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ANALYSIS OF YIELD AND ITS COMPONENTS USING DIALLEL MATINGS AMONG FIVE PARENTS OF FABA BEAN

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ABSTRACT

A diallel cross excluding reciprocals among five parents of faba bean (Giza 843, Sakha2, Giza2, Triple white and x – 1468) was used to estimate the heterotic effect of F_1 crosses, combining ability and genetic components for yield and its variables viz: pods, seeds/plant and 100 – seed weight. Analysis of variance indicated highly significant differences among the entries for all the characters. Heterosis over mid and better parents, was highly significant for number of pods, seeds and seed yield/plant. Also highly significant mid-parent heterosis for number of branches/plant was observed. Heterosis over mid parents was, on average 19.95 % for number of branches/plant to 61.24 % for number of pods/plant. On the other hand, heterosis over better parent ranged from 5.22 % for plant height to 87.63 % for number of pods/plant. The two parents: Giza 843 (P_1), Sakha 2 (P_2) showed substantial and highly significant positive general combining ability (gca) effects for 100-seed weight, seed yield/plant. Meanwhile,Giza 2 (P_3) and Triple white (P_4) had highly significant positive (gca) effects for number of pods and seeds/plant. On the other hand, the two parents Sakha 2 (P_2) and X -1468 (P_5) recorded highly significant positive (gca) effects for plant height and 100-seed weight, respectively. Two crosses (Giza 843 x X - 1468) and (Giza 2 x X Triple white) had significant specific combining ability (sca) effects for number of pods, seeds and seed yield/plant. The ratio of gca/sca revealed the preponderance of additive gene action for all characters except plant height. The regression coefficient was close and not significant from unity, indicating absence of epistasis for all studied traits and revealed simple additive gene action system controlling these traits. D component was less than H_1 for plant height, number of pods, seeds and seed yield/plant, indicating the importance of dominance genetic variance. Narrow sense heritability ranged from 51.44 % for number of branches/plant to 87.99 % for 100-seed weight.

Key words: ***Faba bean, Heterosis, Combining ability, Heritability***

INTRODUCTION

Faba bean is an important legume crop in Egypt for both human and livestock, due to its high nutritive value. Seed yield is a complex trait and is quantitatively inherited with low heritability value, (Bond 1966, Kambal

1969 and Yassin 1973). Therefore, yield itself may not be the best criterion for selection, so that breeding for high yield is associated with yield and its components: number of pods, seeds/plant and 100-seed weight (Rowlands 1955).

The diallel analysis is a method for identifying those parents and hybrids that have superior combination of the characters of interest. Superiority of hybrids over the mid and better parents is usually due to some types of gene action and additive effects. Manifestations of heterotic effects ranged from significantly positive to significantly negative values. Even in the absence of epistasis, multiple alleles at a locus could lead to either positive or negative heterosis (Cress 1966).

Combining ability analysis helps the breeder to identify the best combiners which may be hybridized either to exploit heterosis or to build up the favorable fixable genes. In self fertilized crops where commercial exploitation of heterosis, of advantageous, is not always feasible, the breeder will primarily be interested in higher magnitude of additive genetic variance for establishing superior genotypes.

Heritability estimates provide values of relative importance of genetic components to phenotypic variation. Bond (1966), Poulsen (1977), Mahmoud *et al* (1984), El-Hady *et al* (1991-2); El-Lithy (1996), Helal (1997), Abdalla *et al* 1999, Mansour *et al* (2001), Attia *et al* (2002) and Rabie *et al* (2003) reported that narrow sense heritability values were high for 100-seed weight, and low to moderate for seed yield, number of pods and seeds/plant.

The present study aimed to determine the magnitude of heterosis, the general and specific combining ability and the nature of gene action of some faba bean hybrid combinations.

MATERIALS AND METHODS

Giza 843 (P_1), Sakha 2 (P_2), Giza 2 (P_3), Triple white (P_4) and X-1468 (P_5) of faba bean genotypes were included in a 5 x 5 diallel matings during 2003/04 season. The origin and some features of the parents are briefly described in Table (1). Parents and derived ten F_1 hybrids were grown in 2004/05 season under the screen house at Giza Research Station, Agricultural Research Center. A randomized complete block design with three replicates was used. Seeds were planted in single seeded hills, 20 cm apart. Each entry was represented by one row, 3 meters long, 50 cm in between. At maturity ten guarded individual plants were taken at random from each experimental plot for recording plant height, number of branches, pods, seeds, seed yield/plant and 100-seed weight.

