**
Abbreviations: L_1 location Gemmeiza ; L_2 location Mallawy; D_1 density one (30000 plant / fed.) and D_2 density two (24000 plant / fed.).

Table 3. Mean squares of analysis of variance for plant height and ear height at combined data over locations and over two densities.

S.O.V.	df Comb	Plant height (cm)				Ear height (cm)			
		$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
Location	1	12701.6**	23280.1**	12701.6**	23280.1**	12701.6**	23280.1**	12701.6**	23280.1**
Rep.	5	2548.97**	5143.83**	2548.97**	5143.83**	2548.97**	5143.83**	2548.97**	5143.83**
Rep.× Location	4	10.80**	609.75**	10.80**	609.75**	10.80**	609.75**	10.80**	609.75**
Genotypes	38	3719.08**	7237.50**	3719.08**	7237.50**	3719.08**	7237.50**	3719.08**	7237.50**
Parents	11	581.41**	634.14**	581.41**	634.14**	581.41**	634.14**	581.41**	634.14**
Crosses	26	212.11**	412.75**	212.11**	412.75**	212.11**	412.75**	212.11**	412.75**
Par. vs. crosses	1	129414.6**	257318.1**	129414.6**	257318.1**	129414.6**	257318.1**	129414.6**	257318.1**
Lines	8	171.07**	537.26**	171.07**	537.26**	171.07**	537.26**	171.07**	537.26**
Testers	2	238.35**	133.90**	238.35**	133.90**	238.35**	133.90**	238.35**	133.90**
Lines × testers	16	229.35**	385.35**	229.35**	385.35**	229.35**	385.35**	229.35**	385.35**
crosses × location	26	202.30**	336.50**	202.30**	336.50**	202.30**	336.50**	202.30**	336.50**
line × location	8	140.40**	265.10**	140.40**	265.10**	140.40**	265.10**	140.40**	265.10**
tester× location	2	134.60**	335.00**	134.60**	335.00**	134.60**	335.00**	134.60**	335.00**
line× tester × loc.	16	241.70**	372.30**	241.70**	372.30**	241.70**	372.30**	241.70**	372.30**
par× loc	11	360.53**	381.83**	360.53**	381.83**	360.53**	381.83**	360.53**	381.83**
p.vs. cr. ×location	1	210.62**	21692.3**	210.62**	21692.3**	210.62**	21692.3**	210.62**	21692.3**
Error	152	84.35	262.76	84.35	262.76	84.35	262.76	84.35	262.76

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

Table 4. Mean squares of analysis of variance for ear position and grain yield at combined data over locations and over two densities.

S.O.V.	df Comb	Ear position (%)				Grain yield (ard./fed.)			
		$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
Location	1	156.97**	380.63**	37.38**	0.75	110.83**	310.29**	357.17**	139.50**
Rep.	5	38.10**	113.66**	15.60**	36.31**	24.72**	67.59**	75.26**	32.11**
Rep.× Location	4	8.41**	46.92**	10.15**	45.17**	3.20	6.93*	4.82	5.30
Genotypes	38	18.79**	30.91**	39.00**	18.06**	689.47**	755.08**	790.06**	652.14**
Parents	11	39.78**	50.89**	78.23**	37.80**	46.94**	31.89**	56.51**	31.15**
Crosses	26	10.18**	13.78**	23.75**	6.08*	66.09**	49.47**	75.70**	31.73**
Par. vs. crosses	1	11.43**	256.34**	4.09*	112.55**	23965.5**	27056.0**	27432.6**	23613.5**
Lines	8	5.88*	10.75**	22.33**	6.30*	56.04**	25.38**	64.30**	30.08**
Testers	2	9.62**	29.49**	37.07**	2.02	165.89**	124.85**	238.13**	90.92**
Lines × testers	16	12.41**	13.34**	22.79**	6.48*	58.63**	52.08**	61.09**	25.16**
crosses × location	26	11.10**	12.20**	13.00**	4.40*	24.00**	19.30**	27.70**	23.70**
line × location	8	11.30**	14.60**	11.90**	2.00	41.90**	21.60**	21.30**	29.30**
tester× location	2	7.20*	14.30**	12.40**	9.10**	18.80**	46.20**	24.30**	2.40
line× tester × loc.	16	11.40**	10.70**	13.70**	5.00*	15.70**	14.80**	31.30**	23.60**
par× loc	11	40.56**	23.37**	14.86**	23.72**	23.79**	12.64**	17.61**	9.98*
p.vs. cr. ×location	1	225.42**	557.22**	92.38**	841.46**	11.42**	73.58**	55.35**	5.02
Error	152	9.29	15.31	6.68	16.44	7.38	6.31	7.99	6.17

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

Abbreviations: L_1 location Gemmeiza ; L_2 location Mallawy; D_1 density one (30000 plant / fed.) and D_2 density two (24000 plant / fed.).

Mean Performance

The mean performance of 9 lines , 3 testers and 27 top crosses for all the studied traits at their combined data over two densities are shown in Tables 5 - 8.

Means of days to 50% tasseling are presented in Table (5). The differences between number of days to 50% tasseling for lines and testers were highly significant at combined data over two densities. Number of days from sowing to 50% tasseling were ranged from 54.83 to 60.83 days in $L_1L_2D_1$, 55.17 to 59.67 days in $L_1L_2D_2$, 56.50 to 60.50 days in $L_1D_1D_2$, and 53 to 60.33 days in $L_2D_1D_2$. The earliest line in 50% tasseling was P_1(line 10) in $L_1L_2D_1$, $L_1L_2D_2$, $L_2D_1D_2$. Meanwhile, P_9 (line 48) in $L_1L_2D_2$, $L_2D_1D_2$ and P_7 (line 26) in $L_1L_2D_1$ were the latest lines at combined data over two densities respectively. The latest tester at combined data over two densities were Gm 1002 for all characters except $L_1D_1D_2$.

The differences between number of days to 50% tasseling for all crosses were earliest than both single crosses 162 and 168; All 27 top crosses were significantly earlier than the best check SC 162 and SC 168 . $L_1L_2D_1$ had 26 crosses significantly earlier than the best check SC 162 and SC 168. Days to 50% tasseling were ranged from 53.50 to 58.67 days in $L_1L_2D_1$, 53.17 to 56.33 days in $L_1L_2D_2$, 54.17 to 57.84 days in $L_1D_1D_2$, and 52.17 to 57.17 days in $L_2D_1D_2$.The earliest crosses were P_5×Gm 174 in $L_1L_2D_1$, $L_1L_2D_2$ and $L_2D_1D_2$, P_4×Gm174 and P_4×Gm1021 in $L_2D_1D_2$ than S.C 162 and Sc168 . Similar results were obtained by Abd El-Aty and Katta (2002); Nawar *et al.* (2002) and Machado *et al.* (2009).

