Bull. Fac. Agric., Cairo Univ., 62: 387- 394 (2011)

COMBINING ABILITY FOR YIELD AND SOME AGRONOMIC TRAITS IN DIALLEL CROSSES OF TEN NEW YELLOW MAIZE INBRED LINES

(Received: 22.7.2011)

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ABSTRACT

A diallel cross among ten newly developed yellow maize inbred lines excluding reciprocals was made during 2009 summer season. These inbred lines were derived from French populations *i.e.*, FP.POP$_{20}$F$_{10}$(P$_1$), FP.POP$_6$F$_{15}$(P$_2$), FP.POP$_9$F$_{19}$(P$_3$), FP.POP$_{28}$F$_{21}$(P$_4$), FP.POP$_{34}$F$_{13}$(P$_5$), FP.POP$_{39}$F$_{31}$(P$_6$), FP.POP$_9$F$_{40}$(P$_7$), FP. POP$_{12}$F$_{41}$(P$_8$), FP.POP$_{42}$F$_{50}$(P$_9$) and FP.POP$_{25}$F$_{52}$(P$_{10}$).The resulting 45 crosses along with three yellow commercial check hybrids; SC162, SC164 and SC166 were evaluated during 2010 summer season at two locations (Gemmeiza and Mallawy). The main objectives of this study were identifying the most superior hybrids for further use in maize breeding program and improving high yielding yellow single cross hybrids. The results showed that the mean squares were highly significant for all the studied traits, except for ears/100 plants for the interactions of location x genotype; location x general combining ability (GCA) and location x specific combining ability (SCA). Variances due to GCA (additive) and SCA (non-additive) were involved in the inheritance of the studied traits, with the additive gene action playing the major role in the inheritance of these traits, except for grain yield and plant height, which were controlled by non additive gene action. Parental inbred lines P$_5$ and P$_7$ had the highest favorable GCA effect for 50% silking, and plant height, respectively. Parent 4 (P$_4$) and P$_5$ were the best donors for more ears/plant, and P$_1$andP$_9$ were the best for high grain yield. Crosses (P$_3$ x P$_7$), (P$_4$ x P$_8$), and (P$_9$ x P$_{10}$) showed negative and significant SCA effects for silking date (desirable). While, crosses (P$_2$ x P$_5$) and (P$_6$ x P$_9$) significantly outyielded the commercial yellow check hybrids SC 162 and SC 164. Therefore, these crosses may be released as new high yielding single crosses.

Key words: *combining ability, diallel analysis, yellow maize.*

1. INTRODUCTION

The total cultivated area of yellow maize (*Zea mays* L.) in Egypt reached 307470 feddan (one feddan = 4200 m^2) in 2010 with an average yield of 22.7 ardab/feddan (one ardab = 140 Kg) (Economic Sector, Ministry of Agriculture, 2010). Meanwhile, Egypt is importing about five million tons of yellow maize annually, to meet the feed requirements of livestock and growing poultry industry. Accordingly, increasing the production per unit area through developing new high yielding yellow maize hybrids is considered one of the most important objectives of the National Maize Research Program, in order to minimize the amounts of imported yellow maize.

To establish a sound basis for any breeding program, aimed at achieving high yield, breeders must have information on the nature of combining ability of parents, their behavior and hybrid combination performance (Chawla and Gupta, 1984).

Diallel analysis technique is the choice of providing such detailed genetic information for selecting breeding materials that show great promise for success (Lonnquist and Gardner, 1961). General (GCA) and specific (SCA) combining ability were defined by Sprague and Tatum (1942). 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. A series of studies on combining ability has been made by many researchers *i.e*., Shehata and Salem (1972), Nawar *et al*. (1980), Nawar and El-Hosary (1985), Galal *et al.* (1987), Abdel-Aziz *et al.* (1994), Ragheb *et al.* (1995), Khalifa *et al.* (2001), Barakat *et al.* (2003), Soliman *et al.* (2005), Barakat and Abdel-Aal (2006), Motawei and Mosa (2009) and Mosa *et al.* (2010). They studied and estimated the general and specific combining abilities and their role in the inheritance of grain yield and other agronomic traits. They found that both GCA and SCA effects were of equal importance in the inheritance of most studied traits.

