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DETERMINATION OF YIELD POTENTIAL, PHYSIOCHEMICAL AND TECHNOLOGICAL CHARACTERISTICS OF SOME FABA BEAN GENOTYPES

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ABSTRACT

Six faba bean cultivars with their F_1 crosses (excluding reciprocals) were evaluated for yield potential along with some physical and chemical characters. The study was carried out at Giza Research Station during 2003/04, 2004/05 and 2005/06 growing seasons using diallel mating design. Analysis of variance showed highly significant differences among the tested genotypes which increase the chance of recovering recombinations in the following generations. Heterosis estimates were significant or highly significant over mid-parent value for most studied characters. Different values of heterosis over mid-parent might be due to the genetic diversity of the parents, which increase or decrease the expression of heterosis. Additive as well as non-additive gene action seemed to be the expression of the various characters. Values of H_1 were significantly larger in magnitude than the respective D ones for all traits revealing that dominance gene effect was the prevalent type in these traits. All estimates of the environmental variance (E) were insignificant for all characters (except plant height and number of branches/plant) indicating that these traits have not been affected by environmental factors.

Four crosses:(Misr 1 x Giza 716, Giza 843 x Giza 716, Giza 843 x Giza 40 and Giza 716 x Nubaria 1) exhibited significant/highly significant positive heterosis over mid-parent for seed yield and all other components. Heterosis percentages over mid-parents were detected for physical and cooking properties except total carbohydrates.

Narrow sense heritability ranged from 9.8 % for tannin content to 87.0 % for total carbohydrate content. Also the results revealed that seed yield/plant and cotyledons% are controlled by additive gene action and it is possible to improve these traits by selection.

INTRODUCTION

Faba bean (*Vicia faba* L.) is an important seed legumes in Egypt, which can be used as pulse, vegetable, fodder, green manure and as a cover crop. It is essential in farming system to increase soil fertility where it is an important nitrogen supplier to the soil.

Seeds of legumes are used directly or indirectly (after processing) for human nutrition and animal feeding, consequently, the nutritional quality of the seeds is an important breeding objective. Increased seed protein content along with a decrease in the amount of total tannins and phenols are the main traits to be used as selection criteria during breeding for seed quality. The improvement of faba bean production is focused on increasing both seed yield and its stability as well as seed quality.

The chemical composition is subjected to fluctuations, depending on various factors like cultivar and maturity stage, environment (mostly weather conditions), agrotechnics and others (Dostalova, 2002).

Results reported by Mahmoud *et al.* (1997) showed a slight variation between varieties for hulls to seed ratio which was found in the range of 11.4 and 14.51 %. Stewing percentage ranged from 20 to 90%. The highest stewing percentage was found in Giza 643 while the lowest one was fond in Giza blanca.

Mahmoud et al. (1998) reported that hydration coefficient of the dried seeds ranged between 93.95 and 116.55. The highest hydration coefficient was recorded by Giza blanca while the lowest one was found in Giza 3. Hull percentage ranged from 10.75-13.74 %. The ratio between cotyledon and hull showed an opposite trend of hull percentage. The percentage of stewed faba bean seeds ranged from 50 to 100% when autoclaving method was used, while it ranged from 30 to 100% due to oven method.

Seed proteins are deficient in some amino acids that are essential for humans and other mono-gastric animals, so, the most economic approach is through breeding programs to develop promising genotype with high yield potential and good agronomic performance. Protein content of bean seeds depended on cultivars and oscillated from 23.9 to 29.8 % (Korus *et al.*, 2006). Brand *et al.* (2004) reported that ash content in faba bean was 2.79 %.

Korus et al. (2006) reported that cultivars of bean significantly differed in total dietary fiber and its soluble fraction. Seed legumes are important source of carbohydrates in diet. Their content in 100 g of dry matter varied from 59.9 g to 68.4g.

Tannin is a complex polyphenolic compound with molecular weights in the range of 500-20,000 Daltons. They are widely distributed in foods and feed of plant origin. Tannin may form soluble and insoluble complex with proteins which may be responsible for the antinutritional effects of tannin containing feed ingredients for non-ruminants and ruminants (Naczk *et al.*, 2001). The development of tannin-free cultivars of *Vicia faba* well helps to enhance the nutritional quality of this legume (Cabrera and Martin, 1989).

The performance of F_1 hybrids in comparison with that of the parents provides the first opportunity in the sequence of events in hybrid populations to obtain information on gene action. Manifestations of heterotic effects for yield components as well as chemical composition ranged from significantly positive to significantly negative values (El-Lithy, 1996 and El-Hady *et al.*, 1998, Ghareeb 2000, Mohamed 2001; Attia *et al.*, 2002; Darwish *et al.*, 2005 and Attia *et al.*, *2006*). These differences in percent heterosis might be due to genetic differences of the parents used and/or allelic interactions, which can either, increase or decrease the expression of heterosis.

Mahmoud (1977), Nassib (1982), El-Hady (1988), El-Hady *et al.* (1991 a and b), El-Lithy (1996), Helal (1997) and El-Hady *et al.* (1998), Ghareeb (2000), Attia *et al.* (2002), Rabie *et al.* (2003) and Attia and Salem (2006) reported that non-additive effect was more important for some yield components (number of pods, seeds and seed yield/plant) and technological characters (tannin, HCA and TSS) than additive. However, the additive variance was important for 100-seed weight and protein content.

The low heritability and limited response to selection for yield had led many workers to search for characters which are associated with yield but which are relatively highly heritable.