Means of days to 50 % silking for genotypes are presented in Table 5. The differences between number of days to 50% silking for lines and testers were highly significant in two location under two density . Number of days from sowing to 50% silking were ranged from 55.33 to 61.33 days in $L_1L_2D_1$, 56 to 60.33 days in $L_1L_2D_2$, 56.67 to 60.84 days in $L_1D_1D_2$, and 53.84 to 61.50 days in $L_2D_1D_2$. The earliest line in 50% silking was P_1(line 10) in $L_1L_2D_1$, $L_1L_2D_2$ and $L_2D_1D_2$, P_3(line 12) in $L_1L_2D_2$, P_8 (line 32) $L_1D_1D_2$. Meanwhile, line P_4 (line 17) in $L_1L_2D_2$ and $L_2D_1D_2$ and P_5(line 20) in $L_1L_2D_2$ and $L_1D_1D_2$ and P_7 (line 26) in $L_1L_2D_1$, were the latest lines at combined data over two densities , respectively. For testers the earliest tester in 50% silking was Gm174 for all characters , were the latest testers at combined data over two densities were Gm 1002 in $L_1L_2D_1$, $L_2D_1D_2$ and Gm1021 in $L_1L_2D_2$ and $L_1D_1D_2$, respectively.

The differences between number of days to 50% silking for all crosses were earliest than both single crosses 162 and 168. All 27 top crosses showed that significantly earlier than both checks SC 162 and SC 168 for all characters , had 26 crosses were significantly earlier than the best check SC 162 and SC 168. Days to 50% silking were ranged from 53.67 to 58.83 in $L_1L_2D_1$, 53.67 to 56.67 in $L_1L_2D_2$, 54.50 to 57.34 in $L_1D_1D_2$, and 53 to 58.17 in $L_2D_1D_2$.The earliest crosses were P_5×Gm 174 in $L_1L_2D_1$, $L_1D_1D_2$, P_4×Gm174 in L_2D_1 , L_2D_2 , $L_2D_1D_2$, P_8×Gm 1021 in $L_1L_2D_2$ and $L_1D_1D_2$ and P_9×Gm 1021 in $L_1D_1D_2$ than S.C 162 and SC168 . Similar results were obtained by Abd El-Aty and Katta (2002); Nawar *et al.* (2002) and Machado *et al.* (2009).

Means of plant height for genotypes at combined data over two densities were presented in Table (6) The differences between plant height for parental inbred lines were high significant. Plant height were ranged from 157 cm to 179.67 cm in $L_1L_2D_1$, 125.67 cm to 157.17 cm in $L_1L_2D_2$, 140.84 cm to 186.17 cm in $L_1D_1D_2$, and 141.84 cm to 162.67 cm in $L_2D_1D_2$. The tallest line was P_2 (line 11) in $L_1L_2D_1$ and $L_1D_1D_2$. Meanwhile, line P_5(line 20) were the shortest lines in combined data over two densities respectively. For tester the tallest tester was Gm174 for all characters. Were the shortest tester in combined over two densities were Gm 1002 in $L_1D_1D_2$, Gm1021 in $L_1L_2D_1$, $L_1L_2D_2$ and $L_2D_1D_2$ respectively.

The differences between plant height for crosses were highly significant compared to both single crosses 162 and 168. 27 crosses showed that significantly shorter than both checks SC 162 and SC 168 $L_1L_2D_1$, $L_2D_1D_2$, 26 crosses in $L_1D_1D_2$, 18 crosses in L_2D_2 , 17 crosses in $L_1L_2D_1$ were significantly shorter than the best check SC 162 and SC 168. Plant height ranged from 213.83 cm to 241.33 cm in $L_1L_2D_1$, 208.83 cm to 238.33 cm in $L_1L_2D_2$, 206.17 cm to 250.17 cm in $L_1D_1D_2$, and 219.17 cm to 229.17 cm in $L_2D_1D_2$. These results are in agreement with findings by Abd El-Aty and Katta (2002); Nawar *et al.* (2002) and Machado *et al.* (2009).

Means of ear height for genotypes are presented in Table (6) The differences between ear height for lines and testers at combined data over two densities ranged from 73.33 cm to 92.67 cm in $L_1L_2D_1$, 60.67 cm to 82.83 cm in $L_1L_2D_2$, 60 cm to 96.17 cm in $L_1D_1D_2$, and from 73.67 cm to 81.67 cm in $L_2D_1D_2$. Meanwhile, lines P_5 (line 20) in al characters was lowest line at all environment except in L_2D_1.

The differences between ear heights for crosses were highly significant over both single crosses 162 and 168. All 27 top crosses showed that significantly lower ear height than both checks SC 162 and SC 168 at combined data over two densities. Ear height ranged from 104.67 cm to 120.83 cm in $L_1L_2D_1$, 96 cm to 115.17 cm in $L_1L_2D_2$, 91.34 cm to 121.17 cm in $L_1D_1D_2$, and from 108.34 cm to 116 cm in $L_2D_1D_2$. These results are supported by those concluded by Abd El-Aty and katta (2002) and Nawar *et al.* (2002)).

Ear position for genotypes are presented in Table 7. The differences between ear position for lines and testers were high significant over combined data under two densities. The highest ear placement were recorded by P_1(line 10) and Gm 1021 in combined data over two densities. Meanwhile, parents P_8(line 32) and Gm174 had lowest ear placement.

The differences between ear position for crosses were highly significant. However all crosses were significantly lower ear placement than both checks SC 162 and SC 168. It may indicated that ear position is better influenced by different agronomic treatments. These results are supported by those concluded by Abd El-Aty and Katta (2002) and Nawar *et al.* (2002)).

Means of grain yield per feddan for genotypes are presented in Table (7). The differences between grain yield for lines and testers were highly significant at combined data over densities. Grain yield per fed. ranged from 8.50 ard/fed to 18.46 ard/fed in $L_1L_2D_1$, 10.16 ard/fed to 17.63 ard/fed in $L_1L_2D_2$, 8.71 ard/fed to 18.89 ard/fed in $L_1D_1D_2$, and from 10.40 ard/fed to 17.98 ard/fed in $L_2D_1D_2$.

The differences between grain yield for crosses were highly significant for most crosses at combined data over densities. Out of 27 crosses , 7 crosses were significantly higher than checks SC 162 and SC 168 in $L_1L_2D_1$, 8 crosses were significantly higher than checks SC 162 and SC 168 in $L_1L_2D_2$, 5 crosses were significantly higher than checks SC 162 and SC 168 in $L_1D_1D_1$ and 11 crosses were significantly higher than checks SC 162 and SC 168 in $L_2D_1D_2$. These crosses were significantly out yielded the two checks SC 162 and SC 168 at 5%and 1%. P_6×Gm 1021 had highly significant and significant at combined over densities , P_1×Gm 174 had highly significant and significant in all traits at combined over densities, P_7×Gm 1021 had highly significant and significant in all traits over combined under density and P_8×Gm 1021 had highly significant and significant in all traits over combined under density except $L_1D_1D_2$. Hence it could be concluded that these crosses may be useful for improving grain yield of maize. Similar results were reported by Abd El-Aty and Katta (2002) and Machado *et al.* (2009).

Table 5 . Mean Performance of maize genotypes for days to50% tasseling and days to 50% silking at combined data over two locations and two densities.