The main objectives of this investigation were to estimate GCA and SCA effects and their interaction with locations for grain yield and other agronomic traits using a set of 10 newly developed inbred lines, excluding reciprocals and to provide information for selecting superior hybrid combinations which surpass the commercial ones.

2. MATERIALS AND METHODS

Ten promising yellow maize inbred lines (Table 1) were developed at Gemmeiza farm through the activity of "Maize Improvement Production by Introduction of New Industrial Genotypes Project", National Maize Research Program, Agricultural Research Center (ARC), Egypt. These ten inbred lines were derived from French populations.

Table (1): Names and origin of inbred lines.

Inbred line	Origin	Inbred line	Origin
FP.POP$_{20}$F$_{10}$ (P$_1$)	F.POP. no.10	FP.POP$_{39}$F$_{31}$ (P$_6$)	F.POP. no.31
FP.POP$_6$F$_{15}$ (P$_2$)	F.POP. no.15	FP.POP$_9$F$_{40}$ (P$_7$)	F.POP. no.40
FP.POP$_9$F$_{19}$ (P$_3$)	F.POP. no.19	FP.POP$_{12}$F$_{41}$ (P$_8$)	F.POP. no.41
FP.POP$_{28}$F$_{21}$ (P$_4$)	F.POP. no.21	FP.POP$_{42}$F$_{50}$ (P$_9$)	F.POP. no.50
FP.POP$_{34}$F$_{13}$ (P$_5$)	F.POP. no.13	FP.POP$_{25}$F$_{52}$ (P$_{10}$)	F.POP. no.51

These ten inbred lines were crossed in a half diallel mating design according to Griffing's method 4 to generate 45 F$_1$ crosses at Gemmeiza farm during the summer season 2009. In 2010 season, the 45 F$_1$'s as well as the three yellow commercial check hybrids; SC162, SC164 and SC166 were evaluated at two locations; Gemmeiza and Mallawy Research Stations, Agricultural Research Center (ARC), Egypt.

A randomized complete block design with four replications was used in each location. Experimental plot was one row, 6m long and 80 cm apart. Sowing was in hills spaced of 25 cm along the row, maintaining one plant per hill to provide a population density of approximately 21,000 plants /feddan. The recommended cultural practices for maize cultivation were applied at each location. Data were recorded on the number of days to 50% silking, plant height (cm), ear position %, ears /100 plants and grain yield (ardab/ Feddan) adjusted at 15.5% moisture content.

General and specific combining abilities were estimated according to Griffing's (1956) diallel cross analysis method 4, model 1 for each location. Combined analysis across two locations was carried out whenever homogeneity of variances was detected (Steel and Torri, 1980). Means of genotypes were compared using LSD at 5% probability level.

3. RESULTS AND DISCUSSION

3.1. Analysis of variance

Analysis of variance for ordinary and combining ability analysis of the combined data across two locations for 50% silking, plant height, ear position, ears/100 plant and grain yield (ardab/feddan) are presented in Table (2). Significant differences were detected among locations for all the studied traits, except for ear position, indicating the differences in environmental conditions between locations. Results indicated existence of highly significant differences among genotypes for the five studied traits. Mean squares due to genotype x location interaction were significant for all the studied traits, except for ears /100 plants, indicating that the performance of genotypes differed at both locations. These results agree with those obtained by Galal *et al*. (1985), Nawar and El-Hosary (1985), El-Sherbiny (1986), Abdel-Aziz *et al*. (1994), Abdel-Moula (1997), Nass *et al*. (2000) and Barakat and Abdel-Aal (2006).

