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RELATIVE IMPORTANCE OF GENETIC VARIANCE FOR IMPROVING BROAD BEAN (*Vicia faba* L.)

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ABSTRACT

The female broad bean parents: Nubaria-1, Mansoura-1, Kassasin-1, Kassasi-7, Kobrosy, and Aquadulce, were crossed by the male parents Giza-643, Giza-716, and Giza-717. Eighteen F] crosses in top crosses scheme (6 x3) were produced during 2004/05 season. In 2005/06 season, nine parents and 18 F_1 hybrids were evaluated to explore the combining ability, heterosis, potence ratio, correlation coefficient and average degree of dominance for some traits of broad bean.

Significant differences were found between either parents or F_1 crosses for all traits. Both additive and non-additive gene actions were important for controlling most of studied traits, Significant to highly significant mean squares of heterosis, females, males, and female x male were recorded for most traits. For plant height, number of branches, flowering date, pod length and diameter, the estimated additive genetic variance were higher (more than one), suggesting that the total genetic variability were a result of additive and additive x additive types of gene action. Significant progress could be achieved in the segregating generations through selection. Average degree of dominance (ADD) was more than one for number of pods and seeds per pod, pod weight and total green pod yield, suggesting dominance or over-dominance. Therefore, recurrent selection could be useful for upgrading these characters. Both of the additive and dominance were responsible for the inheritance of seed index.

The genotypes Aquadulce, Mansoura-1 and Nubaria-1 showed highly significant desirable GCA effects in 7, 6 and 5 traits, respectively, suggesting good combiners as parents. Also, one, four, two, and three crosses exhibited significant specific combining ability effects for branches per plant, number of seeds per pod, pod length and seed index, respectively.

Significant positive or negative heterotic effects to MP or HP-parents were detected for all studied traits. Estimates of heterosis relative to the better parent showed over- dominance in 3 crosses for pods number per plant, in 2 crosses for seeds number per pod, in 17 crosses for pod weight, in 11 crosses for pod diameter and in 4 crosses for total green pod yield. Some crosses out-yielded the check variety.

Key words: ***Heterosis, Combining ability, Dominance, Broad bean, Vicia faba.***

INTRODUCTION

Green-seeds and young pods of broad bean are eaten as a vegetable. Seeds have a high protein content ranged from 21.61 to 32.11 %(Farag *et al* 2005).The success in developing improved varieties through breeding programs depends on the existence of genetic variation that allows efficient selection. Significant varietal differences among *Vicia faba* genotypes regarding plant growth, yield and yield components were observed by many investigators Khare and Singh (1991), Mulat (1998),Farag and Helal (2004) and Farag *et al* (2005). Information on heterosis and combining ability helps the breeders to choice of suitable parents. Generally, combining ability analysis is associated with additive effects of genes, while SCA is attributed primarily to non-additive (dominance and epistasis) ones. Therefore, the breeder should evaluate the potentialities of the available germplasm for new recombination's and eventually combining ability which have proved to be of considerable use in breeding methods. In this regard, several studies on faba bean reported that both additive and non-additive gene action are important (El-Hady *et al* 1998, Bakheit 1992, El-Shazly *et al* 1995, Farag and Helal 2004 and Attia *et al* 2006). El-Hosary *et al* (1986), El-Tabbakh and Ibrahim(2000) and Farag and Darwish (2005) found that additive gene action was the dominant component for most traits of faba bean. Salama and Mohamed (2004) found that the non-additive genetic components were more important in some traits.

Expression of heterotic effects ranged from significantly positive to significantly negative values (Abo-Zeid 1999, El-Tabbakh and Ibrahim 2000, Salama and Mohamed 2004 and Attia *et al* 2006).

Improvement of a complex character like yield may be proper indirectly through other yield components, which showed strong association with yield and having simpler inheritance than yield itself (Grafius 1984). Bakheit and Mahady (1988) found high positive direct effect between pods/plant and seed yield in the 21 genotypes. They added that seed weight and seeds/pod were the other traits with a major direct positive effect on yield. Mulat (1998) found that most agro-morphological characters except 1000-seed weight showed positive and significant correlation with seed yield. Also, Farag *et al* (2005) based on the correlation coefficient, concluded that number of seeds per pod, pod weight, length, 100-green seed weight, appeared to yield attributes for which selection can be effective.

This investigation aimed to determine general and specific combining ability effects of 6 and 3 *Vicia faba* genotypes as females and males parents, respectively.

MATERIALS AND METHODS

Eighteen F_1 broad bean hybrids resulted from crossing 6 genotypes as lines (females) with 3 ones as testers (males). The 6 female parents were: Nubaria-1, Mansoura-1, Kassasin-1, Kassasi-7, Kobrosy, and Aquadulce. The testers parents were: Giza-643, Giza-716 and Giza-717(Table 1). In the winter season of 2004/05, the 18 F_1 crosses were developed following line X tester method at the Experimental Farm of El-Gemmeza Agriculture Research Station, Gharbia Governorate. In 2005/06 season, the18 F_1 crosses were evaluated in field together with 9 parents in a randomized complete block design with three replicates. The experimental plot consisted of 4.5 m and 65 cm apart. The seeds were sown in one side of the ridge in double seed per hills spaced at 30 centimeter. Recommended agronomic practices

Table 1. Name and origin of the parental cultivars.