	Days to 50% tasseling				Days to 50% silking			
	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
P_1(line 10)	54.83	55.17	57.00	53.00	55.33	56.00	57.50	53.84
P_2(line 11)	56.00	57.00	57.50	55.50	56.17	57.50	57.17	56.50
P_3(line 12)	57.67	55.33	57.17	55.84	57.67	56.00	56.84	56.84
P_4(line 17)	57.67	58.00	57.00	58.67	58.33	58.33	57.00	59.67
P_5(line 20)	58.33	57.83	58.50	57.67	58.83	58.83	58.34	59.34
P_6(line 21)	56.83	56.50	58.33	55.00	56.83	56.83	57.67	56.00
P_7(line 26)	59.33	57.00	58.17	58.17	59.50	57.67	57.83	59.34
P_8(line 32)	55.33	56.33	57.00	54.67	55.83	56.67	56.67	55.84
P_9(line 48)	57.33	58.33	56.50	59.17	59.33	58.00	57.83	59.50
Gm 174	58.83	57.67	59.00	57.50	59.00	57.67	58.33	58.34
Gm 1002	60.83	59.67	60.17	60.33	61.33	59.83	59.67	61.50
Gm 1021	59.50	59.33	60.50	58.34	59.83	60.33	60.84	59.34
P_1×Gm174	54.17	54.50	55.00	53.67	54.50	54.83	54.67	54.67
P_1×Gm1002	58.67	56.33	57.84	57.17	58.83	56.67	57.34	58.17
P_1×Gm1021	54.50	53.17	54.17	53.50	54.83	54.17	54.67	54.33
P_2×Gm174	54.67	54.33	55.34	53.67	55.17	55.00	55.33	54.84
P_2×Gm1002	54.33	53.67	55.34	52.67	55.00	54.33	55.50	53.84
P_2×Gm1021	53.83	53.50	55.00	52.34	54.17	54.00	55.00	53.17
P_3×Gm174	54.67	53.50	55.00	53.17	55.17	54.00	54.84	54.34
P_3×Gm1002	55.00	54.00	55.50	53.50	55.33	55.00	55.67	54.67
P_3×GM1021	54.67	53.83	55.34	53.17	55.17	54.33	55.50	54.00
P_4×Gm174	54.17	53.67	55.67	52.17	54.17	54.50	55.67	53.00
P_4×Gm1002	57.17	54.50	57.17	54.50	57.83	55.17	57.17	55.84
P_4×Gm1021	53.83	53.83	55.50	52.17	54.33	54.50	55.67	53.17
P_5×Gm174	53.50	53.17	54.50	52.17	53.67	54.00	54.50	53.17
P_5×Gm1002	55.83	54.67	57.17	53.33	56.00	55.50	56.83	54.67
P_5×Gm1021	54.33	53.50	55.00	52.84	55.00	54.17	55.17	54.00
P_6×Gm174	54.33	53.33	54.84	52.84	54.83	54.17	55.17	53.84
P_6×Gm1002	54.67	54.00	55.50	53.17	55.17	55.00	56.00	54.17
P_6×Gm1021	54.67	53.83	55.50	53.00	55.67	54.50	55.67	54.50
P_7×Gm174	54.33	54.17	55.17	53.34	55.33	55.00	55.50	54.84
P_7×Gm1002	54.83	54.17	55.83	53.17	55.50	54.83	56.00	54.34
P_7×Gm1021	54.00	54.33	55.34	53.00	54.50	54.67	55.50	53.67
P_8×Gm174	54.83	54.33	56.33	52.83	55.33	54.50	56.33	53.50
P_8×Gm1002	54.33	54.33	55.84	52.84	54.67	54.83	56.00	53.50
P_8×Gm1021	54.00	53.33	55.00	52.33	54.33	53.67	54.50	53.50
P_9×Gm174	54.83	54.50	55.34	54.00	55.00	54.83	54.67	55.17
P_9×Gm1002	53.83	53.50	54.50	52.84	54.50	54.33	55.00	53.84
P_9×Gm1021	53.50	53.67	54.67	52.50	53.83	54.17	54.50	53.50
Sc 162	62.83	62.17	64.00	61.00	63.33	61.47	63.63	61.17
Sc 168	61.67	61.63	62.47	60.83	62.67	61.83	63.17	61.33
LSD 0.05	2.35	1.70	1.87	1.87	2.27	1.78	1.83	1.91
0.01	3.08	2.23	2.46	2.46	2.98	2.33	2.40	2.50

Abbreviations: L_1 location Gemmeiza ; L_2 location Mallawy; D_1 density one (30000 plant / fed.) and D_2 density two (24000 plant / fed.).

Table 6 . Mean Performance of maize genotypes for plant height and ear height (cm)at combined data over two locations and two densities.

		Plant height (cm)				Ear height (cm)			
		$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
P_1(line 10)		165.83	147.83	170.84	142.84	90.50	82.83	92.17	81.17
P_2(line 11)		179.67	155.17	186.17	148.67	92.67	78.00	94.00	76.67
P_3(line 12)		174.50	153.17	165.00	162.67	84.33	72.83	75.50	81.67
P_4(line 17)		159.00	144.00	156.17	146.84	76.83	76.50	74.83	78.50
P_5(line 20)		157.00	125.67	140.84	141.84	73.33	60.67	60.00	74.00
P_6(line 21)		173.17	144.67	168.00	149.84	88.17	71.50	84.34	75.34
P_7(line 26)		164.17	131.00	147.17	148.00	82.83	69.17	77.84	74.17
P_8(line 32)		175.50	154.83	171.17	159.17	80.83	70.50	73.17	78.17
P_9(line 48)		175.00	157.17	176.84	155.33	90.67	77.00	90.67	77.00
Gm 174		191.83	159.50	192.17	159.17	92.00	77.83	96.17	73.67
Gm 1002		180.83	150.83	177.83	153.83	86.67	79.33	87.50	78.50
Gm 1021		176.50	147.17	180.67	143.00	89.17	76.00	89.84	75.34
P_1×Gm174		241.33	228.33	250.17	219.50	120.83	109.17	121.17	108.84
P_1×Gm1002		225.33	212.17	208.83	228.67	115.50	98.83	98.33	116.00
P_1×Gm1021		216.33	223.83	213.83	226.33	108.00	109.83	101.84	116.00
P_2×Gm174		228.00	218.67	222.33	224.34	115.50	110.00	112.17	113.34
P_2×Gm1002		231.00	229.50	237.34	223.17	115.17	109.33	110.50	114.00
P_2×Gm1021		215.83	217.33	214.00	219.17	105.67	107.17	103.00	109.84
P_3×Gm174		222.67	238.33	231.84	229.17	115.33	114.00	113.00	116.34
P_3×Gm1002		232.17	232.50	235.50	229.17	120.17	115.17	117.33	118.00
P_3×GM1021		220.83	217.00	216.83	221.00	108.17	105.83	101.17	112.84
P_4×Gm174		220.83	220.67	217.17	224.33	107.17	109.00	105.17	111.00
P_4×Gm1002		223.67	212.83	213.17	223.34	111.33	104.17	104.67	110.84
P_4×Gm1021		213.83	217.00	208.00	222.83	110.17	105.67	107.50	108.34
P_5×Gm174		220.83	214.67	210.17	225.34	110.67	103.00	100.50	113.17
P_5×Gm1002		229.50	208.83	216.17	222.17	117.17	104.00	106.84	114.33
P_5×Gm1021		228.00	222.33	229.17	221.17	116.17	115.33	117.67	113.84
P_6×Gm174		224.17	216.33	221.34	219.17	110.83	105.67	103.50	113.00
P_6×Gm1002		219.50	208.83	206.17	222.17	108.17	96.00	91.34	112.83
P_6×Gm1021		220.17	219.67	217.17	222.67	107.17	106.50	105.00	108.67
P_7×Gm174		222.33	206.67	208.00	221.00	115.00	99.67	102.67	112.00
P_7×Gm1002		224.17	211.83	214.34	221.67	114.50	105.67	108.84	111.34
P_7×Gm1021		232.17	223.17	226.50	228.84	114.33	108.33	110.00	112.67
P_8×Gm174		223.33	218.67	219.17	222.84	113.50	110.50	111.83	112.17
P_8×Gm1002		223.00	211.67	207.50	227.17	104.67	100.67	96.33	109.00
P_8×Gm1021		223.33	216.17	214.67	224.83	114.50	111.83	110.84	115.50
P_9×Gm174		218.33	213.00	209.00	222.34	113.83	110.67	108.50	116.00
P_9×Gm1002		218.17	232.33	226.33	224.17	109.00	108.83	104.00	113.84
P_9×Gm1021		221.17	232.33	227.67	225.84	106.83	112.67	107.34	112.17
Sc 162		260.83	256.97	265.80	252.00	175.97	158.63	170.10	164.50
Sc 168		260.30	251.63	265.10	246.83	171.67	150.98	168.65	154.00
LSD	0.05	12.73	22.47	13.97	12.67	9.76	10.88	9.08	7.63
	0.01	16.69	29.46	18.31	16.62	12.80	14.27	11.90	10.00