Combined analysis of variance (Table 2) revealed the presence of highly significant mean squares due to general and specific combining ability for all the studied characters. These results indicated that both additive and non additive types of gene effects were involved in the inheritance of these characters. The ratio of GCA/SCA exceeded the unity for days to 50% silking, ear position and the number of ears/100 plants, indicating that the additive genetic action was more important and played the major role in the inheritance. Whereas, for grain yield and plant height, the ratio of GCA/SCA was less than unity, indicating that the non-additive gene action was of more important role than the additive in controlling the inheritance of both traits. These results are in agreement with the findings of Darrah and Hallauer (1972), Hallauer and Mirinda (1981), Salem *et al*. (1986), El-Hosary (1989), Ragheb *et al*. (1995), Barakat *et al*. (2003), Soliman *et al.* (2005) and Mosa *et al.* (2010).

Table (2): Analysis of variance for the studied traits of 10 x 10 diallel , combined across Gemmeiza and Mallawy locations.

		Mean squares				
S.O.V	**D.F**	**50% silking**	**Plant height**	**Ear position%**	**Ears/100 plants**	**Grain yield (ard/fed)**
Loc.	**1**	**207.03****	**32471.0****	**0.003**	**332.16****	**2484.8****
Rep (loc)	**6**	**24.27**	**1255.4**	**29.7**	**31.06**	**19.7**
Geno.	**44**	**24.13****	**1197.2****	**63.2****	**39.45****	**92.1****
Loc x Geno.	**44**	**7.93****	**298.3****	**22.9****	**28.71**	**63.6****
GCA	**9**	**29.56****	**802.4****	**142.1****	**51.98***	**44.1****
SCA	**35**	**22.73****	**1298.7****	**42..9****	**36.22***	**104.1****
Loc x GCA	**9**	**6.17****	**215.6***	**19.4****	**27.04**	**81.3****
Loc x SCA	**35**	**8.38****	**319.6****	**23.8****	**29.15**	**59.0****
Error	**264**	**2.06**	**93.3**	**8.1**	**21.96**	**6.0**
GCA/SCA		**1.30**	**0.618**	**3.383**	**1.435**	**0.422**
Loc x GCA/ Loc x SCA		**0.736**	**0.676**	**0.815**	**0.928**	**1.378**

Mean squares due to the interactions of both GCA and SCA with locations (Table 2) were significant for all the studied traits, except for ears/100 plants. The magnitude of the interaction variance was higher for GCA x location than that of SCA x location for grain yield, indicating that additive genetic variance was more influenced by environment than the non-additive variance. In contrast, SCA x location interaction variance was higher than GCA x location variance for days to 50% silking, plant height and ears/100 plants, indicating that the non-additive component interacted more with the environment than the additive. This conclusion supports the findings of El-Hosary (1989), Mostafa *et al*. (1996). Sughroue and Hallauer (1997), Soliman (2000), Soliman *et al*. (2005) and Motawei and Mosa (2009).

3.2. Mean performance

Mean performance, of the combined analysis across locations for grain yield and other agronomic traits of the 45 diallel crosses are presented in (Table 3).