There are two types of heritability, broad and narrow sense of which the latter is more useful. Abdalla *et al.* (1999), Ghareeb (2000), Mansour *et al.* (2001), Attia *et al.* (2002), Rabie *et al.* (2003) and Attia and Salem (2006) reported that narrow sense heritability values were high for 100-seed weight, protein content and HCB and low to moderate for seed yield, number of pods, seeds/plant and tannin content

This study was conducted to determine the genetic variance components of some faba bean genotypes and their crosses for yield potential along with some physical and chemical traits.

MATERIALS AND METHODS

The present investigation was carried out under insect proof cages at Giza Research Station during 2003/04, 2004/05 and 2005/06 growing seasons. The diallel mating design among six faba bean genotypes excluding reciprocals was used. The parental genotypes are briefly described in Table 1.

All possible cross combinations (without reciprocals) were made in 2003/04. However, hybrid seeds in certain crosses were missing. Therefore, re-hybridization was made in the following season 2004/05 to obtain the breeding material used in this study. The hybrids and their parents were evaluated under insect proof cage in 2005/06 in a randomized complete block design with three replicates. Each plot consisted of one ridge of 3 m length and 50 cm apart in hills with one seed per hill and 20 cm apart. All the recommended cultural practices were applied. Ten individual guarded plants per plot were marked to recorded the following agronomic characters.

1- Plant height (cm)	2-Number of branches/plant
3- Number of pods/plant	4- Number of seeds/plant
5- Seed yield/plant (g)	6- 100-seed weight (g)

Table (1): Date of flowering, seed size and pedigree as well as some features of faba bean genotypes.

Genotype	Flowering	Seed size	Pedigree	Features
Giza 843 (P_1)	Early	Medium	561/2076/85 Sakha x 461/845/83	*Orobanche* and foliar diseases resistance
Misr 1 (P_2)	Early	Medium	Giza 3 x 123A/45/76	*Orobanche* resistance
Giza 716 (P_3)	Early	Medium	461/842/83 x 503/453/83	Foliar diseases resistance
Giza 3 (P_4)	Early	Medium	Giza 1 x Dutch introduction 29	Foliar diseases resistance and possess high yield
Giza 40 (P_5)	Early	Small	An individual plant selection from Rebaya 40	Early maturing
Nubaria 1 (P_6)	Late	Large	An individual plant selection from Giza Blanca	Foliar diseases resistance

For technological analysis, samples were cleaned and ground using a UDY grinder with a 1.0 mm screen.

Physical and cooking properties:

The whole seeds without milling were used for determination of physical properties (true density of seeds and imbibed water%.

Soaking treatments: Seeds of each genotype were soaked in tap water over-night (12 hrs.) and the following were determined in the soaking seeds as described by the method of Fahmy *et al.* (1996).

$$\text{Imbibed water \%} = \frac{\text{Wt. of soaked seeds - Initial wt. of seeds}}{\text{Initial wt. of seeds}} \times 100$$

After soaking time (12 hrs.), seeds were dehulled then, the seed coat or (hulls) and the cotyledons dried in Lab. Oven (60 °C/12 hrs.) and weighted to calculate % of the seed coat and the cotyledons

Cooking process: Faba bean seeds were cooked according to the method mentioned by Fahmy *et al.* (1996). The following measurements were determined in cooked seeds:

$$\text{Imbibed water\%} = \frac{\text{Wt. of cooked seeds - Initial wt. of seeds}}{\text{Initial wt. of seeds}} \times 100$$

Water soluble materials or total soluble solids (TSS): The cooking water containing soluble materials was poured into porcelain pot and placed in an oven at 60 °C until all the cooking water was evaporated. The pot was weighted and TSS calculated as follows:

$$TSS\ \% = \frac{\text{Wt. of pot after drying} - \text{Weight of empty pot}}{\text{Initial wt. of seeds}} \times 100$$

Cookability: The ability of cooked seeds was measured by means of using the normal press of fingers and comparing between the cooked seeds for their hardness

Chemical composition:

Protein, ash, crude fiber and fat were determined according to AOAC (2000). Total carbohydrate was estimated by difference.

Determination of tannins: Tannins were determined using vanillin hydrochloric acid (V-HCl) method as described by Burn (1971) as follows: A sample (2 g) was shaked with 50 ml methanol containing 1 % HCl for 24 hrs at room temperature. One ml of the cleared extract was treated with 5.0 ml of vanillin reagent (equal volume of a mixture of 4 % vanillin and 8 % HCl in methanol) and kept for 20 min. Absorbance was read at 500 nm.

Pure catechin was used for standard curve preparation by dissolving 100 mg catechin in 50 ml methanol as a stock solution to prepare various concentration of catechin (from 1 to 10 mg/ml). Absorbance was read at 500 nm.

Determination of total phenols: Total phenols were determined by using Folin-Denis reagent according to the method of Swain and Hillis (1959) as follows: A sample of seeds flour (0.2 g) was extracted with methyl alcohol 80 % (v/v) for 24 hrs at room temperature. An aliquot of methyl; alcohol extract (0.5 ml) was transferred into test tube and Folin-Denis reagent (0.5 ml) was added then the tubes well shaken. Exactly after 3 min. 1.0 ml of sodium carbonate 10 % (w/v) was added and maximum was made up to 10 ml with distilled water and measured at 720 nm by using Backman DU-40 spectrophotometer. Total phenol was expressed as pyrogallol.

Statistical analysis:

A regular analysis of variance was conducted on plot mean basis for tested differences among genotypes. Heterosis as the percentage deviation of F_1 mean performance from its mid-parent was calculated. Data were subjected to genetic analysis according to Hayman (1954 a and b).