Abbreviations: **L_1 location Gemmeiza ; L_2 location Mallawy; D_1 density one (30000 plant / fed.) and D_2 density two (24000 plant / fed.)**

Table 7 . Mean Performance of maize genotypes for ear position (%) and grain yield at combined over two locations and two densities.

		Ear position (%)				Grain yield (ard./fed.			
		$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
P_1(line 10)		54.70	56.72	54.01	57.41	13.83	14.71	15.76	12.78
P_2(line 11)		51.63	50.46	50.55	51.55	13.35	15.63	16.20	12.78
P_3(line 12)		48.24	48.20	45.76	50.69	14.28	15.19	16.17	13.31
P_4(line 17)		48.28	54.43	48.04	54.68	15.82	16.68	17.46	15.05
P_5(line 20)		46.35	49.13	42.58	52.90	9.48	10.16	8.71	10.93
P_6(line 21)		51.13	50.32	50.32	51.13	14.08	15.64	13.80	15.93
P_7(line 26)		50.93	52.98	52.91	51.01	12.51	14.27	10.39	16.40
P_8(line 32)		45.96	46.29	42.77	49.48	16.73	17.27	16.03	17.98
P_9(line 48)		51.93	49.63	51.40	50.16	15.43	17.63	17.68	15.39
Gm 174		47.99	50.10	50.06	48.02	14.20	10.81	13.74	11.28
Gm 1002		48.01	53.08	49.22	51.88	8.50	15.29	12.23	11.57
Gm 1021		50.49	53.02	49.79	53.73	18.46	16.06	18.89	15.64
P_1×Gm174		50.09	47.78	48.43	49.45	42.51	39.96	43.47	39.00
P_1×Gm1002		51.21	46.46	46.99	50.69	33.33	31.29	34.04	30.59
P_1×Gm1021		49.74	49.12	47.62	51.25	33.19	39.75	39.66	33.29
P_2×Gm174		50.59	50.31	50.49	50.42	40.43	37.27	41.24	36.47
P_2×Gm1002		49.90	47.65	46.53	51.02	38.45	37.04	40.14	35.36
P_2×Gm1021		48.93	49.32	48.12	50.13	34.11	39.83	37.34	36.61
P_3×Gm174		51.79	47.93	48.98	50.73	34.68	35.30	34.43	35.55
P_3×Gm1002		51.79	49.59	49.84	51.54	33.54	41.12	38.71	35.95
P_3×GM1021		48.88	48.84	46.68	51.04	35.70	38.93	42.31	32.33
P_4×Gm174		48.52	49.39	48.43	49.49	37.81	40.57	40.29	38.09
P_4×Gm1002		49.75	49.05	49.14	49.67	32.09	34.01	32.63	33.48
P_4×Gm1021		51.61	48.78	51.76	48.63	35.19	34.88	34.46	35.62
P_5×Gm174		50.04	48.04	47.89	50.20	31.24	41.27	37.46	35.05
P_5×Gm1002		51.01	49.81	49.46	51.37	28.78	36.65	32.68	32.76
P_5×Gm1021		50.94	51.84	51.33	51.47	37.49	37.35	39.80	35.04
P_6×Gm174		49.35	48.87	46.75	51.46	39.25	39.84	41.75	37.35
P_6×Gm1002		49.17	45.84	44.25	50.77	32.96	34.26	34.46	32.76
P_6×Gm1021		48.69	48.54	48.41	48.83	41.75	43.59	44.89	40.46
P_7×Gm174		51.77	48.24	49.36	50.66	33.74	39.30	36.93	36.12
P_7×Gm1002		51.08	49.88	50.78	50.19	32.09	39.43	36.98	34.56
P_7×Gm1021		49.20	48.53	48.57	49.17	39.39	40.72	43.82	36.30
P_8×Gm174		50.78	50.55	51.05	50.28	37.50	37.11	38.11	36.51
P_8×Gm1002		46.91	47.55	46.44	48.03	36.64	41.15	39.59	38.19
P_8×Gm1021		51.23	51.73	51.61	51.36	38.43	40.56	41.33	37.66
P_9×Gm174		52.10	51.95	51.88	52.18	34.25	37.85	34.01	38.09
P_9×Gm1002		49.80	46.94	46.02	50.73	36.24	33.94	34.19	36.01
P_9×Gm1021		48.24	48.52	47.13	49.64	36.24	39.64	37.05	38.83
Sc 162		67.52	61.72	64.00	65.23	34.63	36.24	38.03	32.85
Sc 168		65.98	60.05	63.70	62.33	34.35	37.02	37.64	33.67
LSD	0.05	4.22	5.42	3.58	7.63	3.77	3.48	3.92	3.44
	0.01	5.54	7.11	4.70	10.00	4.94	4.56	5.14	4.51

Abbreviations: L_1 location Gemmeiza ; L_2 location Mallawy; D_1 density one (30000 plant / fed.) and D_2 density two (24000 plant / fed.).

General combining ability effects

Results of GCA effects for days to 50% tasseling in table 8 show that Gm 1021 recorded significant and negative GCA effects in $L_1L_2D_1$, $L_1L_2D_2$, $L_1D_1D_2$ and $L_2D_1D_2$. Inbred line P_1 had highly significant and positively GCA effects in $L_1L_2D_1$, $L_1L_2D_2$ and $L_2D_1D_2$, line P_4 had significant and positive GCA effects in $L_1D_1D_2$ and Gm 1002 had highly significantly positive GCA effects in $L_1L_2D_1$, $L_1L_2D_2$, $L_1D_1D_2$ and $L_2D_1D_2$. These results indicating that Gm 1021 could be considered as a good general combiner for earliness and parental inbred line P_1 (line10) , P_4 (line17) and Gm 1002 could be considered as a good general combiners for lateness. Such results agree with those of Singh(2005) , Parmar (2007) , and Sultan *et al.* (2010).