Table 1 . Origin and some characteristics of the five faba bean parents.

Genotype		Pedigree	Origin	Flowering	Special remarkable characters
Giza 843	(P_1)	461/845/83 x 561/2076/85	Egypt	Early	Resistant to *Orobanche* and foliar diseases
Sakha 2	(P_2)	Reina. Blanca x 461/845/83	Egypt	Early	Resistant to foliar diseases
Giza 2	(P_3)	Individual selection from land races	Egypt	Early	High yielding ability
Triple white	(P_4)	Individual selection from Sudanese genotype	Sudan	Early	High autofertile
X-1468	(P_5)	716/1036/89 x x.903	Egypt	Early	Resistant to foliar diseases

The heterotic effect of F_1 crosses were estimated as percentage over mid and better parents. Combining ability effects and variances were calculated according to Methods 2, Model 1 of Griffing (1956) including parents and F_1 s without reciprocals. Values of: Vr, Wr components of variation and genetic ratios were estimated according to Jinks (1954). Hayman (1954) and Mather and Jinks (1971). Data were statistically analyzed on plot mean basis.

RESULTS AND DISCUSSION

Results of statistical analysis presented in Table (2) revealed highly significant differences among tested entries for all studied characters, indicating genetic variability for all variables. 100-seed weight recorded the highest mean square followed by plant height. However, number of branches/plant recorded the lowest mean square.

These findings could be mainly attributed to wide genetic diversity between parental genotypes along with F_1 hybrids. Results given in Table (2) revealed highly significant general and specific combining ability variances for all traits and general combining ability variances were larger than specific combining ability variances for only 100-seed weight, indicating that gca effects appeared to be more important than sca effects for this trait. Due to the presence of significant sca and the gca variances, the additive as well as non-additive gene action might be controlling the inheritance of the various studied characters. Similar results were obtained by Bond (1966), Poulsen (1977), Waly (1982), Mahmoud and Al-Ayoubi (1986), El-Hady *et al* (1991 1,2), Rabie *et al* (2003) and Darwish *et al* (2005).

Table 2. Significance of mean squares due to genotypes, general (GCA), specific (SCA) combining ability and ratio of additive (g^2i) to non-additive (s^2i) gene effects for yield and some its components

Source of variation	d f	Plant height (cm)	Number of branches/ plant	Number of pods/ plant	Number of seeds/ plant	100-seed weight (g)	Seed yield/ plant (g)
Genotype	14	1498.71**	2.75**	118.27**	860.60**	1674.24**	466.41**
GCA	4	449.80**	1.93**	77.49**	634.23**	1777.18**	306.76**
SCA	10	519.48**	0.51**	24.20**	147.92**	70.44**	94.95**
σ^2g/σ^2s		-0.02	0.40	0.35	0.51	3.97	0.32
Error	28	67.78	0.003	2.29	11.80	9.06	0.42

*** and ** indicate significance at the 0.05 and 0.01 level of probability, respectively.**

In comparing the relative magnitudes of gca and sca, all the ratios for all measured traits were less than unity except 100-seed weight, indicating that the main genetic variation for these traits was due to non-additive gene action since gca and sca variances are mainly due to additive and non-additive actions, respectively. However, such conclusion does not entirely eliminate the presence of a considerable portion of additive genetic variance in these traits.

The mean performance of parents and F_1's for different characters are presented in Table (3). The Triple white recorded the highest number of pods and seeds/plant and Sakha 2 had the highest 100-seed weight and seed yield/plant. Giza 843 had the tallest plants and Giza 2 exhibited the highest number of branches/plant.

Table 3. Mean performance of parents and their crosses for yield and its components.