RESULTS AND DISCUSSION

Data presented in Table (2) revealed highly significant differences among tested genotypes, parents, crosses and parents *vs.* crosses for most studied characters, indicating wide genetic variability for different studied genotypes. The tested genotypes and parents exhibited highly significant differences for studied traits for most cases, indicating that variability existed among all entries, which increases the chance of recovering recombination's in the following generations. Data also revealed that crosses were highly significantly differed for all traits.

Table (2): Mean squares due to different source of variation for studied traits.

Trait	Genotypes	Parents	Crosses	P vs C	Error
	20	5	14	1	40
Plant height	498.452	624.722	335.079	2154.33	121.667
No. of branches/plant	8.371	4.089 ns	6.66	53.74	3.00
No. of pods/plant	226.338	55.656	136.641	2335.51	21.70
No. of seeds/plant	2524.22	190.089ns	986.486	35723.1	166.578
100-seed weight (g)	1150.66	1879.01	972.09	8.669 ns	183.171
Seed yield/plant (g)	2579.44	27.436 ns	1542.91	29850.95	65.497
Protein	15.373	7.232	2.381	237.968	0.132
Ash	0.128	0.076	0.155	0.002	0.0004
Fiber	2.780	1.926	3.075	2.934	0.550
Total carbohydrates	22.158	4.718	11.346	260.724	0.728
Fat %	1.248	0.465	1.129	6.827	0.067
Tannin (mg/100 g)	13278.7	6704.6	16504.6	986.59	114.228
Total phenols (mg/100 g)	215.743	352.001	153.504	405.796	11.613
Density	0.159	0.168	0.166	0.010 ns	0.011
Imbibed water after soaking %	227.741**	297.130**	214.319**	68.706*	17.184
Cotyledons %	9.863	1.016	13.345	5.354	0.361
Seed coat %	2.361	2.821	2.198	2.342	0.186
Imbibed water after cooking %	1818.87**	136.678ns	2403.38**	2046.77*	301.931
Total soluble solids %	11.266	10.585	10.427	26.408	0.432

ns, * and ** indicate insignificant, significant at 5% and 1 % level of probability, respectively.

Mean squares due to parents *vs* crosses were significant for all traits, except 100-seed weight and density, showing the presence of heterotic effects as non-additive genetic variance controlling studied crosses. Mean performance of parents, F_1's (excluding reciprocals) for agronomic traits is presented in Table 3.

Nubaria 1 recorded the highest values with respect to number of branches, 100-seed weight and seed yield/plant. Moreover, Misr 1 gave the highest number of pods and seeds/plant, Giza 40 was the tallest parent. Three crosses; P_1 x P_5 (Misr 1 x Giza 40), P_4 x P_5 (Giza 3 x Giza 40) and P_4 x P_6 (Giza 3 x Nubaria 1) exceeded the tallest parent for plant height. Six crosses; P_1 x P_6 (Misr 1 x Nubaria 1), P_2 x P_3 (Giza 843 x Giza 716), P_2 x P_4 (Giza 843 x Giza 3), P_2 x P_5 (Giza 843 x Giza 40), P_2 x P_6 (Giza 843 x Nubaria 1) and P_3x P_6 (Giza 716 x Nubaria 1) gave the highest values for number of branches/plant. All crosses recorded the highest values of number of pods, seeds and seed yield/plant except the three remaining ones; P_2 x P_6 (Giza 843 x Nubaria 1), P_3 x P_6 (Giza 716 x Nubaria 1) and P_4 x P_6 (Giza 3 x Nubaria 1) for number of pods/plant. For 100-seed weight, parents varied from 73.0 g in Giza 843 to 135.9 in Nubaria 1. Also hybrids varied from 50.7 g in P_1 x P_2 (Misr 1 x Giza 843) to 117.3 g in P_2 x

P_3 (Giza 843 x Giza 716). It is suggested that the above mentioned crosses could be useful in faba bean breeding for improving seed yield and its components. The mean performance of parental genotypes and their F_1 hybrids for the studied physical and cooking properties are shown in Table (4).

Table (3): Mean performance of parents and their crosses for yield components traits.

Genotypes	Plant height, cm	No. of branches/ plant	No. of pods/plant	No. of seeds/ plant	100-seed weight	Seed yield/ plant, g
Misr 1 (P_1)	110.0	4.7	21.0	47.0	74.8	34.9
Giza 843 (P_2)	90.0	3.7	15.7	42.7	73.0	30.9
Giza 716 (P_3)	98.3	4.3	8.0	28.3	104.3	28.9
Giza 3 (P_4)	115.0	5.3	15.7	35.7	81.6	28.8
Giza 40 (P_5)	130.0	5.7	18.0	41.7	74.8	31.1
Nubaria 1 (P_6)	98.3	7.0	15.3	27.7	135.9	36.0
P_1 x P_2	95.0	4.7	38.3	86.0	50.7	43.5
P_1 x P_3	118.3	7.0	31.7	100.3	84.4	81.2
P_1 x P_4	131.7	6.0	27.3	76.0	81.0	60.2
P_1 x P_5	135.0	5.0	42.7	119.3	74.5	88.7
P_1 x P_6	111.7	9.7	30.0	113.0	85.7	96.1
P_2 x P_3	115.0	8.7	34.3	107.3	117.3	126.4
P_2 x P_4	111.7	7.7	25.3	74.3	94.3	70.3
P_2 x P_5	123.3	7.7	23.7	69.0	80.0	55.2
P_2 x P_6	121.7	8.0	19.3	70.0	66.5	45.7
P_3 x P_4	118.3	6.3	28.3	97.0	103.0	96.9
P_3 x P_5	115.0	7.3	35.0	109.3	95.8	103.4
P_3 x P_6	116.7	9.7	20.7	66.7	112.8	75.0
P_4 x P_5	133.3	6.0	32.7	102.7	95.7	94.5
P_4 x P_6	133.3	6.3	21.3	70.7	109.9	77.3
P_5 x P_6	118.3	7.3	25.7	87.3	97.1	84.6
LSD 0.05	**18.2**	**2.9**	**7.7**	**21.3**	**22.3**	**13.4**