Regarding the number of days from planting to 50% silking, both crosses (P_3x P_5) and (P_3 x P_7) were the earliest (58.4 and 58.9 days, respectively). Out of the 45 crosses, 24 crosses were significantly earlier than the earliest check SC 164. While crosses (P_3 x P_4) and (P_7 x P_9) were the latest (64.6 and 66 days, respectively). The shortest plants were shown by the crosses (P_1 x P_7), (P_4 x P_6) and (P_2 x P_8) (195,197and 201cm, respectively). Concerning ear position, the highest values (62 and 60%) were scored for single crosses (P_1 x P_2) and (P_1 x P_5). Meanwhile, five single crosses; (P_4 x P_7), (P_2 x P_9), (P_7 x P_9), (P_2 x P_8) and (P_8 X P_9); had the lowest ear position (48, 51, 57, 52 and 52%, respectively). Number of ears/100 plants ranged from 101 to 112, and all were significantly less than the best performing check hybrid (SC 166), except the value 112% of the cross (P_3 x P_4), which was similar to that of the check hybrid. Hence it could be concluded that (P_3xP_4) cross may be useful for improving prolificacy. The highest grain yield was obtained from crosses; (P_1 x P_4), (P_1 x P_5), (P_1 x P_8), (P_1 x P_9), (P_2 x P_4), (P_2 x P_5), (P_4 x P_8), (P_6 x P_7), (P_6 x P_9) and (P_8 x P_9). These crosses were significantly

Table (3): Mean performance of F_1 crosses and check hybrids for the studied traits (combined across two locations) in summer 2010.

No.	Crosses	50% silking No.	Plant height cm	Ear position %	Ears/100 plants%	Grain yield (ard/fed)
1	P1 x P2	64.1	241	62	106	23.94
2	P1 x P3	60.8	224	54	103	23.04
3	P1 x P4	63.3	227	59	104	29.39
4	P1 x P5	60.6	223	60	104	27.87
5	P1 x P6	61.1	211	59	104	19.89
6	P1 x P7	64.8	195	55	104	19.84
7	P1 x P8	63.9	222	59	105	29.29
8	P1 x P9	64.0	240	58	103	28.71
9	P1 x P10	62.8	225	57	106	26.28
10	P2 x P3	61.1	213	54	102	25.29
11	P2 x P4	61.8	227	58	105	26.67
12	P2 x P5	60.9	208	57	108	32.05
13	P2 x P6	61.4	213	58	102	25.41
14	P2 x P7	61.0	213	55	103	20.90
15	P2 x P8	64.3	201	52	106	18.59
16	P2 x P9	60.6	207	51	101	24.03
17	P2 x P10	62.8	221	58	104	24.03
18	P3 x P4	64.6	248	59	112	20.50
19	P3 x P5	58.4	211	57	104	23.21
20	P3 x P6	61.6	222	53	107	20.58
21	P3 x P7	58.9	204	55	102	25.68
22	P3 x P8	63.9	222	54	102	23.66
23	P3 x P9	61.5	214	55	103	25.53
24	P3 x P10	63.1	224	58	101	24.54
25	P4 x P 5	62.0	213	54	107	24.73
26	P4 x P6	60.0	197	56	103	24.72
27	P4 x P7	60.5	234	48	102	25.98
28	P4 x P8	59.3	208	54	109	27.29
29	P4 x P9	64.4	206	53	106	19.43
30	P4 x P10	63.8	214	54	103	17.23
31	P5 x P 6	60.3	210	56	107	22.87
32	P5 x P7	59.5	201	54	106	24.92
33	P5 x P8	60.6	210	53	103	22.62
34	P5 x P9	63.0	238	58	104	25.63
35	P5 x P10	62.6	223	54	104	20.55
36	P6 x P 7	63.4	233	57	103	28.98
37	P6 x P8	60.4	207	55	103	23.19
38	P6 x P9	61.8	214	59	102	31.55
39	P6 x P10	63.1	228	57	104	25.01
40	P7 x P8	62.1	212	53	102	20.01
41	P7 x P9	66.0	214	51	104	21.35
42	P7 x P10	62.4	207	55	103	21.76
43	P8 x P9	62.5	232	52	103	27.19
44	P8 x P10	62.6	222	54	104	27.53
45	P9 x P10	60.3	202	56	102	24.99
46	SC162	65.4	248	58	104	28.98
47	SC164	63.6	234	59	109	28.77
48	SC166	63.9	225	56	113	28.17
	L.S.D $_{0.05}$	1.387	9.522	3.183	4.639	2.449