Entries	Plant height (cm)	Number of branches /plant	Number of pods /plant	Number of seeds /plant	100-seed weight (g)	Seed yield/ plant (g)
Giza 843 (P_1)	154.67	2.87	14.87	46.93	77.93	36.57
Sakha 2 (P_2)	146.67	4.50	14.27	48.60	95.33	46.33
Giza 2 (P_3)	94.33	4.93	14.40	29.73	64.65	19.22
Triple white (P_4)	153.33	1.87	18.37	49.03	54.63	26.80
X-1468 (P_5)	143.67	4.83	9.80	23.57	85.20	20.03
P_1 X P_2	149.00	4.07	22.37	61.17	88.50	54.70
P_1 X P_3	94.00	4.07	27.90	75.83	52.83	40.00
P_1 X P_4	151.00	3.93	24.97	70.20	71.50	49.83
P_1 X P_5	143.33	4.93	22.00	60.07	90.87	54.43
P_2 X P_3	95.67	4.90	26.53	69.07	62.43	42.87
P_2 X P_4	146.67	4.53	26.77	74.17	55.77	40.50
P_2 X P_5	154.33	4.43	13.50	35.60	105.87	37.63
P_3 X P_4	98.33	5.30	31.90	88.23	43.73	38.17
P_3 X P_5	134.00	5.63	17.40	49.67	51.57	25.47
P_4 X P_5	158.33	3.77	18.33	48.93	71.87	35.00
C.V. %	10.63	2.26	12.54	10.27	7.64	3.01
L.S.D. 0.05	23.52	0.16	4.32	9.81	8.60	1.85

Comparing the performance of crosses to corresponding highest parents, seven crosses (P_1 x P_2, P_1 x P_3, P_1 x P_4, P_1 x P_5, P_2 x P_3, P_2 x P_4 and P_3 x P_4) had higher number of pods and seeds than the highest parent. Only one cross (P_4 x P_5), two crosses (P_3 x P_4 and P_3 x P_5) had the tallest plants and highest branches, respectively. With respect to 100-seed weight only one F_1 cross (P_2 x P_5) produced the heaviest seed.

Three crosses (P_1 x P_2, P_1 x P_4, P_1 x P_5) significantly exceeded the highest parental genotypes for seed yield/plant. It could be concluded that the above-mentioned crosses would prospect in faba bean breeding and therefore may be valuable for improving seed yield and its components.

Mean of heterosis expressed as percent increases of the F_1 hybrids over mid and higher parents are tabulated in Table (4). Highly significant heterosis for number of pods, seeds and seed yield/plant, and also highly significant mid-parent heterosis for number of branches/plant, however, negative heterosis was observed for plant height and 100-seed weight. Similar results were obtained by El-Hady *et al* (1991 -2).

Table 4. Means and ranges of parents, hybrids as well as heterosis percentages for various traits.

Traits	Parents		Hybrids	
	Mean	Range	Mean	Range
Plant height	138.53	94.33 - 154.67	132.27	94.00 -158.33
No. of branches/plant	3.80	1.87 – 4.93	4.56	3.77 – 5.63
No. of pods/plant	14.34	9.80 – 18.37	23.17	13.5 – 31.90
No. of seeds/plant	39.57	23.57 – 49.03	63.29	35.60 – 88.23
100-seed weight (g)	75.55	54.63 – 95.33	69.49	51.57 – 105.87
Seed yield/plant (g)	29.79	19.22 – 46.33	41.86	25.47 – 54.70
Traits	**Heterosis %**			
	Mid-parent		Better-parent	
	Mean	Range	Mean	Range
Plant height	-4.38**	-24.5 -12.61	-12.60**	-39.23 -5.22
No. of branches/plant	19.95**	-5.14 -65.82	-1.04	-21.95 -36.93
No. of pods/plant	61.54**	12.13 – 94.63	43.76**	-5.40 -87.63
No. of seeds/plant	59.93**	-1.36 – 124.05	35.70**	-26.75 -79.95
100-seed weight (g)	-10.33*	-31.63 – 17.28	-18.96**	-41.50 -11.06
Seed yield/plant (g)	40.51**	10.75 – 92.33	13.54**	-27.64 -48.84

Mean values of the F_1 crosses significantly exceeded the mid-parent values with a range of -10.3 % for 100-seed weight to 61.54 % for number of pods/plant. However, heterosis over better performing parent that included into the cross ranged from -39.23 to 5.22 % for plant height, -21.95 to 36.93 % for number of branches/plant, and ranged from -5.40 to 87.63 % for number of pods/plant, -26.75 to 79.95 % for number of seeds/plant, -41.50 to 11.06 % for 100-seed weight and from -27.64 to 48.84 % for seed yield/plant. Among the yield components, the number of pods/plant showed the highest heterosis % followed by number of seeds/plant.

It could be safely suggested that the heterotic effects for number of pods/plant might have contributed significantly to seed yield. These results indicated that heterosis for seed yield/plant was associated with heterosis for number of pods/plant.