Data revealed that, Giza 843 (P_2) exhibited the highest values of density and cotyledons % and recorded 2.53 and 80.97 %, respectively. Meanwhile, Nubaria 1 (P_6) recorded the lowest estimates of density and total soluble solids with values of 1.97 and 8.37, in the same order. The crosses: P_3 x P_6 (Giza 716 x Nubaria 1) and P_3 x P_5 (Giza 716 x Giza 40) had the highest values of density and recorded 2.76 and 2.65, respectively. On the other hand, the cross P_1 x P_4 (Misr 1 x Giza 3) followed by P_3 x P_4 (Giza 716 x Giza 3) had the highest percentage of seed coat and recorded 13.65 and 17.17 %, respectively. Moreover, two crosses (P_3 x P_4 (Giza 716 x Giza 3) and P_3 x P_6 (Giza 716 x Nubaria 1) had the lowest values of cotyledons % and total soluble solids and recorded 79.48 and 8.33, in the same order. The significant differences among genotypes and hybrids were obtained indicating wide genetic variability among tested materials.

Table (4): Mean performance of parents and their crosses for physical and chemical properties.

Genotypes	Density	Imbibed water after soaking%	Cotyledons %	Seed Coat%	Imbibed water after cooking%	Total soluble solids%
Misr 1 (P_1)	2.51	112.78	80.90	10.39	201.73	13.68
Giza 843 (P_2)	2.53	100.51	80.97	10.91	196.30	12.48
Giza 716 (P_3)	2.23	110.61	80.40	12.75	202.08	12.83
Giza 3 (P_4)	2.12	124.86	79.90	12.22	194.35	12.78
Giza 40 (P_5)	2.06	100.62	80.52	11.48	210.43	12.45
Nubaria 1 (P_6)	1.97	99.59	79.47	12.68	210.20	8.37
$P_1 \times P_2$	2.05	112.66	80.93	10.75	209.33	12.56
$P_1 \times P_3$	1.93	108.82	80.24	10.93	214.98	12.76
$P_1 \times P_4$	2.13	131.80	77.23	13.65	202.83	14.39
$P_1 \times P_5$	2.34	96.73	85.64	11.08	204.54	10.63
$P_1 \times P_6$	2.09	112.84	80.38	11.38	201.87	10.70
$P_2 \times P_3$	2.13	111.36	85.22	11.44	206.55	11.42
$P_2 \times P_4$	2.24	112.44	81.90	10.89	199.78	11.39
$P_2 \times P_5$	2.01	106.88	81.07	10.36	194.38	12.56
$P_2 \times P_6$	1.99	112.74	81.28	10.17	190.15	9.40
$P_3 \times P_4$	2.37	112.85	79.48	12.17	194.38	8.40
$P_3 \times P_5$	2.65	101.20	81.33	10.74	94.90	8.57
$P_3 \times P_6$	2.76	106.64	80.74	11.46	178.15	8.33
$P_4 \times P_5$	2.12	107.37	80.46	10.91	183.87	8.85
$P_4 \times P_6$	2.18	121.47	79.91	11.84	181.57	9.15
$P_5 \times P_6$	2.12	101.31	79.27	11.89	191.20	10.84
LSD 0.05	**0.17**	**6.84**	**0.99**	**0.71**	**28.67**	**1.08**

The mean performance for chemical and cooking properties of parental genotypes and their crosses are presented in Table (5).

Data indicating that, Nubaria 1 (P_6) had the highest estimates of protein content (25.68) and recorded the lowest levels of total carbohydrates and fat % with a mean of 60.5 and 1.50 %, respectively. Meanwhile, Misr 1 and Giza 40 had the lowest amounts of tannin and phenols contents and recorded 189.68 and 13.26, respectively. The following three crosses: $P_2 \times P_3$ (Giza 843 x Giza 716), $P_1 \times P_5$ (Misr 1 x Giza 40) and $P_4 \times P_5$ (Giza 3 x Giza 40) exhibited the highest estimates of protein content and recorded 29.56, 28.83 and 28.04 %, respectively. Two crosses: $P_4 \times P_5$ (Giza 3 x Giza 40) and $P_2 \times P_6$ (Giza 843 x Giza 40) had the lowest levels of both tannin and total phenols and recorded 109.10 and 22.32 mg/10g, in the same order.

Heterosis over mid-parents:

Heterosis expressed as the percentage deviation of F_1 mean performance from its mid-parents average values for all studied traits are presented in Table (6).

Table (5): Mean performance of parents and their crosses for chemical composition traits.

