HETEROSIS AND COMBINING ABILITY ANALYSIS OF SOME FABA BEAN GENOTYPES

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ABSTRACT

Six advanced faba bean lines were crossed with four widely different varieties (testers) were planted and crossed under insect free cages at Giza Research Station during 2002/03 and 2003/04 seasons. The parental genotypes along with the 24 F_1's were planted in randomized complete block design with three replications in 2004/05 season: The mean heterosis (%), genetic variance components and combining ability effects were calculated according to line x tester procedure. Several crosses showed significant positive heterosis relative to both mid and better parents for number of branches, number of pods, number of seeds, seed yield per plant and 100- seed weight. The results suggested that the parental genotypes X-1451 and Giza 40 were good combiners for number of pods, seeds and seed yield per plant. Meanwhile, two crosses, namely X-1468 x Sakha 2 and X-1451 x Giza 716 exhibited significant positive SCA effects for number of branches, pods, seeds and seed yield per plant. Moreover, four crosses exhibited significant positive SCA for 100-seed weight (X-1441 x Sakha 2, X1459 x Giza 716, X-1451 x Misr 1and X-1459 x Misr 1). Dominance genetic variance was more important than additive variance for all characters, indicating an excess of dominant genes in the parents for these traits.

Key words: Faba bean breeding, Heterosis, Combining ability, Line X Tester.

INTRODUCTION

Faba bean (*Vicia faba L.*) is a well known pulse crop grown for its seed. The possibility of increasing its annual cultivated area in Egypt is limited and hence increasing productivity through improving cultural practices and developing new high yielding varieties is the most effective approach .

The annual faba bean acrease over the last five years (2001–05) was 265.389 feddans with an average productivity of 8.86 ardab/fed. The crop is generally included in the crop rotation and has succeeded to keep the Egyptian soil fertile through biological N_2 – fixation. Increasing seed yield and improving yield characteristics are the primary objectives of most faba bean breeding programs. Several methodologies had been used adapted in the genetic analysis i.e. partial and full diallel matings, six-population model and line x tester analysis which helped in choosing the most efficient breeding scheme .

The exploitation of heterosis through synthetics and ultimately hybrids could pay off in improving yield potential. Hybrid vigour for seed yield was found to be associated with manifestations of heterotic effects in plant yield components (number of pods, seeds, and 100- seed weight) which might be reflected in improved yielding ability and the expression of hybrid vigour relative to mid or better parent (El-Hosary, 1983 a; El-Hosary and Nawar, 1984; Mahmoud and Al-Ayoubi, 1986 a and b; El-Hady *et al.*, 1991 a and b; El-Hady *et al.*, 1997 and 1998; Attia, 1998 and Attia *et al.*, 2002). Abdalla, 1977 a reported that, heterosis was very pronounced in F_1 especially among widely divergent materials but was less manifested in hybrids between local varieties .

Combining ability is a general concept considered collectively for classifying an inbred line relative to its cross performance. El-Hosary (1985), Mahmoud and Al-Ayoubi (1986 b), El-Hady *et al.*, (1991 a & b) and El-Lithy (1996) reported that both GCA and SCA variances were important for yield and its components. However, information about the genetic control of yield components in faba bean which is essential for maximizing seed yield is limited. El–Hosary (1983 a) suggested that the additive variance as well as non-additive gene action might be controlling the inheritance of yield and its components. In addition, the additive variance was reported to be important for 100 seed weight (El-Hady, 1988 and El-Hady *et al.*, 1997). On the other hand results obtained by Nassib (1982); El–Hady *et al.*, (1991a and b) and El–Hady *et al.*, (1997) revealed that non–additive effects were more important for number of pods, seeds and seed yield/plant than additive effects. However, additive gene effects were almost equal to non- additive for seed yield and seed components (El-Hosary, 1983 a; El-Hady *et al.*, 1991 a and b; El-Hady *et al.*, 1997 and 1998; Attia 1998; Mansour *et al.*, 2001; Attia *et al.*, 2002; Abd El-Mohsen, 2004 and Darwish *et al.*, 2005).

This study aimed to :1) evaluating the performance of lines some faba bean and their F_1 crosses and 2) estimating the magnitude of heterosis and combining ability using the line x tester analysis.