Different values of heterosis might be due to, the genetic variability of the parents along with non-allelic interactions, which increase or decrease the expression of heterosis (Hayman 1957 and 1958). These findings are in accordance with those reported by Bond (1966), Abdalla (1977), Abo El-Zahab *et al* (1984), El-Hosary *et al* (1986), El-Hady *et al* (1991 1,2) and Rabie *et al* (2003).

Comparisons between gca effects ($\hat{g}i$) associated with each parent (Table 5), indicated that the two parents Giza 843 (P_1) and Sakha 2 (P_2) showed substantial and highly significant positive gca effects for 100-seed weight and seed yield/plant. On the other hand Giza 2 (P_3) and Triple white (P_4) had highly significant positive gca effects for number of pods and seeds/plant. With respect to sca effects ($s\hat{i}j$), (Table 6) two crosses $P_1 x P_5$ and P_3 x P_4 had significant sca effects for number of pods, seeds and seed yield/plant.. For seed yield only seven crosses P_1 x P_2, P_1 x P_3, P_1 x P_4, P_1 x P_5, P_2 x P_3, P_3 x P_4 and P_4 x P_5 had highly significant sca effects.

Table 5. General combining ability effects ($\hat{g}i$) estimated for various parents and traits.

Parent	Plant height (cm)	Number of branches/ plant	Number of Pods /plant	Number of seeds/ plant	100-seed weight (g)	Seed yield /plant (g)
Giza 843 (P_1)	5.51	-0.44	0.23	1.91	7.20**	6.96**
Sakha 2 (P_2)	8.98**	0.16	-1.09*	-1.51	13.44**	6.43**
Giza 2 (P_3)	5.73*	0.56	3.88**	10.24**	-24.12**	-8.09**
Triple white (P_4)	-10.50**	-0.65	1.91**	4.55**	-8.15**	-0.90**
X-1468 (P_5)	1.74	0.37	-4.93**	-15.19**	11.63**	-4.49**
S.E. $\hat{g}i$	2.78	1.90	0.51	1.16	1.02	0.22
S.E. $\hat{g}i-\hat{g}j$	4.40	3.01	0.81	1.84	1.61	0.35

*, ** 0.05 > P < 0.01

Table 6 . Estimates of specific combining ability effects (Si^j).

Crosses	Plant height (cm)	Number of branches/ plant	Number of pods/plant	Number of seeds/plan t	100-seed weight (g)	Seed yield/plant (g)
$P_1 X P_2$	-1.95	0.05	2.34	2.81	-0.33	4.08^{**}
$P_1 X P_3$	11.43	-0.36	2.89^{*}	5.72	1.55	3.90^{**}
$P_1 X P_4$	21.52^{**}	0.72	1.94	5.78	4.25	6.54^{**}
$P_1 X P_5$	-48.71^{**}	0.70	5.81^{**}	15.39^{**}	3.84	14.64^{**}
$P_2 X P_3$	-5.38	-0.13	2.85^{*}	2.37	4.92	7.30^{**}
$P_2 X P_4$	16.71^{*}	0.72	5.06^{**}	13.17^{**}	-17.72^{**}	-2.26^{**}
$P_2 X P_5$	-3.19	-0.40	-1.37	-5.66	12.61^{**}	-1.63^{**}
$P_3 X P_4$	-23.24^{**}	1.08	5.22^{**}	15.48^{**}	7.80^{**}	9.92^{**}
$P_3 X P_5$	-0.81	0.39	-2.44	-3.34	-4.14	0.72
$P_4 X P_5$	24.62^{**}	-0.26	0.47	1.62	0.19	3.07^{**}
S.E. (Sij)	7.19	4.91	1.32	2.99	2.63	0.57
S.E. (Sij-Skl)	9.84	6.73	1.81	4.11	3.60	0.77

*, ** 0.05 > P < 0.01

From the breeding point of view parents characterized by good general combining ability effects for yield and its components along with heterosis and high estimates of Sca effects are obviously essential. El-Hady (1988) and El-Hady *et al* (1991-2) observed that high general combining lines may not always results in high specific combining ability effects. Therefore, most of the previous crosses may be of importance for breeding programs. These results are in full agreement with those obtained by El-Lithy (1996), El-Hady *et al* (1998), Abdalla *et al* (1999), Attia *et al* (2002) and Rabie *et al* (2003).

Table 7. Values of Vr, Wr and Vr + Wr as well as Wr intercept and regression coefficient values of seed yield and some its components.