Code number	Cultivar	Origin
A	Nubaria-1	Egypt
B	Mansoura-1	Egypt
C	Kassasin-1	Egypt
D	Kassasin-7	Egypt
E	Kobrosy	Spain
F	Aquadulce	Spain
G	Giza 643	Egypt
H	Giza 716	Egypt
K	Giza 717	Egypt

were carried out as usual for the ordinary broad bean fields in the area. The cultivar Aquadulce, which is widely grown, was used as check.

The following characters were recorded: plant height, number of branches per plant(measured at the end of the growing season), days to flowering 50%of plants, number of seeds per pod, number of pods per plant, pod weight, pod length, pod diameter, seed index (100 green-seeds weight) and total green pod yield per plant.

Statistical analysis was performed according to Snedecor and Cochran (1982). Mean values representing the various investigated genotypes were compared by the Duncan multiple range test (Duncan 1955). The analyses of general(GCA) and specific(SCA) combining abilities were computed using the line x tester procedure suggested by Kempthorne (1957).Average degree of dominance (ADD) was worked out as $(\sigma^2D / \sigma^2A)^{½}$ given by Comstock and Robinson (1952). Average degree of heterosis was expressed as the percentage increase or decrease of the F_1 performance from the mid (MP) and high (HP) parent values. Simple correlation coefficients were calculated according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Performance of the F_1 crosses and their parents

Data in Table (2) showed the mean values of the parents and their F_1 crosses for all studied characters. Significant differences were found between either parents or F_1 crosses for all traits. These differences may be mainly due to the genetic diversity of the parents. Regard to plant height, and branches per plant, the tallest plants and highest branches were recorded by the F_1 crosses "D x H" (123.7 cm), and" E x K" (9.1 branch/ plant), respectively. The cross "D x K" and the cultivar Giza-716 surpassed all other genotypes in number of seeds per pod, and number of pods per plant recording 5.30 seeds per pod and 29.0 pods per plant, respectively. Concerning average pod weight, length, and diameter, the crosses "A x H","

Table 2. Mean performances of the studied broad bean genotypes for yield components and some pod characteristics.

Character / Genotype	Plant height (cm)	Branch number	Days to flowering	Pod number/plant	Seed number / pod	Pod weight (g)	Pod length (Cm)	Pod diameter (mm)	Seed index (g)	Total green pod yield/plant(g)
A	110.3 ij	5.75	52.7 cd	25.8 c	4.24 ef	18.8	17.0 ı	17.3 ;	204.2	481.7 g
B	103.8	7.00	45.0 i	21.9 jk	4.50 d	17.2	16.6	17.3 ;	197.1	377.7 m
C	111.0	7.27	38.7 o	22.0 jk	4.80 c	15.1 m	15.0 ;	14.2	179.7	335.7 o
D	117.0	6.50	39.7 n	21.5 k	4.00 h	15.4 l	10.7 ı	12.6 ı	183.7 h	333.3 o
E	101.3	6.75	42.0 m	16.8	3.67 k	16.0	15.0 ;	13.0	192.0	267.7 q
F	113.2	6.83 ‹	52.6 cd	21.6 i	4.90 b	18.5	16.8 ɔc	19.5	215.7	416.7 kl
G	107.6	6.05 ı	53.7 b	23.5 fg	4.03 h	12.0	12.9	12.0	164.7	285.0 p
H	104.4	6.77	56.1 a	29.0 a	3.92 ij	11.1	12.5 n	11.3	153.0 ı	328.0 o
K	110.5 ij	7.62	50.0 f	25.7 c	3.87 j	11.2	11.8 ı	12.4 ı	144.7	287.3 p
A x G	109.7	7.90	51.0 e	19.2 l	4.77 c	27.2	15.3	17.1	183.3 h	521.7 d
A x H	114.0 ;	8.50	52.0 d	18.4 m	4.23 ef	28.3	16.0 l	17.4	180.7 i	517.7 d
A x K	117.3	8.50	50.0 f	24.0 ef	4.15 g	21.8 ef	18.5 ı	17.5 f	191.7	525.0 d
B x G	105.5 ı	9.17	44.0 j	17.8 n	4.00 h	23.3 d	16.0 l	18.3 c	184.8	415.3 l
B x H	108.7	8.83	43.0 kl	17.9 mn	4.20 fg	24.7 c	16.0 l	17.4	175.7	443.0 ij
B x K	108.3 l	8.83	45.0 i	23.2 gh	4.20 fg	21.8 ef	15.7	18.2	196.0	510.0 de
C x G	114.7 f	7.83	46.3 gh	25.1 d	3.70 k	14.5 m	14.3 ı	18.5	174.0	362.3 n
C x H	119.3	8.00 ;	47.0 g	27.3 b	3.93 ij	17.8 j	14.2 ı	17.5 f	196.0	484.7 fg
C x K	110.0	8.50	43.7 jk	18.4 m	3.50 l	26.7 b	13.5 k	17.7 e	185.0	497.7 ef
D x G	115.3	7.97 ;	45.3 i	25.4 cd	3.87 j	22.4 e	13.8	15.4	183.3 h	548.0 c
D x H	123.7	8.17 f	45.7 hi	22.8 hi	3.88 j	21.3 fg	13.5 k	14.7	157.3	489.0 fg
D x K	117.7	8.25 e	43.0 kl	19.3 l	5.30 a	23.5 d	13.7 j	14.5	167.3	449.7 i
E x G	117.0	8.50	42.3 lm	17.7 n	3.10 m	18.5 i	13.5 k	14.8	182.0 hi	325.7 o
E x H	120.7	8.42 d	46.3 gh	24.3 e	3.65 k	18.9 i	13.4 ;	14.5	183.0 h	464.7 h
E x K	117.7	9.10	44.0 j	21.5 k	3.10 m	19.9 h	12.5 ı	14.5	182.0 hi	431.0 jk
F x G	110.7 i	8.17 f	52.0 d	25.0 d	4.27 e	25.0 c	15.0 ;	18.3 c	188.7	624.3 a
F x H	120.0 c	8.33 de	53.0 bc	23.5 fg	4.80 c	24.7 c	16.2 l	18.4 c	200.3	585.0 b
F x K	113.3	9.00 b	51.0 e	22.3 ij	3.97 hi	20.9 g	16.0)	17.8	215.3	467.0 h
Mean	112.69	7.87	47.23	22.26	4.09	19.87	14.64	16.00	183.74	436.11