MATERIALS AND METHODS

Six new faba bean breeding lines (females) namely: X-1441, X-1451, X-1459, X-1468, X-1548 and X-1554 were grown and crossed to each of the following varieties (males): Sakha 2, Giza 40, Giza 716 and Misr 1 under insect free cages at Giza Research Station during 2002/03 season. The pedigree and different characteristics of the parental genotypes are shown in Table (1). In 2003/04 season the parental genotypes were planted again and re-hybridized in order to obtain more hybrid seeds. The resulted F_1 progenies along with their parental genotypes were planted in a randomized complete block design with three replications during 2004/05 season.

Table (1) : Pedigree and characteristics of faba bean parental genotypes used in the present study.

Parents Female: (Lines)	Pedigree	Characteristics
X - 1441 (P_1)	Derived from 749/954/90 x Giza 429	Resistant to foliar diseases
X - 1451 (P_2)	Derived from 627/382/86 x X.899	Resistant to foliar diseases
X -1459 (P_3)	Derived from 749/926/90 x X.900	Resistant to foliar diseases
X - 1468 (P_4)	Derived from 716/1036/89 x X.903	Resistant to foliar diseases
X - 1548 (P_5)	Derived from Line 40/93 x X.843	Resistant to foliar diseases
X - 1554 (P_6)	Derived from 716/1036/89 x X.900	Resistant to foliar diseases
Male: (Testes)		
Sakha 2 (P_7)	Derived from Reina Blanca x 461/845/83	Resistant to foliar diseases
Giza 40 (P_8)	An individual plant selection from Rebaya 40	Early maturing variety
Giza 716 (P_9)	461/843/83 x 503/453/84	Resistant to foliar diseases and early maturing variety
Misr 1 (P_{10})	Derived from Giza 3 x 123 A / 45 / 76	Resistant to *Orobanche* and early maturing variety

Seeds were planted in single seeded hills, 20 cm apart, each entry was represented by one row for parents and their F_1's. The row was 3 meters long and 50 cm in between. Cultural practices were applied as usually recommended for faba bean production. Data were recorded on all plants from each experimental plot of parents and F_1's. The following traits were recorded on individual plant basis: number of branches, number of pods and number of seeds/plant, as well as 100-seed weight (g) and seed yield/plant (g).

Statistical analysis:

The analysis of variance of randomized complete block design for each studied trait was carried out as described by Steel and Torrie (1980).

The heterosis (%) was expressed as the percentage deviation of F_1 mean performance from the mid and better parent as follows:

Mid parent heterosis $(\overline{MP}) = (\overline{F_1} - \overline{MP}) / \overline{MP} \times 100$

Mid parent heterosis L.S.D.= $t.\{(3MSE)/2r\}^{0.5}$

Better parent heterosis $(\overline{BP}) = (\overline{F_1} - \overline{BP}) / \overline{BP} \times 100$

Better parent heterosis L.S.D.= $t.\{(2MSE)/r\}^{0.5}$

Where t. is the tabular value at the stated level of probability for the degrees of freedom of the experimental error. MSE: is the error mean square and (r) is the number of replications.

Combining ability analysis and genetic parameters were calculated based on the procedure developed by Kempthorne (1957).

RESULTS AND DISCUSSION

Variance analysis and mean performance for different studied characters:

The analysis of variance for the studied characters (Table 2) revealed significant differences among genotypes, parents, crosses, parents vs. crosses, and line X tester. These results indicated wide range of genetic variability for studied traits in the material analyzed .

Table (2) : Analysis of variance for the faba bean studied characters

Source of variation	d f	No. of branchs/ plant	No. of pods/ plant	No. of seeds/ plant	100 seed weight	Seed yield/plant
Replications	2	48.54	70.31	374.81	210.44	439.33
Genotypes	33	0.90**	46.77**	372.84**	861.68**	223.18**
Parents	9	0.89**	27.29**	89.77**	2490.91**	308.32**
Crosses	23	0.85**	44.85**	373.28**	230.90**	156.33**
P vsC	1	2.26**	266.50**	2910.44**	706.60**	994.40**
Lines (L)	5	1.36	41.03	467.10	244.39	216.24
Testers (T)	3	0.68	95.50	826.17*	171.96	284.87
L x T	15	0.71**	35.99**	251.42**	238.20**	110.66**
Error	66	0.13	4.39	27.74	44.68	26.33

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

The mean performance of lines, testers and their F_1's for the studied traits are presented in Table (3). The mean values of lines showed wide differences with a range of 4.17- 5.67; 10.47- 17.63; 27.89- 42.79; 19.89-38.58 and 71.32-112.31 for number of branches, number of pods, number of seeds, seed yield per plant and 100- seed weight, respectively. Similarly, the mean values of testers showed wide variability with a range of 3.82- 5.14; 7.9- 15.59; 26.04-40.02; 19.12- 29.39 and 71.53- 92.57 for the previously mentioned characters in the same order. The female genotype X-1459 (P_3) recorded the highest values for number of pods/plant, seed yield/plant and 100-seed weight. In addition the maternal genotype X-1554 (P_6) recorded the highest values for number of branches and number of seeds per plant.