Sources	Plant Height (cm)			Number of branches/plant			Number of pods/plant		
	Vr	Wr	Vr+Wr	Vr	Wr	Vr+Wr	Vr	Wr	Vr+Wr
Giza 843 (P_1)	632.86	630.73	1263.59	0.541	0.568	1.110	23.44	15.83	39.27
Sakha 2 (P_2)	582.26	582.80	1165.06	0.088	0.181	0.269	41.71	29.32	71.03
Giza 2 (P_3)	298.08	67.07	365.14	0.343	0.200	0.543	28.63	12.85	41.48
Triple white (P_4)	600.92	591.20	1192.12	1.628	1.448	3.076	33.71	20.54	54.25
X-1468 (P_5)	93.86	181.43	275.28	0.471	0.649	1.120	21.97	13.23	35.20
Intercept	-32.58			0.091			-4.828		
Regression Coefficient	1.0037 ± 0.290			0.8432 ± 0.1186			0.7755 ± 0.2009		

Sources	Number of seeds/plant			100-seed weight (g)			Seed yield/plant (g)		
	Vr	Wr	Vr+Wr	Vr	Wr	Vr+Wr	Vr	Wr	Vr+Wr
Giza 843 (P_1)	121.63	88.88	210.51	234.35	477.70	712.05	70.09	28.56	98.66
Sakha 2 (P_2)	243.18	194.61	437.79	464.95	556.03	1020.98	43.29	52.42	95.71
Giza 2 (P_3)	195.83	118.95	314.78	328.99	570.91	899.90	184.67	175.75	360.42
Triple white (P_4)	288.11	212.98	501.09	145.79	283.03	428.82	70.18	45.39	115.58
X-1468 (P_5)	200.43	148.97	349.40	420.76	633.95	1054.72	174.57	126.06	300.64
Intercept	-15.124			217.459			-10.874		
Regression Coefficient	0.8006 ± 0.1325			0.8993 ± 0.2937			0.8890 ± 0.1966		

Values of Vr,Wr and Vr + Wr are presented in Table (7). None of the parental genotypes had the maximum number of dominant alleles for any trait under study.

The regression coefficient was close and not significant from unity, indicating absence of epistasis for all studied characters and revealed simple additive gene action system controlling these traits. However; b value significantly differed from zero for all studied traits except 100-seed weight, indicating interactions between concerned parents.

Wr- intercept values, (Table 7) were negative which revealed the presence of over dominance for plant height, number of pods, seeds and seed yield/plant, whereas, number of branches/plant and 100-seed weight showed partial dominance. Jinks (1955) reported that over dominance effects were frequently artifacts caused by non-allelic interaction involving one or more parental arrays. These results agreed with those detected by Abo El-Zahab *et al* (1984), Nassib *et al* (1984), El-Hady (1988), El-Hady *et al* (1991 1,2) and Rabie *et al* (2003).

Estimated values of genetic components and ratios are presented in Table (8). Additive genetic variance (D) was highly significant for all traits. This may give evidence that additive genetic variance was more important for all traits under study.

The covariance of additive and dominance effects over all arrays (F) significantly different from zero in the positive direction for number of branches/plant indicating the presence of dominance alleles in the parents. For other characters, significantly negative values were observed for number of pods and seeds/plant.

The components of H_1 and H_2 significantly differed from zero except for 100-seed weight. Theoretically, H_2 should be equal to or less than H_1 (Hayman 1954). H_1 was greater than H_2 indicating that the positive and negative alleles at the loci were not equal in proportion in the parents. Since D was greater than H_1 for number of branches/plant and 100-seed weight, this suggested that additive genetic variance was more important. However, plant height, number of pods, seeds and seed yield/plant showed higher values of H_1 than D, indicating the importance part of dominance genetic variance. These results are in accordance with those obtained by El-Hosary (1981), Abo El-Zahab *et al* (1984), Nassib *et al* (1984), El-Hady *et al* (1991 1,2) and Rabie *et al* (2003).