* Mean within a column followed by different letters is significantly different at 0.05level.

(A) = Nubaria-1 ,(B) = Mansoura-1 ; (C) = Kassasin-1 ; (D) = Kassasin-7; (E) =Kobrosy ; (F) =Aquadulce ; (G) = Giza-643 ; (H) = Giza-716 and (K) = Giza-717.

A x K" and the parent Aquadulce, gave the highest values (28.3 g, 18.5 cm and 19.5 mm, respectively). Whereas for seed index (100 green-seeds weight), and total green pod yield, the heaviest seeds were recorded by Aquadulce and the cross "F x G", respectively, since they were significantly superior in this respect. Conversely, Kobrosy gave the shortest plant as 101.3 cm, fewer number of pods per plant as 16.8 and lowest total green pod yield as 267.7 g/plant (Table 2). With regard to number of branches per plant, Nubaria-1 gave the lowest number of branches per plant (5.75).The cross "E x K" gave the lowest number of seeds per pod (3.10). The parent Giza-716 gave the lightest pod weight (11.1 g), and narrow pod width (11.3 mm), while, the shortest pod length (10.7 cm) was given by Kassasein-7. Finally, relating to seed index, the parent Giza-717 gave the lowest values as 144.7. These results are in agreement with those of Khare and Singh (1991), Mulat (1998) Farag and Helal(2004), Farag and Darwish (2005) and Farag *et al* (2005) found significant varietal differences among *Vicia faba* genotypes.

Combining Ability

Highly significant mean squares were found due to entries, parents, crosses, heterosis(P vs C) , females, males, and female x male for all traits except pod length(testers),branches and pod diameter(line X tester) (Table 3). Also, mean squares of the male parents were significant to high significant for all traits except pod weight and length. Highly significant mean squares of female x male parent's interaction were obtained for all traits except pod diameter. The observed highly significant differences for both general and specific combining abilities indicated that both additive and non-additive gene effects were involved in the genetic control. These results agree with those obtained by El-Shazly *et al* (1995), Farag and Helal(2004), Farag and Darwish (2005) and Attia *et al* (2006).

Variance of general (GCA) and specific (SCA) combining abilities and estimates genetic components for studied traits are shown in Table (3). Significant to highly significant variances of GCA were detected for all traits except for branches number per plant .While; SCA variances were significant for all traits except number of branches per plant, days to flowering and pod diameter.

Estimated values of additive (σ^2 A) to non-additive (σ^2 D) genetic components of variance as an indication of the relative importance of both types of gene actions were 2.4,4.5,2.6 and 45.6 (more than unity) for plant height, branch number/plant, pod length and diameter respectively, suggesting the predominance of additive types of gene action controlling these traits. The remaining traits recorded lower σ^2 A / σ^2 D ratios than unity, except seed index (equal one).Similar results were obtained by Farag and Helal (2004).Due to the predominance of additive gene effect,

Table 3. Variances of combining ability analysis, genetic components of variance and average degree of dominance (ADD) for broad bean plant and pod characteristics.

S.O.V.	df	Plant height	Branch number /plant	Days to flowering	Pod number / plant	Seed number/ pod	Pod weight	Pod length	Pod diameter	Seed index	Total green pod yield
Entries	26	95.28**	2.68**	65.79**	31.39**	0.80**	69.54**	9.73**	16.63**	847.34**	27466.46**
Parents(P)	8	74.10**	0.99**	129.81**	35.99**	0.55**	26.59**	16.78**	25.43**	1686.18**	14359.50**
Crosses(C)	17	74.71**	0.51**	38.69**	29.40**	0.93**	38.14**	6.64**	7.31**	491.73**	15862.95**
Heterosis (P vs.C)	1	614.45**	53.02**	14.34**	28.29**	0.59**	947.00**	5.79**	104.63**	181.98**	329581.78**
Lines (L)	5	152.02**	0.97**	116.83**	24.62**	1.79**	57.05**	17.98**	23.80**	941.49**	27090.29**
Testers (T)	2	144.88**	0.94**	13.46**	4.00*	0.13**	3.22*	0.47	1.00**	305.85**	4373.35**
Line x tester (LXT)	10	22.02**	0.19	4.66*	36.88**	0.65**	35.66**	2.20**	0.33	304.03**	12547.20**
Error	52	2.41	0.13	2.10	0.86	0.01	1.28	0.15	0.17	29.26	599.62
σ2GCA	8	7.873**	0.050	5.892**	0.882**	0.084*	2.530**	0.887*	1.201*	45.36**	1254.078**
σ2SCA	17	6.536**	0.022	0.856	12.006**	0.214**	11.463**	0.684*	0.053	91.59**	3982.524**
σ2A		15.747	0.099	11.784	1.765	0.168	5.061	1.774	2.403	90.72	2508.157
σ2D		6.536	0.022	0.856	12.006	0.214	11.463	0.684	0.053	91.59	3982.524
(σ2 A /σ2D)		2.409	4.526	13.775	0.147	0.786	0.441	2.594	45.624	0.99	0.630
ADD		0.644	0.470	0.269	2.608	1.595	1.505	0.621	0.148	1.00	1.260

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

significant progress could be achieved in the segregating generation through pedigree and bulk selection method.