Results of GCA effects for Days to 50 % silking in Table 8 showed that parental inbred line Gm 1021 had negatively highly significant and significant GCA effects in their combined data $L_1L_2D_1$, $L_1L_2D_2$, $L_1D_1D_2$ and $L_2D_1D_2$, P_8 (line32) had significant and negative GCA effects in $L_2D_1D_2$ and inbred line P_9 (line48) had significant and negative GCA effects in $L_1D_1D_2$. The inbred line P_1 (line10) had significant and positive GCA effects in $L_1L_2D_1$, $L_1L_2D_2$, $L_2D_1D_2$; P_4 (line17) had significant and positive GCA effects in $L_1D_1D_2$ and Gm 1002 had positively highly significant and significant GCA effects in combined data $L_1L_2D_1$, $L_1L_2D_2$, $L_1D_1D_2$ and $L_2D_1D_2$. These results indicating that parental inbred line Gm 1021 , P_8 (line32) and P_9 (line48) could be considered as a good general combiners for earliness. The inbred line P_1 (line10)and Gm1002 could be considered as a good general combiners for lateness. Similar conclusions was obtained by other worker including Surya and Ganguli (2004), Singh (2005) and Sultan *et al.* (2010).

In Table 9 results of GCA effects for Plant height (cm) showed that parental inbred line P_4 (line17) had significant and highly significant negatively GCA effects in $L_1L_2D_1$ and $L_1D_1D_2$. The parental inbred line P_8 (line 32) showed that highly significant and significant negatively GCA effects in $L_1D_1D_2$ and P_9 (line48) had significant and negative GCA effects in $L_1L_2D_1$. suggesting that these inbred lines are the best general combiners for plant shortness. Similar trend were obtained by Surya and Ganguli (2004),Singh (2005) and EL-Shenawy *et al.* (2009).

Results of GCA effects for ear height (cm) in Table 9 showed that parental inbred line P_4 had highly significant and negatively significant GCA effects in $L_2D_1D_2$; inbred line P_6 had highly significant and negatively significant GCA effects in $L_1L_2D_1$, $L_1L_2D_2$ and $L_1D_1D_2$;Gm 1002 had highly significant and negative GCA effects in $L_1L_2D_2$ and $L_1D_1D_2$ and Gm 1021 had significant and negative GCA effects in $L_1L_2D_1$. On the other side's inbred line P_3 (line 12) had significant and positive significant GCA effects in $L_1L_2D_2$, $L_1D_1D_2$ and $L_2D_1D_2$ .It is suggested that parental inbred line P_4 (line17) and P_6 (line 21) are good general combiner for low ear height. While, parental inbred lines P_3 (line 12) is the best general combiners for high ear height. Similar trend were reported by Surya and Ganguli (2004),Singh (2005) , Singh and Roy (2007) , Parmar (2007) , and EL-Shenawy *et al.* (2009).

In Table 10 results of GCA effects for ear position (%) showed that parental inbred line P_6 had highly significant and negative GCA effects in $L_1D_1D_2$; Parental inbred line Gm 1002 had highly significant and negative GCA effects in $L_1D_1D_2$. These results suggested that P_6 (line21) and Gm 1002 inbred line could be considered as the best general combiner for lower ear placement. Similar conclusions was obtained by other workers including Singh (2005) Rakesh *et al.*(2006) , and EL-Shenawy *et al.* (2009).

Results of GCA effects for grain yield Table 10 revealed that the best general combiners for increasing grain yield was P_6 (line21) ,where it had significant and highly significant positive GCA effects in $L_1L_2D_2$ and $L_2D_1D_2$, P_8 (line 32)had significant and highly significant positive GCA effects in $L_1L_2D_1$, $L_1L_2D_2$, $L_1D_1D_2$ and $L_2D_1D_2$; P_2 (line 11) had significant and highly significant positive GCA effects in $L_1L_2D_1$, $L_1L_2D_2$ and $L_1D_1D_2$, P_7 (line 26) had significant and highly significant positive GCA effects in $L_1L_2D_2$. P_9 (line 48) had significant and highly significant positive GCA effects in $L_2D_1D_2$, Gm 174 had significant and highly significant positive GCA effects in $L_1L_2D_1$, $L_1L_2D_2$ and $L_2D_1D_2$. Gm1021 had significant and highly significant positive GCA effects in $L_1L_2D_1$, $L_1L_2D_2$ and $L_1D_1D_2$. These results are in conformity by the finding of Welcker et al.(2005), Rakesh *et al.*(2006), Osman and Ibrahim (2007) , Singh and Roy (2007) , Parmar (2007) , EL-Shenawy *et al.*(2009) and Sultan *et al*. (2010).

Table 8 . GCA effects of nine parents and three testers of maize for days to 50% tasseling and days to 50% silking at combined data over two locations and over two densities during growing season 2016.

		Days to 50% tasseling				Days to 50% silking			
		$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
P_1(line 10)		1.13**	0.68*	0.21	1.60**	0.95*	0.60*	0.06	1.49**
P_2(line 11)		-0.37	-0.15	-0.23	-0.29	-0.33	-0.17	-0.22	-0.28
P_3(line 12)		0.13	-0.21	-0.18	0.10	0.12	-0.17	-0.16	0.10
P_4(line 17)		0.41	0.01	0.65	-0.23	0.34	0.10	0.67*	-0.23
P_5(line 20)		-0.09	-0.21	0.10	-0.40	-0.22	-0.06	0.01	-0.28
P_6(line 21)		-0.09	-0.27	-0.18	-0.18	0.12	-0.06	0.12	-0.06
P_7(line 26)		-0.26	0.23	-0.01	-0.01	0.01	0.22	0.17	0.05
P_8(line 32)		-0.26	0.01	0.27	-0.51	-0.33	-0.28	0.12	-0.73*
P_9(line 48)		-0.59	-0.10	-0.62	-0.07	-0.66	-0.17	-0.77*	-0.06
L.S.D.	0.05	0.76	0.56	0.60	0.62	0.76	0.56	0.60	0.62
	0.01	1. 00	0.74	0.79	0.82	1.00	0.74	0.79	0.82
Gm 174		-0.26	-0.04	-0.22	-0.09	-0.26	-0.04	-0.22	-0.09
Gm 1002		0.76**	0.36*	0.62**	0.51**	0.76**	0.36*	0.62**	0.51**
Gm 1021		-0.50*	-0.32*	-0.40*	-0.42*	-0.50*	-0.32*	-0.40*	-0.42*
L.S.D.	0.05	0.45	0.31	0.35	0.36	0.45	0.31	0.35	0.36
	0.01	0.59	0.41	0.46	0.48	0.59	0.41	0.46	0.48

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

Abbreviations: L_1 location Gemmeiza ; L_2 location Mallawy; D_1 density one (30000 plant / fed.) and D_2 density two (24000 plant / fed.).

Table 9. GCA effects of nine lines and three testers of maize for plant height and ear height (cm) at combined data over two locations and over two densities during growing season 2016.