For testers, the parental genotype Sakha2 (P_7) exhibited the highest values of number of branches per plant and 100- seed weight. Giza 40 (P_8) recorded the highest values of number of pods and seeds per plant. For seed yield/plant the parental genotype Giza 716 (P_9) recorded the highest estimates of seed yield followed by Giza 40 (P_8). With respect to the tested crosses, results indicated

Table (3) : Mean perfor mance of ten faba bean Parents and their F_1's.

Genotype	No. of branchs/plant	No. of pods/plant	No. of Seeds	100 -seed weight	Seed yield/plant
Parents:					
Line					
X-1441 (P_1)	4.32	13.84	31.87	75.04	23.99
X-1451 (P_2)	4.57	14.92	37.52	79.07	29.57
X-1459 (P_3)	4.89	17.63	34.35	112.31	38.58
X-1468 (P_4)	4.17	10.47	27.89	71.32	19.89
X-1548 (P_5)	5.09	13.17	36.02	84.23	30.34
X-1554 (P_6)	5.67	17.07	42.79	88.97	38.39
Tester					
Sakha 2 (P_7)	5.14	7.90	28.28	92.57	26.19
Giza 40 (P_8)	4.34	15.59	40.02	71.53	28.64
Giza 716 (P_9)	4.74	13.68	32.98	89.13	29.39
Misr 1 (P_{10})	3.82	11.29	26.04	73.50	19.12
Crosses					
$P_1 X P_7$	5.12	12.39	33.94	94.37	31.89
$P_2 X P_7$	4.44	14.72	37.89	79.57	30.22
$P_3 X P_7$	4.57	11.44	29.64	84.97	25.17
$P_4 X P_7$	5.57	22.02	65.19	69.03	45.37
$P_5 X P_7$	6.02	20.39	54.44	76.90	41.87
$P_6 X P_7$	5.17	23.45	64.56	79.60	51.26
$P_1 X P_8$	5.24	13.65	39.46	76.40	30.17
$P_2 X P_8$	5.02	20.62	56.82	84.30	47.49
$P_3 X P_8$	4.24	11.97	34.89	81.57	28.49
$P_4 X P_8$	4.54	19.37	52.04	75.80	39.47
$P_5 X P_8$	4.87	19.53	46.29	79.27	36.89
$P_6 X P_8$	4.57	18.17	46.72	81.87	38.22
$P_1 X P_9$	4.67	14.04	40.40	78.83	32.12
$P_2 X P_9$	4.87	24.27	65.72	76.63	50.39
$P_3 X P_9$	4.79	15.92	40.64	90.10	36.67
$P_4 X P_9$	4.39	18.57	57.96	66.93	38.73
$P_5 X P_9$	5.19	17.19	43.67	71.50	31.14
$P_6 X P_9$	4.54	16.02	40.62	86.73	35.24
$P_1 X P_{10}$	5.44	11.22	27.29	92.05	25.12
$P_2 X P_{10}$	6.09	14.43	36.04	92.77	33.49
$P_3 X P_{10}$	6.12	16.92	40.04	100.57	40.55
$P_4 X P_{10}$	5.04	22.12	53.47	73.17	39.19
$P_5 X P_{10}$	4.74	18.39	45.04	92.40	41.62
$P_6 X P_{10}$	4.79	13.67	34.94	93.57	32.82
L.S.D. 0.05	0.58	3.42	8.60	10.92	8.38
L.S.D. 0.01	0.77	4.54	11.41	14.48	11.12

that three (P_5 x P_7, P_2 x P_{10} and P_3 x P_{10}); five (P_4 x P_7, P_6 x P_7, P_2 x P_8, P_2 x P_9 and P_4 x P_{10}) ; six (P_4 x P_7, P_5 x P_7, P_6 x P_7, P_2 x P_8, P_2 x P_9 and P_4 x P_9); three (P_1 x P_7, P_3 x P_{10} and P_6 x P_{10}) and four crosses (P_4 x P_7, P_6 x P_7, P_2 x P_8 and P_2 x P_9) had higher constant estimates for number of branches, pods, seeds per plant, 100- seed weight and seed yield per plant, respectively. It could be concluded that the above mentioned parents and crosses would be interesting and prospective for the future in faba bean breeding for improving seed yield and yield components.