Average of dominance (ADD) was found to be more than one for pod weight ,seed number per pod, pod number per plant and total green pod yield(1.505,1.595,2.608 and 1.255,respectively) (Table 3).High average degree of dominance revealed the predominance of non-additive type of gene effects for these traits. Therefore, recurrent selection or building heterozygous/heterogeneous varieties could be useful for improving the performance of these characters. The remaining traits showed ADD values less than one, except seed index with value equal one. These results comply with the estimated additive gene actions (Table 3).

Concerning general combining ability (GCA) effects of parental genotypes, significant effects were detected for most traits (Table 4). The parents Kassasein-7 and Mansoura-1 can be considered as good combiners and may be used through cross breeding programs for increasing plant height, branch number and early flowering, since they showed the highest positive significant GCA effects for these traits. Only one parent (Nubaria-1) showed positive significant GCA effects for seeds number per plant and pod weight and it can be considered as good donor for improving these traits.

Concerning general combining ability (GCA) effects for pods number per plant ,seed index and total green pod yield, the parent Aquadulce showed the highest significant positive GCA effects as 1.765,16.657 and 77.574,respectively. The genotypes Mansoura-1, Kassasein-7 and Kobrosy showed significantly negative GCA effects (-2.20,-15.45 and -74.09, respectively) for the same tra s. For the previous results the parent Aquadulce may be considered the best genotype for pods number per plant, seed index, and total green pod yield and could be used as donors for these traits

Generally, the parents Aquadulce, Mansoura-1 and Nubaria-1 showed highly significant desirable GCA effects in 7, 6 and 5 traits, respectively (Table 4). Therefore, these parental cultivars could be considered as good combiners and could be used as donors for improving to these traits

Estimates of specific combining ability effects (SCA) for plant height, pod weight, number of pods per plant and total green pod yield showed that the highest positive significant values(4.250, 6.861, 3.974, and 80.537,respectively) were given by the F_1 combinations “A x K”, “C x K”, “B x K “and “F x G”, respectively(Table 5). Conversely, the crosses, which showed negative or low positive SCA effects, were the poorest in these traits. Also, one, four, two, and three crosses exhibited significant specific combining ability effects for number of branches per plant, seeds number per pod, pod length and seed index, respectively. Generally, each of the

Table 4. General combining ability (GCA) effects for yield and yield components of the studied broad bean characters.

CO. No.	Character cultivar	Plant height	Branch number /plant	Days to flowering	Pod number / plant	Seed number /pod	Pod weight	Pod length	Pod diameter	Seed index	Total green pod yield
Parents:	**(1) Female**										
A	Nubaria-1	-0.97	-0.143	4.074**	-1.313**	0.349 **	3.489**	1.758 **	0.537**	0.417	40.241**
B	Mansoura-1	-7.139 **	0.502 **	-2.926**	-2.202**	0.099 **	0.978*	1.058 **	1.138**	0.694	-25.093**
C	Kassasin-1	0.028	-0.331 **	-1.259*	1.765**	-0.323 **	-2.633**	-0.831 **	1.089**	0.194	-32.981**
D	Kassasin-7	4.250 **	-0.315 **	-2.259**	0.654*	0.315 **	0.111	-1.164 **	-1.922**	-15.472**	14.352
E	Kobrosy	3.806 **	0.230	-2.704**	-0.669*	-0.750 **	-3.178**	-1.714 **	-2.211**	-2.472	-74.093**
F	Aquadulce	0.028	0.057	5.074**	1.765**	0.310 **	1.233**	0.892 **	1.367**	16.639**	77.574**
L.S.D.	0.05	1.035	0.236	0.965	0.619	0.073	0.753	0.256	0.279	3.607	16.327
	0.01	1.337	0.314	1.284	0.823	0.098	1.002	*0.341*	0370.	4.797	21.714
(2) Male (Tester)											
G	Giza 643	-2.500 **	-0.187 *	-0.093	-0.141	-0.084 **	-0.478	-0.175	0.269**	-2.111	-14.981*
H	Giza 716	3.083 **	-0.068	0.907*	0.526*	0.082 **	0.328	0.033	-0.164	-2.639	16.130**
K	Giza 717	-0.583	0.255 **	-0.815*	-0.385	0.002	0.150	0.142	-0.105	4.750**	-1.148
L.S.D.	0.05	0.732	0.167	0.683	0.438	0.052	0.532	0.181	0.197	2.550	11.545
	0.01	0.973	0.222	0.908	0.582	0.069	0.708	0.241	0.262	3.392	15.354

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

Table 5. Estimates of specific combining ability(SCA) effects of the different crosses for the studied characters .