Genotypes	Protein %	Ash %	Fiber %	Total carbohy-drates	Fat %	Tannin mg/100 g	Total phenols mg/100 g
Misr 1 (P_1)	22.48	3.40	9.77	61.9	2.48	189.68	27.20
Giza 843 (P_2)	24.52	3.50	8.11	62.1	2.07	230.59	41.89
Giza 716 (P_3)	22.49	3.49	8.42	63.9	1.73	218.20	16.57
Giza 3 (P_4)	21.91	3.75	9.21	63.6	1.53	313.66	33.30
Giza 40 (P_5)	21.99	3.30	10.17	63.0	1.53	280.18	13.26
Nubaria 1 (P_6)	25.68	3.62	8.68	60.5	1.50	285.14	20.50
P_1 x P_2	26.31	3.41	8.31	60.3	1.62	256.63	44.10
P_1 x P_3	26.81	3.37	8.36	60.1	1.33	255.39	36.35
P_1 x P_4	27.00	3.87	6.36	61.1	1.68	241.76	28.81
P_1 x P_5	28.83	3.11	7.98	58.1	1.99	376.88	30.62
P_1 x P_6	26.22	3.32	8.59	60.3	2.74	225.63	28.16
P_2 x P_3	29.56	3.34	9.67	54.4	2.97	256.63	26.28
P_2 x P_4	27.87	3.50	8.85	57.4	3.22	173.57	27.57
P_2 x P_5	27.45	3.45	9.52	56.7	2.50	359.53	27.54
P_2 x P_6	27.37	3.50	8.75	56.8	3.16	174.80	22.32
P_3 x P_4	27.40	3.75	9.16	56.8	3.04	197.12	25.54
P_3 x P_5	27.49	3.51	10.00	55.5	3.02	283.90	40.82
P_3 x P_6	26.97	3.81	8.89	57.3	3.09	292.59	25.38
P_4 x P_5	28.04	3.46	6.57	59.2	2.72	109.10	41.10
P_4 x P_6	27.97	3.95	8.67	57.1	2.37	156.21	22.94
P_5 x P_6	26.92	3.51	9.07	59.0	2.61	302.50	38.56
LSD 0.05	**0.60**	**0.03**	**1.22**	**1.4**	**0.43**	**17.64**	**5.62**

For seed yield and its components, mean values of F_1 crosses compared to the respective mid-parents were significantly or highly significant positive in eight, eight, fourteen, fifteen, three and fifteen crosses for plant height, number of branches, number of pods, number of seeds/plant, 100-seed weight and seed yield/plant with a range of 12.1-29.2, 46.7-116.7, 37.6-190.1, 63.6-212.4, 22.0-32.3 and 32.2-322.6 % in the same order. Four crosses; P_1 x P_3 (Misr 1 x Giza 716), P_2 x P_3 (Giza 843 x Giza 716), P_2 x P_5 (Giza 843 x Giza 40) and P_3 x P_6 (Giza 716 x Nubaria 1) exhibited significant or highly significant positive heterosis over mid-parent for seed yield and its components.

Heterosis over mid-parent for physical and cooking properties were significant in four, seven, six, one and one cross in density, imbibed water after soaking %, cotyledons %, seed coat %, and TSS % in the same order. For chemical traits, fifteen, seven, one, eleven, five and two crosses gave desirable highly significant heterosis over mid-parent with a range of 8.9-29.7; 1.3-8.2; 17.0; 37.7–91.0, -63.3- -25.9 and –28.4--26.7, for protein, ash, fiber, fat, tannin and total phenols contents. Insignificant positive heterosis was detected for total carbohydrates.

Table (6): Heterosis percentage over mid-parents (MP) for seed yield and its components, physical and chemical traits.

Genotypes	Plant height, cm	No. of branches/ plant	No. of pods/plant	No. of seeds/ plant	100-seed weight	Seed yield/ plant, g
Yield components						
$P_1 \times P_2$	-5.0	12.0	109.1	91.8	-31.4	32.2
$P_1 \times P_3$	13.6	55.6	118.4	166.4	-5.8	154.4
$P_1 \times P_4$	17.0	20.0	49.1	83.9	3.6	89.2
$P_1 \times P_5$	12.5	-3.2	118.8	169.2	-0.5	168.9
$P_1 \times P_6$	7.2	65.7	65.1	202.7	-18.7	171.3
$P_2 \times P_3$	22.1	116.7	190.1	202.3	32.3	322.6
$P_2 \times P_4$	8.9	70.4	61.7	89.8	22.0	135.6
$P_2 \times P_5$	12.1	64.3	40.6	63.6	8.2	78.2
$P_2 \times P_6$	29.2	50.0	24.7	99.1	-36.3	36.7
$P_3 \times P_4$	10.9	31.0	139.4	203.1	10.9	236.0
$P_3 \times P_5$	0.7	46.7	169.2	212.4	6.9	244.6
$P_3 \times P_6$	18.6	70.6	77.1	138.1	-6.1	131.0
$P_4 \times P_5$	8.8	9.1	94.1	165.5	22.4	216.0
$P_4 \times P_6$	25.0	2.7	37.6	123.2	1.1	138.7
$P_5 \times P_6$	3.6	15.8	54.0	151.9	-7.8	152.5

Genotypes	Density	Imbibed water after soaking%	Cotyledons %	Seed coat%	Imbibed water after cooking%	Total soluble solids%
Physical and cooking properties						
$P_1 \times P_2$	-18.7	5.6	0.0	1.0	5.2	-4.0
$P_1 \times P_3$	-18.7	-2.6	-0.5	-5.5	6.5	-3.7
$P_1 \times P_4$	-7.9	10.9	-3.9	20.7	2.4	8.8
$P_1 \times P_5$	2.4	-9.3	6.1	1.3	-0.7	-18.7
$P_1 \times P_6$	-6.6	6.3	0.2	-1.3	-2.0	-2.9
$P_2 \times P_3$	-10.4	5.5	5.6	-3.3	3.7	-9.8
$P_2 \times P_4$	-3.6	-0.2	1.8	-5.9	2.3	-9.8
$P_2 \times P_5$	-12.4	6.3	0.4	-7.5	-4.4	0.8
$P_2 \times P_6$	-11.5	12.7	1.3	-13.7	-6.4	-9.8
$P_3 \times P_4$	9.2	-4.2	-0.8	-2.5	-1.9	-34.4
$P_3 \times P_5$	23.7	-4.2	1.1	-11.3	-54.0	-32.2
$P_3 \times P_6$	31.5	1.5	1.0	-9.9	-13.6	-21.4
$P_4 \times P_5$	1.6	-4.8	0.3	-7.9	-9.1	-29.8
$P_4 \times P_6$	6.6	8.2	0.3	-4.9	-10.2	-13.4
$P_5 \times P_6$	5.1	1.2	-0.9	-1.6	-9.1	4.1