Heterosis values (%):

Estimates of heterosis relative to mid ($\overline{MP}$) and better ($\overline{BP}$) parent are given in Table (4). Results revealed significant positive mid-parent heterosis in eight, thirteen, fourteen, eight and thirteen crosses with a range of 12.56-45.0; 17.01-139.61; 20.70-132.08; 11.91-23.75 and 25.09- 100.87 % for number of branches, pods and seeds per plant, 100-seed weight and seed yield per plant, respectively.

However, heterosis (%) relative to the better parent was significantly positive in eight, eleven, twelve, four and ten crosses with a range of 8.37-29.16; 2.19-110.32; 18.31-130.52; 12.78-21.14 and 21.59-97.03 % for the same previous traits in the same order.

Based on the two estimates of heterotic effects, seven (P_1 x P_7, P_1 x P_8, P_2 x P_8, P_1 x P_{10}, P_2 x P_{10}, P_3 x P_{10}, and P_4 x P_{10}) ; eleven (P_4 x P_7, P_5 x P_7, P_6 x P_7, P_2 x P_8, P_4 x P_8, P_5 x P_8, P_2 x P_9, P_4 x P_9, P_5 x P_9, P_4 x P_{10} and P_5 x P_{10}) ; twelve (P_4 x P_7, P_5 x P_7, P_6 x P_7, P_2 x P_8, P_4 x P_8, P_1 x P_9, P_2 x P_9, P_3 x P_9, P_4 x P_9, P_5 x P_9, P_4 x P_{10} and P_5 x P_{10}) four (P_1 x P_{10}, P_2 x P_{10}, P_3 x P_{10} and P_5 x P_{10}) and ten ((P_4 x P_7, P_5 x P_7, P_6 x P_7, P_2 x P_8, P_4 x P_8, P_5 x P_8, P_2 x P_9, P_4 x P_9, P_4 x P_{10} and P_5 x P_{10}) crosses exhibited significantly positive heterotic effects over both mid and better parent for number of branches, pods and seeds per plant, 100 – seed weight and seed yield per plant, respectively.

It could be suggested that the heterotic effects for seed yield/plant was associated with other components. Different values of heterosis might be due to the genetic diversity of the parents with non-allelic interactions which increase or decrease the expression of heterosis, (Hayman, 1957 and Melchinger *et al.*, 1994) reported that heterosis for a complex trait like yield is simply

Table (4) : Heterotic effects for all studied traits relative to mid ($\overline{MP}$) and better parent ($\overline{BP}$) for 24 faba bean crosses.