Character / Cross		Plant height	Branch number /plant	Days to flowering	Pod number /plant	Seed number/ pod	Pod weight	Pod length	Pod diameter	Seed index	Total green pod yield
A x G		-1.500	-0.213	0.093	-1.193*	0.468**	1.867**	-1.147**	-0.484*	0.222	15.204
A x H		-2.750**	0.268	0.093	-2.693**	-0.232**	2.228**	-0.622**	0.193	-1.917	-19.907
A x K		4.250**	-0.055	-0.185	3.885**	-0.235**	-4.094**	1.769**	0.291	1.694	4.704
B x G		0.500	0.409*	0.093	-1.737**	-0.049	0.511	0.286	0.062	1.444	-25.796
B x H		-1.917*	-0.044	-1.907*	-2.237**	-0.016	1.072	0.078	-0.384	-7.194*	-29.241*
B x K		1.417	-0.366	1.815*	3.974**	0.065	-1.583*	-0.364	0.323	5.750	55.037**
C x G		2.500**	-0.091	0.759	1.630**	0.073	-4.678**	0.508*	0.331	-8.889**	-70.907**
C x H		1.583	-0.044	0.426	3.163**	0.140	-2.183**	0.133	-0.236	13.639**	20.315
C x K		-4.083**	0.134	-1.185	-4.793**	-0.213**	6.861**	-0.642**	-0.095	-4.750	50.593**
D x G		-1.056	0.026	0.759	3.074**	-0.398**	0.478	0.342	0.242	16.111**	67.426**
D x H		1.694	0.106	0.093	-0.259	-0.551**	-1.428*	-0.200	0.009	-9.361**	-22.685
D x K		-0.639	-0.132	-0.852	-2.815**	0.949**	0.950	-0.142	-0.251	-6.750*	-44.741**
Ex G		1.056	0.015	-1.796*	-3.337**	-0.100	-0.133	0.558	-0.036	1.778	-66.463**
E x H		-0.861	-0.188	1.204	2.630**	0.286**	-0.506	0.200	0.064	3.306	41.426**
E x K		-0.194	0.173	0.593	0.707	-0.186*	0.639	-0.758**	-0.028	-5.083	25.037
Fx G		-1.500	-0.146	0.093	1.563**	0.006	1.956**	-0.547*	-0.114	-10.667**	80.537**
F x H		2.250*	-0.099	0.093	-0.604	0.373**	0.817	0.411	0.353	1.528	10.093
F x K		-0.750	0.245	-0.185	-0.959	-0.380**	-2.772**	0.136	-0.239	9.139**	-90.630**
L.S.D.	0.05	1.793	0.409	1.672	1.072	0.127	1.304	0.444	0.482	6.247	28.280
	0.01	2.385	0.544	2.224	1.426	0.169	1.735	0.590	0.642	8.309	37.611

*,** Significant at 0.05 and 0.01 levels of probability, respectively.
A) = Nubaria-1 , B)= Mansoura-1 ; C) =Kassasin-1 ; D) = Kassasin-7; E) =Kobrosy ; F) =Aquadulce ; G) =Giza 643 ; H) = Giza 716 and K)= Giza 717.

crosses "A x K","C x G" ,"D x G", "E x H" and" F x G" showed positive significant SCA effects in different three traits , therefore, they could be considered the best combinations.

Heterosis and potence ratio

Estimates of heterosis (H %) and potence ratio are presented in Table (6). The average degree of heterosis was only estimated for the crosses that parents differed significantly for the trait.

Estimates of heterosis relative to the better parent showed over-dominance in 8 crosses for plant height, in 15 crosses for number of branches per plant, 2 crosses for flowering date, 3 ones for number of pods per plant, 2 crosses for number of seeds per pod, 17 crosses for pod weight, 4 crosses for pod length, 11 crosses for pod diameter, one cross for seed index and 4 crosses for total green pod yield. The degree of dominance as determined by estimated potence ratio is shown in Table (6). Obtained high potence ratios more than one (P>1) were in accordance with over-dominance hypothesis. Also, all types of dominance; i.e., complete, partial and over-dominance were obtained for all studied traits. The estimated ratios were in accordance with the estimated heterosis % for the studied traits. These results are in agreement with those of El-Hosary and Nawar (1984), Habetinek (1985), Mahmoud and Al-Ayobi (1987), El-Tabbakh and Ibrahim (2000) and Farag and Helal (2004).

Finally, the crosses "D x G", "F x K" ," A x H" ," D x K" and" C x H" gave the highest HP-heterosis values as 64.40, -0.16, 50.95, 32.50 and -0.06% for total green pod yield, seed index , pod weight, seeds number per plant and pods number per plant, respectively. While, in relation to the check cv. they gave significant heterosis values as 31.52, -0.15, 53.15, 8.16 and26.39%, for these traits, respectively.