Genotypes	Protein %	Ash %	Fiber %	Total carbo-hydrates	Fat %	Tannin mg/100 g	Total phenols content mg/100 g
Chemical composition							
$P_1 \times P_2$	11.9	-1.3	-7.1	-2.7	-29.0	22.1	27.7
$P_1 \times P_3$	19.2	-2.2	-8.1	-4.4	-36.7	25.2	66.1
$P_1 \times P_4$	21.6	8.2	-33.0	-2.6	-16.3	-3.9	-4.8
$P_1 \times P_5$	29.7	-7.3	-20.0	-7.0	-1.0	60.4	51.4
$P_1 \times P_6$	8.9	-5.5	-6.9	-1.5	37.7	-5.0	18.1
$P_2 \times P_3$	25.8	-4.4	17.0	-13.6	56.3	14.4	-10.1
$P_2 \times P_4$	20.1	-3.4	2.2	-8.7	78.6	-36.2	-26.7
$P_2 \times P_5$	18.1	1.5	4.2	-9.3	38.9	40.8	-0.1
$P_2 \times P_6$	9.0	-1.8	4.2	-7.3	77.0	-32.2	-28.4
$P_3 \times P_4$	23.4	3.7	3.9	-10.9	86.2	-25.9	2.4
$P_3 \times P_5$	23.6	3.3	7.6	-12.6	85.3	13.9	173.7
$P_3 \times P_6$	12.0	7.1	3.9	-8.0	91.0	16.3	36.9
$P_4 \times P_5$	27.8	-1.9	-32.2	-6.5	77.5	-63.3	76.5
$P_4 \times P_6$	17.5	7.0	-3.1	-8.1	56.4	-47.8	-14.7
$P_5 \times P_6$	13.0	1.3	-3.7	-4.5	72.3	7.0	128.4

*, ** indicates significant at 5 % and 1 % level of probability, respectively.

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). Even in the absence of epistasis multiple alleles at a locus could lead to either positive or negative heterosis (Cress, 1966). These results are in full agreement with those obtained by El-Hady *et al.* (1998), Mansour *et al.* (2001) and Attia *et al.* (2006).

Estimates of the genetic and environmental components of variance and other statistics derived from these estimates are given in Table 7. Results revealed that, the additive component of genetic variability "D" was highly significant for plant height, 100-seed weight, imbibed water after soaking, seed coat %, TSS as well as protein, ash and total phenols content. Significant values for the dominance components H_1 were obtained for all studied traits. H_2 component values were significantly positive in number of pods, seeds/plant, seed yield/plant, tannin and total phenols content. H_1 was greater than H_2 in all cases indicating that the positive and negative alleles at the loci for these traits were not equal in proportion in the parents. Theoretically, H_2 should be equal to or less than H_1 (Hayman 1954b). Values of H_1 were significantly larger in magnitude than the respective D ones for all traits revealing that dominance gene action was the prevalent type in these traits. The relative sizes of D and H_1 were estimated as a weighted measure of the average degree of dominance at each locus. Results revealed the presence of over dominance for yield components and technological traits. The overall dominance effects of heterozygous loci (h^2 values) were computed for all traits. Significant h_2 values were detected in all traits except number of pods, seeds, seed yield and fat content % indicating that dominance was unidirectional in these traits. The estimates of K_D/K_R were greater than one for most studied characters, which indicated an excess of additive genes in the parents of these traits

It may be noted that this value is estimated under either when the dominance effects of all the genes concerned are not equal in size and direction or when the distribution of the genes is correlated or when both conditions are fulfilled (Jinks, 1954). All estimates of the environmental variance E were insignificant for most cases and indicating that these traits have not been affected by environmental factors.

Narrow sense heritability estimated ranged from 9.8 % for tannin content to 87. % for total carbohydrates.

The results of present study showed that cross P_4 x P_5 (Giza 3 x Giza 40) manifests reliable seed yield characteristics and high quality features such as low tannin content and could be examined in further evaluation trails to be utilized in breeding program to develop a new released variety for faba bean improvement.

Table (7): Estimates of genetic and environmental values for seed yield components and chemical components as well as technological traits in F_1's diallel cross.

Yield components						
Estimates	**Plant height, cm**	**No. of branches/ plant**	**No. of pods/plant**	**No. of seeds/ plant**	**100-seed weight**	**Seed yield/ plant, g**
E	40.56**	1.00**	7.23ns	55.526ns	61.057ns	21.832ns
D	167.69**	0.363 ns	11.32ns	7.837ns	565.28**	-12.687ns
F	27.16 ns	-0.247 ns	-3.40ns	-61.02ns	278.80ns	34.334ns
H_1	279.60**	7.13**	224.49**	2695.48**	685.78**	3210.486**
H_2	-37.28 ns	-19.19**	134.25**	2458.25**	632.39ns	2883.11**
H2	6135.5**	5.99**	2.62ns	166.06ns	5821.14**	186.9 ns
S2	831.84	0.296	348.48	12070.12	21847.92	38320.28
$(H_1/D)^{1/2}$	1.29	4.43	4.45	18.55	1.10	15.91
K_D/K_R	1.13	0.857	0.935	0.653	1.577	1.186
H^2_n	75.4	65.0	56.3	18.6	43.7	15.9