Crosses	No. of branches/plant		No. of pods/plant		No. of seeds/plant		100 -seed weight		Seed yield/plant	
	$\overline{MP}$	$\overline{BP}$	$\overline{MP}$	$\overline{BP}$	$\overline{MP}$	$\overline{BP}$	$\overline{MP}$	$\overline{BP}$	$\overline{MP}$	$\overline{BP}$
$P_1 X P_7$	8.25	-0.39	13.98	-10.48	12.83	6.50	12.60**	1.94	27.10*	21.76
$P_2 X P_7$	-0.86	-13.62**	29.01*	-1.34	3.16	0.99	-7.28	-14.04**	8.39	2.20
$P_3 X P_7$	-9.15*	-11.09*	-10.42	-35.11**	-7.38	-13.71	-0.02	-4.57	-21.69*	-34.76**
$P_4 X P_7$	19.53**	8.37*	139.61**	110.32**	132.08**	130.52**	-11.78*	-25.43**	96.92**	73.23**
$P_5 X P_7$	17.58	20.62**	93.45**	54.82**	69.33**	51.14**	-11.86*	-16.93**	48.11**	38.00**
$P_6 X P_7$	-4.44	-8.82*	87.75**	2.19**	81.65**	50.88**	-12.31**	-14.10**	58.75**	33.52**
$P_1 X P_8$	21.02**	20.74**	-7.27	-12.44	9.76	-1.40	4.23	1.82	14.63	5.34
$P_2 X P_8$	12.56*	9.85*	35.12**	32.26**	46.56**	41.98**	11.95*	6.61	63.14**	60.60**
$P_3 X P_8$	-8.23	-13.29*	-27.93**	-32.10**	-6.18	-12.82	1.49	-8.39	-15.23	-26.15**
$P_4 X P_8$	6.57	4.61	48.66**	24.25*	53.24**	30.03**	11.91*	5.97	62.63**	37.81**
$P_5 X P_8$	3.18	-4.32	35.81**	25.27**	131.33**	15.67	-7.32	-3.25	25.09*	21.59*
$P_6 X P_8$	-8.78*	-19.40**	11.27	6.44	12.82	9.18	2.02	-7.98	14.02	-0.44
$P_1 X P_9$	3.09	-1.48	2.03	1.45	24.58*	22.50*	-3.97	-11.56*	20.34	9.56
$P_2 X P_9$	4.51	2.74	69.72**	62.67**	86.44**	75.16**	8.88	-14.02**	70.93**	70.41**
$P_3 X P_9$	-0.62	-63.39**	1.66	-9.70	20.70*	18.31*	1.13	1.09	7.88	-4.95
$P_4 X P_9$	-1.57	-7..38	53.73**	35.75**	90.41**	75.74**	-12.54*	-24.91**	57.18**	31.78**
$P_5 X P_9$	5.49	1.96	27.99**	25.66**	26.58**	21.24*	-16.40**	-19.78**	4.25	2.64
$P_6 X P_9$	-12.86**	-19.93**	4.16	-6.15	7.21	-5.07	-2.61	-2.69	3.98	-8.21
$P_1 X P_{10}$	33.66**	25.93**	10.74	-18.93*	-5.77	-14.37	22.39**	21.14**	11.35	4.71
$P_2 X P_{10}$	45.00**	29.16**	10.07	-3.28	13.40	-3.94	21.60**	17.33**	37.54**	13.26
$P_3 X P_{10}$	40.37**	25.15**	17.01*	4.03	32.58**	16.56	23.75**	12.95*	40.55**	5.11
$P_4 X P_{10}$	26.00**	20.86**	103.31**	95.93**	98.26**	91.72**	6.48	-0.45	100.87**	97.03**
$P_5 X P_{10}$	29.60**	-6.88	50.37**	39.64**	73.04**	25.04**	18.89**	12.78*	68.30**	37.18**
$P_6 X P_{10}$	0.84	-15.52**	-3.60	-19.92**	1.51	-18.35*	15.18**	5.17	14.12	-14.51

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

the consequence of multiplicative relationships at the phenotypic level between its components. Pronounced and favorable heterosis were obtained by several authors for faba bean traits which varied according to the cross combinations and traits (Bond, 1966; Abdalla and Fischbeck, 1983; El–Hosary, 1983 a and b; El-Hady *et al.*, 1997 and 1998; Attia, 1998; Abdalla *et al.*, 1999 & 2001; Attia *et al.*, 2002; Rabie *et al.*, 2003; Abel Mohsen, 2004 and Darwish *et al.*, 2005).

General and specific combining ability effects:

The general combining ability effects ($\hat{g}i$) of females and males for all studied characters are presented in Table (5). Comparison between ($\hat{g}i$) effects associated with each parent, indicated that the genotype X-1451 (P_2) had positive and significant GCA effects for number of branches, pods, seeds and seed yield per plant, meanwhile X-1468 (P_4) had significant positive GCA effects for number of seeds per plant.

Table (5) : General combining ability effects ($\hat{g}i$) for all studied characters.