Correlation Coefficients

Estimated correlation coefficients between some pairs of growth characteristics and yield components are illustrated in Table (7).Significant correlation values were found between some traits. Total green-pod yield showed correlation values with high weight of 100- seed (Katiyar and Singh 1990 and Farag *et al* 2005),large pod weight(Mulat 1998 and Farag *et al* 2005), high number of branches per plant, taller plant, long pod (Farag et al 2005) high number of pods(Bakheit and Mahady 1988) and wide pod. Pod weight was associated with long pod, low number of pods, high weight of 100-green seeds, large number of branches and wide pod diameter. Seed index was associated with large pod weight, long pod and wide or broad pod. High seed number per pod was associated with long pod. Large number of pods was associated with high number of branches. Finally, long pod was associated with broad pod diameter. Based on the correlation coefficient, number of seeds per pod, pod weight, pod length and diameter and 100-seed

Table 6. Degree of heterosis (H%) based on mid-parents (MP) and better- parent (HP) ,as well as, potence ratio(P.R.)of crosses for plant and pod characteristics

Character / Cross	Plant height			number of branches/ plant			Days to flowering			Pod number/ plant			Seed number / pod		
	H%		P.R	H%		P.R	H%		P.R	H%		P.R	H%		PR
	MP	HP		MP	HP		MP	HP		MP	HP		MP	HP	
A x G				33.90**	30.58**	13.33	-4.08**	-3.17*	4.34		-25.58**		15.28**	12.42**	6.02
A x H	6.18**	3.33*	2.24	35.78**	25.55**	4.39	-4.41**	-1.27	1.39		-36.67**		3.76**	-0.16	0.96
A x K				27.15**	11.55**	1.94	-2.60**	0.00	1.00				2.34**	-2.12*	0.51
B x G		-1.95		40.49**	30.95**	5.56	-10.81**	-2.22	1.23		-24.49**			-11.11**	
B x H				28.30**	26.19**	16.94	-14.96**	-4.44**	1.36		-38.16**			-6.67**	
B x K		-1.96		20.84**	15.92**	4.91	-5.26**	0.00	1.00		-9.70**		0.36**	-6.67**	0.05
C x G	4.91**	3.30*	3.16	9.40**	-5.28**	0.61	0.35			10.18**	6.67**	3.09	-16.19**	-22.92**	-1.86
C x H	10.80**	7.51**	3.53	20.12**	10.04**	2.20	-0.84			7.00**	-5.86**	0.51	-9.79**	-18.06**	-0.97
C x K				21.08**	16.92**	5.92	-1.51				-28.36**		-19.26**	-27.08**	-1.80
D x G	2.70*	-1.42	0.65	26.96**	22.56**	7.52	-2.86**	14.28**	0.19	12.96**	8.09**	2.88			
D x H	11.71**	5.70**	2.06	23.08**	20.63**	11.35	-4.66**	15.12**	0.27		-21.49**			-3.00**	
D x K	3.44**	0.57	1.21	16.86**	8.27**	2.13	-4.09**	8.39**	0.36		-24.99**		34.69**	32.50**	21.00
E x G	12.02**	8.74**	3.98	32.81**	25.93**	6.00	-11.50**	0.79	0.94		-24.78**			-23.08**	
E x H	17.32**	15.58**	11.49				-5.57**	10.32**	0.39	6.19**	-16.09**	0.23		-6.80**	
E x K	11.11**	6.49**	2.56	26.65**	19.42**	4.40	-4.35**	4.76**	0.50		-16.44**			-19.90**	
F x G		-2.21		26.81**	19.57**	4.43	-2.11*	-1.08		10.94**	6.39**	2.56		-12.93**	
F x H	10.31**	6.04**	2.56				-2.48*	0.82	0.76		-18.85**		8.84**	-2.04**	0.80
F x K		0.14		24.57**	18.11**	4.49	-0.56				-13.46**			-19.05**	

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

A) = Nubaria-1 , B)= Mansoura-1 ; C) =Kassasin-1 ; D) = Kassasin-7; E) =Kobrosy ; F) =Aquadulce ; G) =Giza 643 ; H) = Giza 716 and K)= Giza 717.

Table 6. Cont.

Character / Cross	Pod weight			Pod length			Pod diameter			Seed index			Total green pod yield		
	H%		P.R	H%		P.R	H%		P.R	H%		P.R	H%		P.R
	MP	HP		MP	HP		MP	HP		MP	HP		MP	HP	
A x G	76.41**	44.73**	3.49	1.85**	-10.46**	0.13	16.91**	-1.08**	0.93		-10.22*		36.09*	8.30	1.41
A x H	89.52**	50.95**	3.50	8.44**	-6.16**	0.54	21.52**	0.33	1.02		-11.52*			7.47	
A x K	45.85**	16.32**	1.81	28.25**	8.50**	1.55	18.11**	1.23**	1.09		-6.14		36.54*	9.00	1.45
B x G	59.43**	35.47**	3.36	8.47**	-3.44**	0.69	24.78**	5.60**	1.36		-6.22			9.97	
B x H	74.14**	43.41**	3.46	10.23**	-3.44**	0.72	21.72**	0.52	1.03		-10.87*			17.30	
B x K	53.92**	26.94**	2.54	10.45**	-5.45**	0.62	22.42**	4.95**	1.35	14.70**	-0.56	0.96	53.38**	35.04	3.93
C x G	6.81**	-4.10**	0.60	2.45**	-4.76**	0.32	41.44**	30.56**	4.97		-3.16			7.94	
C x H	35.62**	17.72**	2.34	2.99**	-5.87**	0.32	37.52**	23.50**	3.30	17.63**	9.09*	2.22			
C x K	102.87**	76.37**	6.85	0.56*	-10.30**	0.05	33.38**	24.91**	4.92	14.08**	2.97	1.30	54.80**	39.92	5.16
D x G	63.32**	45.45**	5.15	17.13**	6.99**	1.81	25.10**	21.93**	9.66		-0.18		77.25**	64.40**	9.88
D x H	60.57**	38.31**	3.76	16.63**	8.35**	2.18	23.24**	16.65**	4.12		-14.34**				
D x K	76.89**	52.60**	4.83	21.54**	15.82**	4.36					-8.89		44.90*	34.90	6.06
Ex G	32.00**	15.63**	2.26		-10.00**		18.62**	13.93**	4.52		-5.21				
E x H	39.57**	18.33**	2.20		-11.00**		19.34**	11.37**	2.70		-4.69		56.01**	41.67*	5.53
E x K	46.49**	24.38**	2.61		-16.67**		13.96**	11.11**	5.45	8.12*	-5.21	0.58			
Fx G	63.77**	35.14**	3.01	0.81**	-10.87**	0.06	16.40**	-6.03**	0.69		-12.52**		77.96**	49.84*	4.15
F x H	66.50**	33.33**	2.67	10.39**	-3.94**	0.70	19.30**	-5.86**	0.72	8.68*	-7.11	0.51	57.12**	40.40*	4.80
F x K	40.88**	12.97**	1.65	11.77**	-4.93**	0.67	11.88**	-8.59**	0.53	19.52**	-0.16	0.99		12.08	