		Plant height(cm)				Ear height (cm)			
		$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
P_1(line 10)		3.96	2.01	4.93	1.04	2.58	-1.37	0.41	0.80
P_2(line 11)		1.24	2.40	5.21	-1.57	-0.09	1.52	1.85	-0.42
P_3(line 12)		1.52	9.85**	8.71**	2.65	2.36	4.35*	3.80*	2.91*
P_4(line 17)		-4.26*	-2.60	-6.57**	-0.29	-2.64	-1.04	-0.93	-2.75*
P_5(line 20)		2.41	-4.15	-0.85	-0.90	2.47	0.13	1.63	0.97
P_6(line 21)		-2.43	-4.49	-4.46	-2.46	-3.48*	-4.59*	-6.76**	-1.31
P_7(line 26)		2.52	-5.54	-3.07	0.04	2.41	-2.76	0.46	-0.81
P_8(line 32)		-0.48	-3.93	-5.57*	1.15	-1.31	0.35	-0.37	-0.59
P_9(line 48)		-4.48	6.46	1.65	0.32	-2.31	3.41	-0.09	1.19
L.S.D.	0.05	4.23	7.48	4.64	6.35	3.25	3.62	3.01	2.52
	0.01	5.564	9.84	6.10	8.34	4.276	4.76	3.96	3.23
Gm 174		0.94	0.05	1.67	0.68	1.43	0.65	2.02	0.06
Gm 1002		1.46	-1.60	-0.97	0.84	0.65	-2.57**	-2.46**	0.54
Gm 1021		-2.41	1.55	-0.70	-0.16	-2.09*	1.93	0.44	-0.60
L.S.D.	0.05	3.194	5.66	3.52	4.81	1.86	2.07	1.74	1.45
	0.01	5.564	9.84	6.10	8.34	2.44	2.73	2.29	1.90

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

Abbreviations: L_1 location Gemmeiza ; L_2 location Mallawy; D_1 density one (30000 plant / fed.) and D_2 density two (24000 plant / fed.).

Table 10. GCA effects of nine parents and three testers of maize for ear position (%) and grain yield (ard./fed.) at combined data over two locations and over two densities during growing season 2016.

		Ear position(%)				Grain yield (ard./fed.)			
		$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
P_1(line 10)		0.23	-1.14	-0.98	0.07	0.53	-1.25**	0.84	-1.56*
P_2(line 11)		-0.31	0.17	-0.28	0.14	1.85**	-0.20	1.36*	0.29
P_3(line 12)		0.70	-0.14	-0.16	0.72	-1.18	0.21	0.27	-1.24*
P_4(line 17)		-0.15	0.15	1.11	-1.12	-0.78	-1.76**	-2.42	-0.12
P_5(line 20)		0.55	0.97	0.89	0.62	-3.31	0.18	-1.56*	-1.57**
P_6(line 21)		-1.04	-1.18	-2.19**	-0.03	2.17**	0.99	2.16**	1.00
P_7(line 26)		0.57	-0.04	0.91	-0.38	-0.74	1.57**	1.03	-0.20
P_8(line 32)		-0.48	1.02	1.03	-0.49	1.70**	1.36*	1.46*	1.60**
P_9(line 48)		-0.07	0.21	-0.32	0.46	-0.24	-1.10	-3.13**	1.79**
L.S.D.	0.05	1.39	1.80	1.17	1.86	1.25	1.15	1.29	1.13
	0.01	1.82	2.36	1.54	2.44	1.64	1.51	1.70	1.49
Gm 174		0.44	0.30	0.59	0.16	1.00**	0.47	0.42	1.06**
Gm 1002		-0.05	-0.84	-0.95**	0.06	-2.02**	-1.70**	-2.28**	-1.45**
Gm 1021		-0.40	0.54	0.36	-0.22	1.02**	1.23**	1.86**	0.39
L.S.D.	0.05	0.80	1.03	0.68	1.08	0.70	0.66	0.74	0.64
	0.01	1.05	1.36	0.90	1.41	0.92	0.87	0.97	0.85

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

Abbreviations: L_1 location Gemmeiza ; L_2 location Mallawy; D_1 density one (30000 plant / fed.) and D_2 density two (24000 plant / fed.).

Specific combining ability effects

Results in Table 11for tasseling dates showed that crosses P_1×Gm174 had significant and negative SCA effects in $L_1L_2D_1$, P_1×Gm 1021 had significant and negative SCA effects in $L_1L_2D_2$ and $L_1D_1D_2$ while P_1×Gm 1002 in $L_1L_2D_1$, $L_1L_2D_2$, $L_1D_1D_2$ and $L_2D_1D_2$ and P_4×Gm 1002 in $L_1L_2D_1$ had significant and positive SCA effects. Indicating that crosses P_1×Gm174 and P_1×Gm 1021 are the best combinations for earliness.

Results in Table 11 for silking dates cleared that cross P_1×Gm 1002 in $L_1L_2D_1$, $L_1D_1D_2$ and $L_2D_1D_2$ and P_4×Gm 1002 in $L_1L_2D_1$ and $L_2D_1D_2$ had significant and positive SCA effects. Indicating that these crosses are the best combinations for lateness.

Results in Table 12 refer to P_1×Gm 174 had highly significant and positively SCA effects in $L_1L_2D_1$ and $L_2D_1D_2$, P_1×Gm 1002 had highly significant and negatively SCA effects in $L_2D_1D_2$, P_3×Gm 1021 had highly significant and negative SCA effects in $L_1L_2D_2$ and $L_2D_1D_2$. P_5×Gm 174 had highly significant and negatively SCA effects in $L_1D_1D_2$. P_7×Gm 174 had highly significant and negatively SCA effects in $L_1D_1D_2$. P_9 ×Gm174 had significant and negatively SCA effects in $L_1L_2D_2$ and L_2 D_1D_1. It is noticed that most crosses showed significant and highly significant positive SCA effects for plant height, indicating that these crosses are the best combinations for plant height.

Results in Table 12 cleared that crosses refer to P_1×Gm 174 had significant and negative SCA effects in $L_2D_1D_2$; P_1×Gm 1002 had highly significant and negatively SCA effects in $L_1D_1D_2$, P_1×Gm 1021 had highly significant and negatively significant SCA effects in $L_1D_1D_2$. P_2×Gm 1021 had highly significant and negatively significant SCA effects in $L_1D_1D_2$. P_3×Gm 1021 had highly significant and negative SCA effects in $L_1L_2D_2$ and $L_1D_1D_2$. P_5×Gm 174 had highly significant and negative significant SCA effects in $L_1D_1D_2$. P_7×Gm 174 had highly significant and negatively SCA effects in $L_1D_1D_2$. P_8 ×Gm 1002 had significant and significantly negative SCA effects in $L_1L_2D_2$ and $L_1D_1D_2$, indicating that these crosses are the best combinations for lower ear height.

Results shown in Table 13 for ear position (%) show that cross P_3×Gm 1021 had significant and negative SCA effects in $L_1D_1D_2$, P_8 ×Gm 1002 had significant and negatively significant SCA effects in $L_1L_2D_1$ and $L_1D_1D_2$, Indicating that these crosses are the best combinations for lower ear placement.

Results in Table 13 for grain yield showed that crosses P_1×Gm 174 in $L_1L_2D_1$, $L_1L_2D_2$, $L_1D_1D_2$ and $L_2D_1D_2$; P_2×Gm 1002 in $L_1L_2D_1$, $L_1L_2D_1$ and $L_1D_1D_2$; P_3×Gm in $L_1L_2D_1$, $L_1D_1D_2$ and $L_2D_1D_2$. and $L_2D_1D_2$. P_4×Gm 174 in $L_1L_2D_2$ and $L_1D_1D_2$; P_5×Gm 174 in $L_1L_2D_2$; P_5×Gm 1021 in $L_1L_2D_1$. P_6 ×Gm 1021 in $L_1L_2D_1$, $L_1L_2D_1$, $L_1L_2D_2$, $L_1D_1D_2$ and $L_2D_1D_2$; P_7×Gm 1002 in $L_1L_2D_1$

and $L_1D_1D_2$; P_8×Gm 1002 in $L_1L_2D_2$, and $L_2D_1D_2$ and P_9×Gm 1002 in $L_1L_2D_1$had highly significant and significant positive SCA effects. it could be concluded that the parental inbred line for that crosses could made themselves recombination's. These results are in line with those obtained by Osman and Ibrahim (2007) , Singh and Roy (2007) , Parmar (2007) , Liu (2008)and Fan *et al.*(2009).