Genotype	Number of branchs/plant	Number of Pods	Number of seeds	100 seed weight	Seed yield/plant
Lines (P_1)	-0.079	-1.960**	-3.654**	-0.422	-3.655**
(P_2)	0.359**	2.425**	8.498**	-3.106	5.881**
(P_3)	-0.447**	0.156	-0.336	-2.781	-1.048
(P_4)	-0.322**	1.096	5.857**	-4.281*	2.662
(P_5)	0.316**	-2.388**	-8.417**	3.069	-5.567**
(P_6)	0.172	0.671	-1.948	7.519**	1.728
SE ($\hat{g}i$)	0.102	0.605	1.520	1.930	1.481
Testers (P_7)	0.224	-1.618*	-4.091**	1.549	-2.472
(P_8)	-0.234*	2.886**	7.061**	-3.822	4.146**
(P_9)	-0.059	-2.077**	-7.259**	3.267	-4.212**
(P_{10})	0.070	0.809	4.290**	-0.994	2.537*
SE ($\hat{g}i$)	0.084	0.494	1.241	1.576	1.209

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

Moreover, x–1548 (P_5) exhibited significantly positive GCA effects for number of branches per plant, x–1554 (P_6) showed significant positive GCA effects for 100-seed weight. For testers, the results suggested that Giza40 (P_8) was a good combiner for number of pods, seeds and seed yield per plant. Also, Giza 716 (P_9)

was a good combiner of 100-seed weight. The Misrl (P_{10}) had positive and significant GCA effects for number of seeds and seed yield per plant.

The specific combining ability effects ($s\hat{i}J$) for different crosses are presented in Table (6). The results indicated that five, (P_4 x P_7, P_5 x P_7, P_2 x P_9, P_2 x P_{10} and P_3 x P_{10}), six (P_4 x P_7, P_5 x P_7, P_5 x P_8, P_2 x P_9, P_5 x P_9 and P_5 x P_{10}) ; five (P_4 x P_7, P_5 x P_8, P2 x P_9, P_5 x P_9 and P_5 x P_{10}); four (P_1 x P_7, P_3 x P_9, P_2 x P_{10} and P_3 x P_{10}) and three (P_4 x P_7, P_2 x P_9 and P_5 x P_{10}) crosses revealed constant significant positive SCA effects for number of branches, pods, seeds per plant, 100-seed weight and seed yield per plant, respectively.

Table (6): Specific combining ability effects ($s\hat{i}j$) for all studied characters in F1`s crosses

Crosses	No. of branchs/ plant	No. of pods/ plant	No. of seeds/ plant	100 -seed weight	Seed yield/plant
P_1 X P_7	-0.03	-1.131	-3.634	10.833**	1.205
P_2 X P_7	-0.246	-3.312**	-10.836**	1.406	-7.090**
P_3 X P_7	-0.297	-1.622	-4.766	-0.283	-3.783
P_4 X P_7	0.574**	6.066**	19.235**	-11.956**	9.668**
P_5 X P_7	0.432*	2.484*	4.714	-3.949	1.642
P_6 X P_7	0.0399	1.036	3.679	4.122	4.417
P_1 X P_8	-0.058	-3.801**	-7.101**	-6.167	-8.318**
P_2 X P_8	-0.414*	0.281	-1.293	5.994	2.259
P_3 X P_8	-0.535**	-3.674**	-6.002*	0.392	-4.802
P_4 X P_8	0.223	-0.778	-0.003	-0.0027	-0.447
P_5 X P_8	0.371*	4.352**	8.566**	-3.625	5.337*
P_6 X P_8	-0.058	0.099	-2.560	3.236	-0.088
P_1 X P_9	-0.237	-2.537*	-6.691**	-0.842	-4.888
P_2 X P_9	0.421*	3.182**	7.477**	2.331	6.770**
P_3 X P_9	0.173	-0.205	-3.276	8.708**	1.401
P_4 X P_9	-0.356*	-0.440	2.491	-10.197**	-3.282
P_5 X P_9	-0.349*	4.096**	10.853**	-15.525**	2.366
P_6 X P_9	-0.541**	-1.585	-3.349	5.081	-0.152
P_1 X P_{10}	0.184	-1.421	-2.352	2.158	-1.921
P_2 X P_{10}	0.705**	-1.090	-5.152	8.286*	-0.293
P_3 X P_{10}	0.719**	0.761	0.760	9.092**	4.478
P_4 X P_{10}	0.103	1.457	3.032	-12.936**	-3.497
P_5 X P_{10}	-0.372*	2.697**	8.929**	-0.792	7.284**
P_6 X P_{10}	-0.451**	-4.915**	-12.721**	4.636	-8.265**
SE ($s\hat{i}j$)	0.205	1.209	3.041	3.859	2.962

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

From the breeding point of view, parents characterized by good general combining ability for yield and its components along with heterosis and high estimates of SCA effects are obviously essential. A great deal of interest has been given to select crosses that contain both good gêneral combining parents and crosses involving one good and one poor combining parent with SCA effects as well as high heterosis. This conclusion is in agreement with those obtained by Mahmoud and Al-Ayoubi (1986 b); El-Hady (1988); El-Hady *et al.* (1991 a and b); El–Hady *et al.* (1997 and 1998) Attia (1998) and Attia *et al.* (2002).