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

A) = Nubaria-1 , B)= Mansoura-1 ; C) =Kassasin-1 ; D) = Kassasin-7; E) =Kobrosy ; F) =Aquadulce ; G) =Giza 643 ; H) = Giza 716 and K)= Giza 717

Table 7. Correlation coefficient between some pairs of characters in the studied broad bean genotypes.

No	Characters	"r" value	No	Characters	"r" value
1	Total yield vs. seed index	0.385*	10	Pod weight vs. pod length	0.441*
2	Total yield vs pod weight	0.809**	11	Pod weight vs. pod number	- 0.471*
3	Total yield vs branch number	0.483*	12	Pod weight vs. seed index	0.391*
4	Total yield vs plant height	0.393*	13	Pod weight vs. number of branches	0.617**
5	Total yield vs pod length	0.438*	14	Pod weight vs.pod diameter	0.630**
6	Total yield vs pod diameter	0.656**	15	Seed index vs. pod length	0.643**
7	Total yield vs number of pods	0.113 ns	16	Seed index vs.pod diameter	0.675**
8	Pod length vs. pod diameter	0.740**	17	Pod number vs. number of branches	0.412*
9	Seed number /pod vs. pod length	0.433*			

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

weight appeared to be the principal yield attributes for indirect selection criteria.

REFERENCES

Abou-Zeid, G.G. (1999). Studies on faba bean breeding (estimates of heterosis and combining ability in faba bean under two plant population densities). M.Sc.Thesis,Fac. Agric. Kafr El-Sheikh Tanta Univ, Egypt.

Attia,S.M., M.M.EL-Hady, E.M.Rabie and O.A.El-Galaly (2006). Genetical analysis of yield and its components using six populations mode in faba bean (*Vicia faba* L.).Minufiya J. Agric. 31:669-680.

Bakheit, B.R. (1992). Genetical studies of some Egyptian and imported varieties of faba bean. FABIS Newsletter 30: 10-16.

Bakheit, B.R. and E.E.Mahady (1988). Variation, correlations and path coefficient analysis for some characters in collections of faba bean (*Vicia faba* L.). FABIS Newsletter 20:9-14.

Comstock R.E. and H.F. Robinson(1952). Estimation of average degree of dominance of genes. In :Heterosis(Ed.J.W.Gowen),Iowa State College Press, Ames, pp: 494-516.

Duncan, D.B. (1955). Multiple range and multiple F tests. Biometrics 11: 1- 42.

El-Hady, M., M.A. Omar,S.M.Nasr.S.A. Mohamoud and M.K.El-Waraky(1998). Performance of some faba bean genotypes along with F_1 and F_2 generations. Annals of Agric. Sci. ,Moshtohor 36:729-743.

El-Hosary, A.A. H.A. Dawwam and A.A. Nawar (1986). Heterosis and combining ability in some crosses of field beans (*Vicia faba* L).Annals of Agric. Sci., Moshtohor 24:773-786.

El-Hosary, A.A. and A.A. Nawar (1984). Gene effects in field beans (*Vicia faba* L.). II-Earliness and maturity. Egypt. J. Genet. Cytol. 13: 109-119.

El-Shazly, M.S., M.M. El-Ashry, E.M. Gaafar and M.M. Mohamed (1995). Inheritance of some seed quality characters in faba bean. FABIS Newsletter 36/37: 8-13.

El-Tabbakh, S. and H. Ibrahim (2000). Combining ability and heterosis effects for some different traits of faba bean (*Vicia faba* L.). Minufiya J. Agric. Res. 25: 957-967.

Farag, S.T. and A..A. Darwish (2005). Types of gene effects of some economic traits in broad bean (*Vicia faba* L.) Egypt. J .Plant Breed. 9(1):77- 90.

Farag, S.T. and F.A. Helal (2004). Heterosis and combining ability in broad bean (*Vicia faba* L.). Minoufiya J. Agric. Res. 29: 707-722.

Farag, S.T., M. A. Abd El-Galeel and M. F. El-Nady (2005). Performance of some faba bean (*Vicia faba,* L.) Genotypes grown under delta condition. J. Agric. Res. Tanta Univ. 31 :136 -154 .