Table 11 . SCA effects of 27 yellow single crosses of maize at their combined data over two locations and over two density for Days to 50% tasseling and Days to 50% silking during growing season 2016.

	Days to 50% Tasseling				Days to 50% Silking			
	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
P_1×Gm174	-1.35*	-0.12	-0.45	-1.02	-1.25	-0.31	-0.58	-0.98
P_1×Gm1002	2.13**	1.30*	1.55**	1.88*	2.01**	0.99	1.10*	1.90**
P_1×Gm1021	-0.78	-1.18*	-1.10*	-0.86	-0.77	-0.68	-0.52	-0.92
P_2×Gm174	0.65	0.54	0.33	0.86	0.70	0.64	0.36	0.97
P_2×Gm1002	-0.70	-0.53	-0.51	-0.73	-0.54	-0.57	-0.45	-0.66
P_2×Gm1021	0.06	-0.01	0.18	-0.14	-0.15	-0.07	0.09	-0.31
P_3×Gm174	0.15	-0.23	-0.06	-0.02	0.25	-0.36	-0.19	0.08
P_3×Gm1002	-0.54	-0.14	-0.40	-0.28	-0.65	0.10	-0.34	-0.22
P_3×GM1021	0.39	0.38	0.46	0.31	0.40	0.27	0.53	0.14
P_4×Gm174	-0.63	-0.29	-0.23	-0.69	-0.97	-0.14	-0.19	-0.92
P_4×Gm1002	1.35*	0.14	0.44	1.05	1.62**	-0.01	0.33	1.28**
P_4×Gm1021	-0.72	0.15	-0.21	-0.36	-0.65	0.15	-0.14	-0.36
P_5×Gm174	-0.80	-0.57	-0.84	-0.52	-0.91	-0.48	-0.69	-0.70
P_5×Gm1002	0.52	0.52	0.99	0.05	0.35	0.49	0.66	0.17
P_5×Gm1021	0.28	0.04	-0.15	0.48	0.57	-0.01	0.03	0.52
P_6×Gm174	0.04	-0.35	-0.23	-0.08	-0.08	-0.31	-0.14	-0.25
P_6×Gm1002	-0.65	-0.09	-0.40	-0.34	-0.82	-0.01	-0.28	-0.55
P_6×Gm1021	0.61	0.43	0.62	0.42	0.90	0.32	0.42	0.80
P_7×Gm174	0.20	-0.01	-0.06	0.25	0.53	0.25	0.14	0.64
P_7×Gm1002	-0.31	-0.42	-0.23	-0.51	-0.38	-0.46	-0.34	-0.49
P_7×Gm1021	0.11	0.43	0.29	0.25	-0.15	0.21	0.20	-0.14
P_8×Gm174	0.70	0.38	0.83	0.25	0.86	0.25	1.03	0.08
P_8×Gm1002	-0.81	-0.03	-0.51	-0.34	-0.88	0.04	-0.28	-0.55
P_8×Gm1021	0.11	-0.35	-0.32	0.09	0.01	-0.29	-0.75	0.47
P_9×Gm174	1.04	0.65	0.72	0.98	0.86	0.47	0.25	1.08
P_9×Gm1002	-0.98	-0.75	-0.95	-0.78	-0.71	-0.57	-0.40	-0.88
P_9×Gm1021	-0.06	0.10	0.23	-0.19	-0.15	0.10	0.14	-0.20
L.S.D. 0.05	1.352	0.98	1.078	1.097	1.293	1.019	1.0388	1.097
L.S.D. 0.01	1.777	1.288	1.416	1.442	1.700	1.339	1.365	1.442

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

Abbreviations: L_1 location Gemmeiza ; L_2 location Mallawy; D_1 density one (30000 plant / fed.) and D_2 density two (24000 plant / fed.).

Table 12. SCA effects of 27 yellow single crosses of maize at combined over two locations and over two density for plant height (cm) and ear height (cm)during growing season 2016.

	Plant height (cm)				Ear height (cm)			
	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
P_1×Gm174	12.72**	6.84	24.22**	-4.65	4.62	2.57	12.04	-4.84*
P_1×Gm1002	-3.80	-7.68	-14.47**	2.99	0.07	-4.54	-6.31*	1.85
P_1×Gm1021	-8.93**	0.84	-9.75	1.66	-4.69	1.96	-5.72*	2.99
P_2×Gm174	2.11	-3.22	-3.90	2.79	1.96	0.52	1.59	0.88
P_2×Gm1002	4.59	9.27	13.75**	0.10	2.40	3.07	4.41	1.07
P_2×Gm1021	-6.70	-6.05	-9.86*	-2.90	-4.36	-3.59	-6.00	-1.95
P_3×Gm174	-3.50	9.01	2.10	3.40	-0.65	1.69	0.48	0.55
P_3×Gm1002	5.48	4.82	8.42	1.88	4.96	6.07	9.30	1.73
P_3×GM1021	-1.98	-13.83**	-10.52**	-5.28	-4.30	-7.76**	-9.78**	-2.28
P_4×Gm174	0.44	3.78	2.72	1.51	-3.82	2.07	-2.63	0.88
P_4×Gm1002	2.76	-2.40	1.36	-1.01	1.12	0.46	1.35	0.23
P_4×Gm1021	-3.20	-1.38	-4.08	-0.51	2.70	-2.54	1.28	-1.12
P_5×Gm174	-6.22	-0.66	-10.01**	3.12	-5.43	-5.09	-9.85**	-0.67
P_5×Gm1002	1.93	-4.85	-1.36	-1.56	1.85	-0.87	0.96	0.01
P_5×Gm1021	4.30	5.51	11.36	-1.56	3.59	5.96	8.89	0.66
P_6×Gm174	1.94	1.34	4.77	-1.49	0.68	2.30	1.54	1.44
P_6×Gm1002	-3.24	-4.51	-7.75	-0.01	-1.21	-4.15	-6.15*	0.79
P_6×Gm1021	1.30	3.17	2.98	1.49	0.53	1.85	4.61	-2.23
P_7×Gm174	-4.83	-7.27	-9.95**	-2.15	-1.04	-5.54	-6.52	-0.06
P_7×Gm1002	-3.52	-0.46	-0.97	-3.01	-0.77	3.69	4.13	-1.21
P_7×Gm1021	8.35	7.73	10.92	5.16	1.81	1.85	2.39	1.27
P_8×Gm174	-0.83	3.12	3.72	-1.43	1.18	2.19	3.48	-0.12
P_8×Gm1002	-1.69	-2.23	-5.30	1.38	-6.88*	-4.43	-7.54**	-3.77
P_8×Gm1021	2.52	-0.88	1.59	0.05	5.70	2.24	4.06	3.88
P_9×Gm174	-1.83	-12.94	-13.67**	-1.10	2.51	-0.70	-0.13	1.94
P_9×Gm1002	-2.52	8.04	6.31	-0.78	-1.54	0.69	-0.15	-0.71
P_9×Gm1021	4.35	4.90	7.36	1.88	-0.97	0.02	0.28	-1.23
L.S.D. 0.05	7.33	12.95	8.05	10.99	5.62	6.27	5.23	4.39
L.S.D. 0.01	9.63	17.02	10.58	14.45	7.39	8.24	6.87	5.77

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

Abbreviations: L_1 location Gemmeiza ; L_2 location Mallawy; D_1 density one (30000 plant / fed.) and D_2 density two(24000 plant / fed.).