Variance components of both lines and testers as indicators for GCA and lines x testers as indicators for SCA revealed that SCA variance appeared to be more important than GCA variance in all characters (Table 7). Hence, additive as well as non-additive gene action might be controlling the inheritance of various studied characters. Similar results were obtained by El-Hosary, 1983 a; El-Hosary, 1985; Mahmoud and Al-Ayoubi, 1986 (b); El-Hady, 1988; El-Hady *et al.*, 1991 a, b; El-Lithy, 1996; El-Hady *et al.*, 1997, 1998; Attia, 1998 and Attia *et al.*, 2002.

Table (7) : Estimates of general (σ^2GCA) and specific (σ^2SCA) combining ability variances for all studied characters.

Parameters	Number of branchs /plant	Number of pods	Number of seeds	100 - Seed weight	Seed yield/plant
σ^2GCA (Cov. H. S. line)	0.0549	0.421	17.973	0.516	8.799
σ^2GCA (Cov. H. S. tester)	-0.0014	3.306	31.930	-3.680	9.678
σ^2GCA (Cov. H. S. average)	0.0035	0.223	3.073	-0.184	1.152
σ^2SCA (Cov. F. S.)	0.2548	17.159	154.873	58.283	56.382

This may give evidence that dominance genetic variance was more important for all characters and indicated an excess of dominant genes in the parents for these traits . Generally, for most traits, the results suggested the important role of both testers and lines in the expression of SCA and heterosis in certain crosses.

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قوة الهجين والقدرة على الائتلاف لبعض التراكيب الوراثية في الفول البلدى

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** المعمل المركزى لبحوث التصميم والتحليل الاحصائى – مركز البحوث الزراعية

اجريت هذة الدراسة بمزرعة محطة البحوث الزراعية بالجيزة خلال المواسم ٢٠٠٢ / ٢٠٠٣ و ٢٠٠٣ / ٢٠٠٤ و ٢٠٠٤/٢٠٠٥ وقد اشتملت الدراسة على ستة تراكيب وراثية من الفول البلدى (امهات) وأربعة آباء اختبارية (كشافات) مختلفة فى القدرة المحصولية وبعض الصفات الاخرى .

تم تقييم سلوك الاباء وهجنها القمية فى الجيل الاول بالاضافة لتقدير تأثيرات قوة الهجين على اساس متوسط الابوين والاب الاعلى وكذلك تقدير القدرة العامة والخاصة على الائتلاف وبعض المقاييس الاحصائية الاخرى وقد اجريت التهجينات بين التراكيب الوراثية المستخدمة خلال موسمى ٢٠٠٢/٢٠٠٣ ، ٢٠٠٣/٢٠٠٤ . فى الموسم الزراعى ٢٠٠٤/٢٠٠٥ اقيمت تجربة اشتملت على ١٠ سلالات ابوية وكذلك ٢٤ هجين فى تصميم قطاعات كاملة العشوائية فى ثلاثة مكررات. وقد أظهرت النتائج تفوق بعض الهجن معنويا مقارنة بمتوسط الأبوين والأب الأعلى وذلك بالنسبة لصفات المحصول ومكوناته مما يوضح أهمية العوامل ذات السيادة الجزئية والفائقة فى وراثة الصفات تحت الدارسة. وأظهرت التراكيب الوراثية X-1451 (P_2) ، جيزة ٤٠ (P_8) قدرة عامة مرغوبة على الأئتلاف لصفات عدد فروع ، قرون ، بذور وكذلك محصول النبات فى حين أظهر الهجينان (X-1468 X Sakha 2) (P_4 x P_7) ،(جيزة ٧١٦ × X-1451) (P_2 x P_9) و قدرة خاصة على الأئتلاف لنفس الصفات السابقة فى الإتجاة المرغوب . وكان تأثير تباين السيادة أكبر من تأثير تباين العوامل ذات الأثر المضيف كما كان هناك دورا مهما لكل من الأمهات والأباء الإختباريه فى بعض الهجن لاظهار القدرة الخاصة على الأئتلاف وقوة الهجين .