shorter than to the check hybrids and in the same time their grain yield production were equal or much better than the check hybrids. Grain yield for the single crosses (P_1 x P_4), (P_1 x P_8), (P_2 x P_5), (P_6 x P_9) were higher than the checks. However, the two new very promising yellow single crosses (P_2 x P_5) and (P_6 x P_9) were significantly much better than the check hybrids. These two single crosses (P_2 x P_5) and (P_6 x P_9) gave 32.05 and 31.55 ard/fed respectively, versus 28.98, 28.77 and 28.17 ard /fed for the checks; SC 162, SC 164 and SC 166, respectively. In addition to the superiority of grain yield these two crosses (P_2 x P_5) and (P_6 x P_9) were earlier in flowering (days to 50% silking) and shorter in plant height.

3.3. General and specific combining ability effects

Estimates of general combining ability effects (gi) of the parental inbred lines for the studied traits are presented in Table (4). For days to 50% silking, the parental line P_5 possessed significantly negative GCA effects (desirable). While for plant height, P7 was the only parental line possessing significantly negative GCA effects (desirable). Considering ear position percentage, the parental lines (P_7) and (P_8) had negative and significant GCA effects towards low ear placement. With respect to the number of ears/100 plants, inbred line P_4 was the only inbred that possessed positive significant GCA effects. Concerning grain yield, two inbred lines (P_1 and P_9) exhibited the highest significant positive GCA effects, indicating that these inbred lines possess favorable genes for high grain yield.

Estimates of specific combining ability effects (Sij) of the 45 crosses for the five studied traits are given in Table (5). For days to 50% silking, significant and negative Sij effects were detected for the crosses (P_2 x P_9), (P_3 x P_7), (P_4 x P_6), (P_4 xP_7), (P_4 x P_8) and (P_9 x P_{10}). For plant height, significant and negative SCA effects (favorable) were recorded for crosses (P_1 x P_7), (P_2 x P_8), (P_3 x P_7), (P_4 x P_6), (P_4 x P_9), (P_5 x P_7) and (P_9 x P_{10}). Considering ear position, four crosses *i.e*. (P_1 x P_3), (P_2 x P_9), (P_3 x P_6) and (P_4 x P_7) had significant and negative Sij effects (favorable). For number of ears/100plants, expressing prolificacy, the highest desirable SCA effects were recorded for only the cross (P_3 x P_4).

For grain yield, the highest significant and positive SCA effects were recorded in the crosses (P_1 x P_4), (P_1 x P_8), (P_2 x P_5), (P_3 x P_7), (P_4 x P_7), (P_4 x P_8), (P_6 x P_7) and (P_6 x P_9). These crosses also had the highest mean grain yield. It could be concluded that the previous crosses seemed to be the best

Table (4): Estimates of general combining ability effects (gi) of the parental inbred lines in the F_1 generation for studied traits (combined analysis across two locations) in summer 2010.

Parents	50% silking	Plant height	Ear position%	Ears/100 plants	Grain yield (ard./fed.)
P1	0.872	6.475*	2.832*	0.397	1.091*
P2	- 0.050	- 1.541	0.608	- 0.082	0.277
P3	- 0.550	3.163	-0.116	- 0.132	- 0.937
P4	0.153	2.366	-0.761	1.678*	- 0.447
P5	- 1.300*	- 2.650	-0.569	1.233	0.616
P6	0.659	- 2.666	1.425*	- 0.268	0.378
P7	0.028	- 5.400*	-2.120*	- 1.014	- 1.261*
P8	0.153	- 2.447	-1.800*	- 0.003	- 0.19
P9	0.716	1.459	-0.909	- 1.075	1.072*
P10	0.638	1.241	0.272	- 0.733	- 0.768
Standard error:					
(g_i)	0.481	3.240	0.953	1.572	0.822
(g_i-g_j)	0.717	4.829	1.421	2.343	1.225

Table (5): Estimates of specific combining ability effects (S_{ij}) of 45 diallel crosses for the studied traits in maize (combined analysis across two locations) in summer 2010.