Physical and cooking properties						
	Density	**Imbibed water after soaking%**	**Cotyledons %**	**Seed coat%**	**Imbibed water after cooking%**	**TSS%**
E	0.004ns	5.728 ns	0.120 ns	0.062 ns	100.644 ns	0.144ns
D	0.052 ns	93.315**	0.218 ns	0.878*	-55.084ns	3.384*
F	0.121 ns	14.694ns	-0.951 ns	0.778 ns	79.747 ns	0.819ns
H_1	0.287**	132.288**	13.229**	2.531**	2628.81**	9.527**
H_2	-8.624**	-227.527**	-309.146**	-42.869**	1759.54	-31.486**
h2	3.02**	7779.93**	4412.08**	102.2**	32138.9**	126.6**
S2	0.002	196.215	2.237	0.115	485737.05	1.613
$(H_1/D)^{1/2}$	2.339	1.191	7.785	1.697	6.908	1.678
K_D/K_R	2.961	1.142	0.563	1.706	1.234	1.155
H^2_n	64.6	54.6	85.6	73.5	40.5	54.6

Chemical composition							
	Protein %	**Ash %**	**Fiber %**	**Total carbohydrates**	**Fat %**	**Tannin**	**Total phenols content**
E	0.044	0.000ns	0.183 ns	0.243 ns	0.022ns	38.076ns	3.871ns
D	2.367*	0.025**	0.459 ns	1.370 ns	0.133ns	2196.79ns	113.463**
F	3.828ns	-0.027ns	1.561 ns	3.351 ns	0.527 ns	6680.31ns	199.499**
H_1	17.926**	0.094**	4.482**	26.971**	1.991**	23263.99**	344.259**
H_2	-90.571**	-13.939**	-31.200**	-209.996**	-8.051**	17810.74*	138.98*
h2	246.9**	7.94**	62.9**	3117.97**	0.269 ns	47547.9**	272.6**
S2	0.924	0.000	0.569	4.917	0.027	7514657.22	653.176
$(H_1/D)^{1/2}$	2.752	1.937	3.126	4.503	3.871	3.254	1.742
K_D/K_R	1.832	0.568	3.389	1.777	3.099	2.754	3.038
H^2_n	75.6	85.7	76.5	87.0	63.4	9.8	60.7

. Ns, *, ** indicates insignificant, significant at 5 % and 1 % level of probability, respectively

REFERENCES

Abdalla, M.M.F.; Darwish, D.S.; El-Hady, M.M. and El-Harty, E.H. (1999): Investigations on faba bean, *Vicia faba* L. 12 Diallel crossed materials grown under cages. Proceed. First Pl. Breed. Conf. Egypt. J. Plant Breed. 3: 213-229.

A.O.A.C. (2000): Official methods of analysis (17th). Association of Official Agricultural Chemist, Washington, D.C., USA.

Attia Sabah M. and Manal M. Salem (2006): Analysis of yield and its components using diallel matings among parents of faba bean. Egypt. J. Plant Breed. 10 (1): 1-12.

Attia Sabah M.; El-Hady, M.M.; Rabie, E.M. and Ola A.M. El-Galaly (2006): Genetical analysis of yield and its components using six populations model in faba bean (*Vicia faba* L.). Minufiya J. Agric. Res. 31 (3): 669-680.

Attia Sabah M.; Said, M.Sh.; Zakia M. Ezzat,; Rizk, A.M.A. and Aly, Kh.A. (2002): Heterosis, combining ability and gene action in crosses among six faba bean genotypes. Egypt J. Plant Breed. 6 (2): 191-210

Brand, T.S.; Brandt, D.A. and Cruywagen, C.W. (2004): Chemical composition, true metaboliable energy content and amino acid availability of grain legumes. S. Afr. J. Amin. Sci., 34: 116-122.

Burn, R.E. (1971): Methods for estimation of tannin in grain sorghum. Agron. J. 63: 511.

Cabrera, A. and Martin, A. (1989): Genetics of tannin content and its relationship with flower and testa colours in *Vicia faba*. J. Agric. Sci., 113 (1) : 93-98.

Cress, C.E. (1966): Heterosis of the hybrid related to gene frequency differences between two populations. Genetics, 53: 269-274.

Darwish, D.S.; Abdalla, M.M.F.; El-Hady, M.M. and El-Emam, E.A.A. (2005): Investigations on faba beans, *Vicia faba* l. 19- Diallel and triallel matings using five parents. Proc. 4th Plant Breed. Conf. March 5 (Kanal Suez University), 9(1): 197-208.

Dostalova, J. (2002): Strczkowe-zywrose znona od dawna (Pulses-Food Known for ages]. Przem.Spoz, 12: 42-43.

El-Hady, M.M. (1988): Diallel analysis of resistance to chocolate spot disease (*Botrytis fabae* Sard.) and other agronomic traits in faba bean (*Vicia faba* L). Ph. D. Thesis, Fac. Agric. Cairo Univ.

El-Hady, M.M.; Omar, M.A. and Khalil, S.A. (1991b): Heterosis, combining ability and genetic components for yield and its variables in diallel cross of faba bean. Egypt. J. Appl. Sci., 6 (10): 1-13.

El-Hady, M.M.; Omar, M.A.; Nasr, S.M.; Ali, Kh.A. and Essa, M.S. (1998): Gene action on seed yield and some yield components in F_1 and F_2 crosses among five faba bean (*Vicia faba* L.) genotypes. Bull. Fac. Agric. Cairo Univ., 49 (3): 369-388.