Table 8. Estimates of genetic components, heritability and environmental variances

Components and ratios	Plant height (cm)	Number of branches/plant	Number of pods/plant
D	$627.24 \pm 91.93^{**}$	$1.83 \pm 0.12^{**}$	$27.11 \pm 2.59^{**}$
F	-384.80 ± 229.65	$1.25 \pm 0.30^{**}$	$-17.21 \pm 6.46^{*}$
H_1	$744.43 \pm 248.27^{**}$	$1.79 \pm 0.32^{**}$	$69.32 \pm 6.99^{**}$
H_2	$555.89 \pm 225.19^{*}$	$1.51 \pm 0.29^{**}$	$61.95 \pm 6.34^{**}$
h^2	91.58 ± 152.03	$1.44 \pm 0.20^{**}$	$117.73 \pm 4.28^{**}$
E	4.13 ± 37.53	0.003 ± 0.004	$2.46 \pm 1.06^{*}$
$(H/D)^{1/2}$	1.089	0.99	1.60
$H_2/4H_1$	0.187	0.21	0.22
KO/KR	0.720	1.50	0.79
h^2/H_2	0.165	0.96	1.99
Heritability	80.75	51.44	59.02
Components and ratios	**Number of seeds/plant**	**100-seed weight (g)**	**Seed yield/plant (g)**
D	$240.35 \pm 14.56^{**}$	$1017.72 \pm 52.73^{**}$	$197.63 \pm 18.28^{**}$
F	$-120.99 \pm 36.38^{**}$	26.19 ± 131.73	53.34 ± 45.66
H_1	$448.53 \pm 39.33^{**}$	260.21 ± 142.42	$288.10 \pm 49.36^{**}$
H_2	$390.04 \pm 35.68^{**}$	236.69 ± 129.17	$257.90 \pm 44.77^{**}$
h^2	$644.77 \pm 24.09^{**}$	32.37 ± 87.21	$493.18 \pm 30.23^{**}$
E	$12.28 \pm 5.95^{*}$	10.06 ± 21.53	0.77 ± 7.46
$(H/D)^{1/2}$	1.37	0.51	1.21
$H_2/4H_1$	0.22	0.23	0.22
KO/KR	0.81	1.03	1.14
h^2/H_2	1.65	0.14	1.91
Heritability	65.66	87.99	57.22

* and ** Significance at the 0.05 and 0.01 levels, respectively.

The proportion (H_2/H_1) was lower than 0.25 suggested that positive and negative alleles were not equally distributed among the parents. The parents seemed to carry more dominant alleles than recessive as indicated by the positive values of F components.

In a like manner, estimates of KD/KR were greater than one for number of branches, seed yield/plant and 100-seed weight which indicated an excess of dominant genes in the parents for these three traits.

Narrow sense heritability ranged from 51.44 % for number of branches/plant to 87.99 % for 100-seed weight. These results revealed that dominant genetic variance were more important to the traits under study and more affected by environmental fluctuations than 100-seed weight.

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التحليل للمحصول ومكوناته باستخدام الهجن التبادلية لخمسة آباء من الفول البلدى

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اجريت هذة الدراسة على خمسة أباء من الفول البلدى (جيزة ٨٤٣ ، سخا ٢ ، جيزة ٢ ، Triple white ، X-1468) وجميع هجن الجيل الاول التبادلية الناتجة منها (بدون الهجن العكسية) لدراسة التفاوت الهجينى والقدرة على الائتلاف ومكونات التباين الوراثى لصفة المحصول وبعض مكوناتها مثل عدد القرون والبذور للنبات وكذلك وزن الـ ١٠٠ بذرة .

أظهر تحليل التباين ان هناك فروقا عالية المعنوية بين الاباء والهجن لجميع الصفات المدروسة . واظهرت صفة عدد افرع النبات تفوقا معنويا بالنسبة لمتوسط الابوين . تراوحت قوة الهجين بالنسبة للاب الاعلى من ٥,٢٢ % لصفة طول النبات حتى ٨٧,٦٣ % لصفة عدد قرون النبات . أظهر الابوان جيزة ٨٤٣ و سخا ٢ مقدرة عامة على الائتلاف لصفتى محصول النبات ووزن الـ ١٠٠ بذرة وتشير نسبة القدرة العامة على الائتلاف الى القدرة الخاصة على الائتلاف ان جميع الصفات تتأثر بالعوامل ذات التأثير التجميعى ماعدا صفة طول النبات اشارت النتائج ان مكونات " D " كانت اقل من H_1 لصفات طول النبات و عدد قرون وبذور النبات وكذلك وزن بذور النبات مما يشير الى ان التباين الوراثى السيادى كان اكثر اهمية من التباين الوراثى المضيف لهذة الصفات . اظهرت النتائج ان كفاءة التوريث بالمعنى الخاص قد تراوحت من ٥١,٤٤% لصفة عدد افرع النبات حتى ٨٧,٩٩ % لصفة وزن الـ ١٠٠ بذرة .

المجلة المصرية لتربية النبات: ١٠(١): ١-١٢ (٢٠٠٦)