Crosses	50% silking	Plant height	Ear position	Ears/100 plants	Grain yield ard/fed)
P1 x P2	1.273	18.196*	3.026*	1.498	- 1.816
P1 x P3	- 1.602	- 2.881	- 4.226*	- 0.939	- 1.507
P1 x P4	0.194	1.039	1.232	- 2.461	4.355*
P1 x P5	- 0.977	1.556	1.415	- 1.515	1.769
P1 x P6	- 1.118	- 9.929	- 0.929	- 0.215	- 5.970*
P1 x P7	1.819*	- 23.444*	- 1.808	0.856	- 4.377*
P1 x P8	0.819	0.727	1.909	0.833	3.829*
P1 x P9	0.382	14.571*	0.718	- 0.270	2.151
P1 x P10	- 0.790	0.165	- 1.338	2.213	1.567
P2 x P3	- 0.306	- 6.241	- 2.338	- 2.135	1.563
P2 x P4	- 0.384	9.056*	2.419	- 0.608	2.448
P2 x P5	0.194	- 5.304	- 0.059	2.513	6.772*
P2 x P6	0.054	- 5.538	0.421	- 1.962	0.369
P2 x P7	- 1.009	2.821	1.179	- 0.290	- 2.508
P2 x P8	2.116	- 12.132*	- 2.054	1.711	- 6.057*
P2 x P9	- 2.071*	- 9.913	- 3.982*	- 1.754	- 1.713
P2 x P10	0.131	4.055	1.387	1.028	0.943
P3 x P4	2.991*	25.352*	4.656*	6.429*	- 2.507*
P3 x P5	- 1.806	- 7.256	1.126	- 0.887	- 0.867
P3 x P6	0.804	3.758	- 3.643*	2.900	- 3.251*
P3 x P7	- 2.634*	- 11.007*	1.615	- 1.390	3.489*
P3 x P8	2.241*	3.539	0.819	- 1.776	0.226
P3 x P9	- 0.696	- 7.616	0.167	- 0.192	1.000
P3 x P10	1.007	2.352	1.823	- 2.009	1.854
P4 x P 5	1.116	- 4.085	- 0.979	- 0.421	0.172
P4 x P6	- 1.524*	- 19.694*	- 0.547	- 2.759	0.403
P4 x P7	- 1.711*	19.914*	- 4.989*	- 2.549	3.298*
P4 x P8	- 3.086*	- 9.163	0.603	3.164	3.360*
P4 x P9	1.475*	- 15.069*	- 0.826	1.311	- 5.587*
P4 x P10	0.929	- 7.350	- 1.569	- 2.106	- 5.944*
P5 x P 6	0.179	- 2.554	- 1.252	2.186	- 2.515*
P5 x P7	- 1.259	- 8.818*	0.268	2.095	1.175
P5 x P8	- 0.258	- 1.897	- 1.152	- 2.815	- 2.365
P5 x P9	1.554*	21.821*	2.582	- 0.443	- 0.453
P5 x P10	1.257	6.539	- 1.949	- 0.711	- 3.687*
P6 x P 7	1.976*	23.446*	2.537	- 0.205	5.474*
P6 x P8	- 1.149	- 4.882	0.154	- 0.540	- 1.564
P6 x P9	- 0.336	- 1.913	3.389*	- 0.581	5.412*
P6 x P10	1.116	12.306*	0.130	1.177	1.643
P7 x P8	- 0.087	2.227	1.174	- 1.394	- 3.101*
P7 x P9	3.226*	0.696	- 1.654	2.278	- 2.851
P7 x P10	- 0.321	- 5.835	1.678	0.599	- 0.599
P8 x P9	- 0.399	15.618*	- 0.974	0.329	1.744
P8 x P10	- 0.196	5.962	- 0.480	0.487	3.927*
P9 x P10	- 3.134*	- 18.194*	0.579	- 0.677	0.297
Standard error:					
S_{ij}	1.265	8.518	2.507	4.132	2.160
(S_{ij}-S_{ik})	1.898	12.777	3.761	6.199	3.241
(S_{ij}-S_{kl})	1.757	11.829	3.482	5.739	3.000