El-Hady, M.M..; Gad El-Karim, Gh.A.R.A.; Omar, M.A. and Khalil, S.A. (1991a): Evaluation of some promising faba bean genotypes for combining ability. Egypt. J. Appl. Sci., 6 (10): 226-236.

El-Lithy, R.E.A. (1996): Breeding behaviour of yield and its components in faba bean (*Vicia faba* L.): Ph.D. Theis, Fac. Agric. Minia University, Egypt.

Fahmy, H.H.; Srivastava, S. and Velerrax, M.A. (1996): Physical and textural characteristics of soaked and cooked American common beans. Egypt. J. Food. Sci., 24 (2): 1

Ghareeb, Zeinab E. (2000): Genetical studies on faba bean. M.Sc. thesis, fac. Agric. Zagazig Univ, Egypt.

Hayman, B.I. (1957): Interaction, heterosis and diallel crosses. Genetics, 42: 336-355.

Hayman, B.L. (1954a): The theory and analysis of diallel crosses. Genetics, 39: 789-809.

Hayman, B.L. (1954b):The analysis of variance of diallel tables. Biometrics, 10: 235-244.

Helal, A.G. (1997): Studies on breeding of some genotypes in faba bean (*Vicia faba* L.): M.Sc. Thesis, Fac. Agric. Al-Azhar University, Egypt.

Jinks, J.L. (1954): The analysis of heritable variation in diallel cross of *Nicotiana rustica* varieties Genetics, 39: 767-788.

Korus, J. D. Gumul and Achremovic, B. (2006): The influence of extrusion on chemical composition of dry seeds of bean (*Phaseolus vulgaris* L.). Electronic J. Polish Agric. Univ., 9 (1): 13-23.

Mahmoud, Samia, A.; Basyony, A.E.; Hafez, S.A. and El-Hady, M.M. (1997): Evaluation of faba bean cultivars and some promising breeding lines cultivated in Egypt. Egypt. J. Agric. Res., 75 (2): 505-514.

Mahmoud, Samia, A.; Basyony, A.E.; Amal H. Mahmoud; El-Hady, M.M. and Hafez, S.A. (1998): The relationship between cookabilty characteristics and the different preparing dishes in faba bean. In: Proceedings of 3rd European Conference on Grain Legumes, 14-19 November 1998, Valladolid, Spain, 338.

Mahmoud, Samia. A. (1977): Heterosis and combining ability in some broad bean (*Vicia faba* L.) diallel crosses. Yugoslavia J. Agric. XXV, 73-79.

Mansour, S.H.; Sabah M. Attia; Manal M. Salem and El-Hady, M.M. (2001): Genetic analysis of shedding and some yield characters in faba bean. J. Agric. Sci. Mansoura Univ., 26 (4): 1875-1887.

Mohamed, A.I.A. (2001): Studies on inheritance of some quantitative characters in field bean. M. Sc. Thesis, Fac. Agric. Menoufia Univ.

Naczk, M., Amarowicz, R.; Zadernowski, R. and Shahidi, F. (2001): Protein precipitating capacity of condensed tannins of beach pea, canola hulls, evening primrose and faba bean. J. Food Chem. 73: 467-471.

Nassib, A.M. (1982): Diallel analysis of some agronomic traits in *Vicia faba* L. Ph.D. Thesis, Fac. Agric. Cairo University, Egypt.

Rabie, E.M., Zakia M. Ezzat, Kh. A Abdel-Moneim and Omran, M.M.M. (2003): Genetic analysis of earliness and some yield components in faba bean. Egypt. J. Appl. Sci. 19 (10): 92-110.

Swain, T. and Hillis, W.E. (1959): The qualitative analysis of phenolic constituents. J. Food. Agric. 10: 63.

تقدير الصفات المحصولية وبعض الصفات التكنولوجية والكيميائية لبعض التراكيب الوراثية فى الفول البلدى

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أجريت هذه الدراسة على ستة آباء من الفول البلدى والهجن الناتجة بينها (بدون الهجن العكسية) فى الجيل الأول وذلك لدراسة فعل الجين ومكونات التباين الوراثى لصفة المحصول وبعض مكوناتها مثل عدد أفرع النبات، عدد القرون والبذور للنبات وكذلك وزن الـ ١٠٠ بذرة بالإضافة الى بعض الصفات التكنولوجية والكيميائية.

اظهر تحليل التباين أن هناك فروقا معنوية بين الآباء والهجن لصفات المحصول ومكوناته بالإضافة الى معدل الكثافة، نسبة القشرة للبذرة، نسبة الفلقتين، نسبة المواد الصلبة الذائبة، محتوى البذرة من البروتين والألياف وكذلك الزيوت التانينات والفينولات وذلك يرجع الى التباعد الوراثى بين بعض الأباء. كان تأثير العوامل ذات التأثير الإضافي والغير إضافي واضحاً على كل الصفات. كان تأثير العوامل البيئية غير معنى لجميع الصفات ما عدا صفتي طول النبات وعدد أفرع النبات.

أوضحت نتائج قوة الهجين تفوقا معنويا للهجن مصر ١ x جيزة ٧١٦ ، جيزة ٨٤٣ x جيزة ٧١٦ ، جيزة ٨٤٣ x جيزة ٤٠ ، جيزة ٧١٦ x نوبارية ١ وذلك لصفات المحصول ومكوناته كما اظهرت الصفات الفيزيائية وصفات الطهي قوة هجين فيما عدا نسبة الكربوهيدرات الكلية، وتراوحت كفاءة التوريث بالمعنى الخاص من ٩,٨ % بالنسبة لمحتوى البذرة من التانينات الى ٨٧ % لصفة محتوى البذرة من الكربوهيدرات الكلية.