Grafius,J.E. (1984). A geometry of plant breeding. Crop Sci. 24:241-246.

Habetinek, J. (1985). Evaluation of five white flowered lines of broad bean (*Faba vulgaris* Moench) by means of diallel analysis. Sbornik Vysoke Skoly Zemedelske v Praze , Fakulta Agronomicka, A . 42: 91-102, Czechoslovakia.(c.f. Plant Breed. Abstr. 56: 3349, 1986).

Katiyar, R. P. and A. Singh (1990). Path coefficient studies for yield and yield components in faba bean *(Vicia faba* L.). FABIS Newsletter 26: 3-5.

Kempthorne, O. (1957). An Introduction to Genetic Statistics .John Willey and Sons , New York 468-711

Khare, D. and C. B. Singh (1991). Genetic behavior of yield and quality traits of *Vicia faba* L., FABIS Newsletter 34: 3-8.

Mahmoud, S. and D. Al-Ayobi (1987). Heterotic performance and combining ability in diallel cross among broad bean (*Vicia faba* L). Annals of Agric. Sci., Ain Shams Univ. 32: 1401-1410.

Mulat, G. (1998). Variation among Ethiopian faba bean landraces for seed yield and agro-morphological characters. FABIS Newsletter 41: 5-8.

Salama,S.M. and N.A.Mohamed (2004). Estimates of genetic components for some characters in faba bean (*Vicia faba* L.).Zagazig J. Agric. 31:2621-2634.

Snedecor, G.W. and W.G. Cochran (1982). Statistical Methods (7th Edit, 2nd printing). Iowa State Univ., Press, Ames, Iowa, U.S.A., 507pp.

Steel, R.G. and H.H. Torrie (1980). Principles and Procedures of Statistics. Mc Graw-Hill Book Co., Inc., New York 481pp.

ألأهميه النسبية للتباينات الوراثية في تحسين الفول الرومي

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أجريت هذه الدراسة بهدف تقييم ودراسة السلوك الوراثي ، وتقدير قوه الهجين،وقياس تأثيرات القدرة على الائتلاف ، ودرجة السيادة الجينية ، ومتوسط درجه السيادة، ومعامل الارتباط بين بعض الصفات الهامة في الفول الرومي خلال المواسم الشتوية2005/2004، 2006/2005 . ففي الموسم الأول و بمزرعة الجميزة البحثية / محافظة الغربية ، تم التهجين بين ثلاثة أصناف من الفول كآباء لستة أصناف أخرى (كأمهات) بنظام التلقيح القمى لإنتاج بذور الجيل الهجينى الأول . وفى الموسم الثاني تم زراعة هجن الجيل الأول(18 هجينا) مع الآباءالتسعه. سجلت البيانات على عشره صفات ، وكانت أهم النتائج المتحصل عليها كالتالي:

كانت التباينات معنوية بين التراكيب الوراثية فى جميع الصفات التي درست . كما أوضحت حسابات القدرة العامة والخاصة على الائتلاف أن التأثير الجيني المضيف والغير مضيف كان معنويا فى وراثة معظم الصفات التي درست ، كما أشارت النتائج إلى إن الدور الذي تلعبه الجينات المضيفة (التجميعية) كان هام فى

وراثة صفات طول النبات ، عدد الافرع ، عددالايام اللازمة لتزهير 50% من النباتات، طـول وسـمك القـرن ، بالمقارنة بتأثير الجينات الغير مضيف مما قد يتيح التحسين لمعظم هذه الصفات بالتربية عن طريق الانتخاب ، فى حين كان الدور الذي تلعبه الجينات الغير مضيفة هام فى وراثة صفةعدد القرون/ نبات ، عـدد البـذور/ قـرن، متوسط وزن القرن ، والمحصول الكلى من القرون.

أوضحت حسابات تأثيرات القدرة العامة على الائتلاف إن أفضل الآباء هو أكوادولـسى ومنـصوره-1 ونوباريه-1 . بينما أوضحت حسابات القدرة الخاصة على الائتلاف ان الهجن " نوباريه-1 X جيـزه- 717 "، " قصاصين-1 X جيزه-643 "،"قصاصين-7- X جيزه-643 "،" قبرصى X جيزه-716 " ،" أكوادولـسى × جيزه-643 "هما الأفضل.

أظهرت النتائج وجود معظم أو كل نظم السيادة فى الهجن تحت الدراسة للصفات المختلفة . وكانت قيم الـ potence ratio متوافقة مع متوسط درجات قوة الهجين المحسوبة لهذه الصفات. كما اوضـحت حـسابات درجة قوة الهجين على أساس الأب الأفضل معنوية موجبه لكل الصفات ، حيث وجدت سـيادة فائقـة عـن الأب الأفضل في 3 هجن لصفه عدد القرون /نبات ، 17 هجين لصفه وزن القرن و هجينين لصفه عدد البذور/ قـرن وعدد 4 هجن لصفه المحصول الكلى من القرون الخضراء .

تفوق الهجين "قصاصين-7 X جيزه-643 "على الأب الأعلى بنسبه 64.40% كما تفوق علـى الأب أكوادولسى بنسبه 31.52% في إنتاج أعلى محصول كلى من القرون الخضراء .كما تفوق الهجين" نوباريه-1 X جيزة-716 " على الأب الأعلى بنسبه 50.95% وتفوق على الصنف الكنترول الشائع بنسبه 53.15% فى إعطاء أعلى وزن قرن.