combinations especially (P_2 x P_5) and (P_6 x P_9) and could be considered very promising and significantly better for grain yield, earlier in flowering and shorter in plant height as compared to the best check hybrid. These two new yellow single crosses have to be evaluated in advanced steps for releasing as new commercial hybrids.

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قدرة التآلف لمحصول الحبوب و بعض الصفات الأخرى فى الهجن التبادلية لعشرة سلالات جديدة ومبشرة من الذرة الشامية صفراء الحبوب

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ملخص

تم عمل كل الهجن التبادلية الممكنة فى إتجاه واحد بين عشرة سلالات نقية من الذرة الشامية صفراء الحبوب فى موسم 2009 وتم تقييم الهجن التبادلية الـ 45 بالإضافة إلي ثلاثة هجن فردية تجارية صفراء الحبوب هى 162، 166،164 فى تجارب حقلية من أربع مكررات تم تنفيذها فى موسم 2010 بمحطتى البحوث الزراعية: الجميزة وملوى وذلك لصفات ميعاد ظهور 50% من النورات المؤنثة ، إرتفاع النبات، موقع الكوز، عدد الكيزان / 100 نبات ومحصول الحبوب وكان الهدف من الدراسة هو تقدير القدرة على التألف وتحديد الهجن الأكثر تفوقا لاستخدامها فى برامج التربية كهجن فردية صفراء الحبوب عالية الإنتاجية تتفوق علي الهجن التجارية الأخرى.

أظهرت نتائج التحليل التجميعى عبر الموقعين أن تباينات القدرة العامة والخاصة للإئتلاف كانت عالية المعنوية للصفات تحت الدراسة ووجد أن التأثيرات الجينية غير المضيفة تلعب دورا هاما فى وراثة صفات المحصول وإرتفاع النبات كما وجد أن التأثيرات المضيفة تلعب الدور الهام فى وراثة صفات التزهير وإرتفاع الكوز و عدد الكيزان/ 100 نبات كما أوضحت النتائج أن الأباء (P_5,P_7) كانت أفضل السلالات لصفة التبكير حيث أظهرت تقديرات سالبة ومعنوية للقدرة العامة للتآلف أما (P_7) فكانت الأفضل فى قصر النباتات وموقع الكوز حيث أظهرت تأثيرات سالبة ومعنوية أما ألأباء(P_4,P_5) كانت مانحة جيدة لصفة عدد الكيزان/ 100 نبات كما أعطت الأباء (P_1,P_9) أعلى تأثيرات موجبة لصفة المحصول.

أظهرت نتائج الهجن الفردية (P_3 x P_7) ، (P_4 x P_8) ، (P_9 x P_{10}) أعلى تأثيرات قدرة تآلف خاصة مرغوبة (سالبة) تجاه التبكير كما ظهرت ستة هجن متفوقة فى قدرة التآلف الخاصة المحصول وهى (P_4x P_1)، (P_1 x P_8) ،(P_1 x P_9) ، (P_2 x P_5) ، (P_6 x P_7) ،(P_6 x P_9) وكان الهجينان (P_2 x P_5) ، (P_6 x P_9) متفوقان معنويا فى محصول الحبوب وهذه الهجن تعتبر من الهجن المبشرة والتى يمكن الإستفادة منها فى برنامج التربية لزيادة المحصول والتبكير وزيادة الكثافة النباتية للفدان.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (62) العدد الرابع (أكتوبر 2011):387-394.