Table 13. SCA effects of 27 yellow single crosses of maize at combined data aver two locations and over two density for ear position (%) and grain yield (ard./fed.) during growing season 2016.

		Ear position(%)				Grain yield (ard./fed.)			
		$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$	$L_1L_2D_1$	$L_1L_2D_2$	$L_1D_1D_2$	$L_2D_1D_2$
P_1×Gm174		-0.70	-0.31	0.16	-1.17	5.16**	2.48*	4.00**	3.64**
P_1×Gm1002		0.91	-0.49	0.26	0.17	-0.99	-4.01	-2.74*	-2.25
P_1×Gm1021		-0.21	0.79	-0.42	1.00	-4.17**	1.52	-1.26	-1.39
P_2×Gm174		0.34	0.92	1.52	-0.26	1.76	-1.25	1.25	-0.74
P_2×Gm1002		0.14	-0.60	-0.90	0.44	2.81*	0.69	2.84*	0.66
P_2×Gm1021		-0.48	-0.32	-0.62	-0.18	-4.58**	0.56	-4.09**	0.08
P_3×Gm174		0.52	-1.16	-0.10	-0.53	-0.97	-3.62*	-4.47**	-0.12
P_3×Gm1002		1.02	1.64	2.29	0.38	0.92	4.37**	2.50*	2.79**
P_3×GM1021		-1.55	-0.48	-2.18*	0.15	0.05	-0.75	1.97	-2.66**
P_4×Gm174		-1.88	0.02	-1.93	0.07	1.77	3.61**	4.08**	1.30
P_4×Gm1002		-0.16	0.82	0.31	0.34	-0.91	-0.78	-0.89	-0.80
P_4×Gm1021		2.05	-0.84	1.62	-0.41	-0.86	-2.83*	-3.19**	-0.50
P_5×Gm174		-1.07	-2.16	-2.26*	-0.97	-2.27	2.37*	0.39	-0.29
P_5×Gm1002		0.39	0.76	0.85	0.30	-1.70	-0.07	-1.69	-0.08
P_5×Gm1021		0.67	1.40	1.41	0.67	3.97**	-2.30*	1.30	0.37
P_6×Gm174		-0.17	0.82	-0.30	0.95	0.25	0.14	0.96	-0.57
P_6×Gm1002		0.15	-1.07	-1.27	0.35	-3.00**	-3.27**	-3.62**	-2.65**
P_6×Gm1021		0.02	0.25	1.58	-1.31	2.75*	3.13**	2.66*	3.22**
P_7×Gm174		0.64	-0.94	-0.80	0.50	-2.34	-0.99	-2.74*	-0.60
P_7×Gm1002		0.44	1.84	2.16	0.12	-0.96	1.32	0.02	0.34
P_7×Gm1021		-1.09	-0.89	-1.36	-0.62	3.30**	-0.32	2.72*	0.26
P_8×Gm174		0.70	0.30	0.76	0.24	-1.03	-2.97**	-1.99	-2.01*
P_8×Gm1002		-2.69*	-1.55	-2.31*	-1.92	1.14	3.24**	2.20	2.18*
P_8×Gm1021		1.99	1.25	1.55	1.68	-0.11	-0.27	-0.21	-0.18
P_9×Gm174		1.61	2.51	2.95	1.17	-2.34*	0.24	-1.49	-0.61
P_9×Gm1002		-0.20	-1.35	-1.38	-0.18	2.69*	-1.50	1.38	-0.19
P_9×Gm1021		-1.41	-1.16	-1.57	-0.99	-0.35	1.26	0.10	0.80
L.S.D.	0.05	2.43	3.11	2.05	3.23	2.15	1.99	2.25	1.97
	0.01	3.19	4.09	2.70	4.25	2.83	2.62	2.96	2.60

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

Abbreviations: L_1 location Gemmeiza ; L_2 location Mallawy; D_1 density one (30000 plant / fed.) and D_2 density two (24000 plant / fed.).

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القدرة على التآلف ومتوسط الأداء لبعض سلالات الذرة الشامية الصفراء الجديدة من خلال استخدام نظام السلالة × الكشاف

محمود سليمان سلطان [1] ، صادق الشحات صادق[2]، مأمون احمد عبد المنعم[1] و محمـد صلاح شلوف[2]

[1]قسم المحاصيل – كلية الزراعة – جامعة المنصورة – مصر

[2]قسم بحوث الذرة الشامية – معهد المحاصيل الحقلية – مركز البحوث الزراعية – مصر

في مصر هناك العديد من المعوقات لإنتاج الذرة الشامية من بينها النقص في الأصناف المحسنة والهدف من هذه الدراسة هو ملا حطة متوسط الأداء للهجن وتقدير القدرة علي التآلف للمحصول وبعض الصفات الأخرى في تسعة من السلالات الصفراء وثلاثة كشافات باستخدام نظام السلالة ×الكشاف حيث تم تقييم 27 هجين قمى فردى و9 سلالات وثلاثة كشافات واثنان من الهجن المحلية للمقارنة هما هجين فردى 162و168 في موقعين (الجميزة – ملاوي) تحت كثافتين نباتيتين (24000 ألف نبات – 30000 ألف نبات بالفدان). اظهر تحليل التباين أن تباين السلالات والكشافات والهجن الناتجة كانت عالية المعنوية وذات أهمية كبيرة في التحليل التجميعي تحت الكثافتين و كانت الهجن P_1×Gm 174 , P_6×Gm 1021 , P_7×Gm 1021, P_8×Gm 1021 ذات معدل إنتاج عالية في محصول الحبوب بالنسبة لمتوسط الأداء. وتأثير القدرة العامة على التآلف كانت السلالات P_6 , P_8 , P_2 , P_7, Gm 174 , Gm1021 كان لها تأثير ايجابي وعالي المعنوية بالنسبة لمحصول الحبوب وبالتالي يمكن إدخالها في برامج التربية لتحسين المحصول وكانت السلالة Gm1021 ذات قدرة عامة للتبكير وكذلك السلالات P_1 , P_4 , Gm 1002 ذات قدرة عامة للتأخير بالنسبة لـ50% من عدد الأيام لطرد الحريرة مما يشير إلى أن السلالة Gm 1021 لها قدرة عامة على التآلف في التبكير في النضج وكانت الهجن P_1×Gm 174 , P_2×Gm 1002 , P_3×Gm 1002, P_4×Gm 174, P_5×Gm 1021 , P_6×Gm 1021, P_7×Gm 1002 , P_8×Gm 1002 لها قدرة خاصة على التآلف موجبة وعالية المعنوية بالنسبة لمحصول الحبوب ويستنتج من ذلك أن سلالات هذه الهجن يمكن إعادة استعمالها في إنتاج تلك الهجن. وتعتبر المعلومات الخاصة بتأثير كل من القدرة العامة والخاصة على التآلف بالنسبة للمحصول مفيدة جدا لمربى الذرة الشامية لتحديد أى الآباء يجب أن يتم اختيارها لتحسين السلالات والأصناف المحلية و أى السلالات الأم يجب استخدامها في إنتاج الهجن ذات المحصول العالي من الحبوب.