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TYPES OF GENE EFFECTS OF SOME ECONOMIC TRAITS IN FABA BEAN (*Vicia faba* L.)

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ABSTRACT

Three crosses of fabe bean (Vicia faba L.) *(Mansoura 1 x Kassain 1) (Mansoura 1 X Icaras) and (Kassain 7 x Aquadolce), their six population (P_1 x P_2, F_1, F_2, BC_1 and BC_2) were tested for total green pod yield, some of yield components and some growth attributes. Significant positive heterotic effects to mid-parents value were detected for all studied traits. Over dominance for the higher parent was found for number of seeds per pod and total green pod yield, while over dominance for the lower parent was found for first fruiting node in the three crosses. Significant values of inbreeding depression were detected for most studied characters.*

Significant epistatic effects, i.e. , E_1 and E_2 were detected for most studied traits. Additive gene effects were significant in all traits in the three crosses. Dominance types of gene action was found to be significant for all traits except number of branches per plant in the cross " Mansoura 1 x Icarus " and pod length in the cross " Kassasin 7 x Aquadolce ".

Additive X additive type of gene action was found to be significant for all traits except first fruiting node, number of seeds per pod and pod length in the cross " Kassasin 7 x Aquadolce ". Also, additive X dominance and dominance X dominance types of gene action was found to be significant in the three crosses for most traits.

Heritability estimates in broad sense were moderate to high in magnitude with values between 51.73% (for number branches/ plant) to 81.42% (for first fruiting node). Heritability estimates in narrow sense, were moderate to high in magnitude with values between 37.03% for Days to flowering in the third cross to 71.45% for first fruiting node.

The predicted genetic advance from selection was rather moderate for number of branches/ plant, first fruiting node, number of pods/ plant, number of seeds/ pod and pod weight in the three crosses, while, it was low for remain traits. The results indicated that " Monsoura1 X Kassain1" was superior in total green pod yield and its components.

Key words: *Vicia faba*, **Gene effect, Genetic advance.**

INTRODUCTION

The different gene actions involved in the inheritance of quantitative characters are additive and non-additive. The relative importance of these two components provides the breeders with a valuable information about the possibilities and methods to improve these characters. Where both additive and non-additive gene action are important, it is advisable to adapt recurrent selection for handling such population. If the additive gene action appears to be more important, plant breeder through exact designed selection program must expect a maximum improvement in this particular character. On the other hand, the presence of a relatively high non-additive (dominance and epistasis) gene action suggests that a hybrid program will be performed good prospects for the character(s).

To start a successful breeding program for improving any quantitative characters, the breeder should know the variation, heritability and the nature of gene action controlling the various characters. In this respect, El-Hosary (1981 and 1983 a and b), Abo El-Zahab (1984), Bakheit (1992) and El-Shazly *et al* (1995) and El-Refaey (1999) reported that both additive and non additive genetic effects controlled the genetic systems for yield traits, while, the dominance gene effects were higher in magnitude than additive one for yield and its components. Also, El-Tabbakh and Ibrahim (2000) indicated that additive and additive x additive types of gene action controlled some traits, i.e., number of branches/ plant and number of pods/ plant, while the non additive gene action controlled the inheritance of plant height and seed yield/ plant. Information on heterosis and combining ability helps the breeders to choice of suitable parents for the breeding programs. El-Refaey (1999) found high significant positive heterosis over both mid and betters for plant height, number of pods, seed yield/ plant. El-Tabbakh and Ibrahim (2000) reported that heterosis values relative to better parent ranged from --17.24 to 7.76 for plant height, -36.31 to 13.12% for 100- seed weight, -19.10 to 68.49% for seed yield/ plant, -45.0 to 27.50% for number of branches/ plant and -13.43 to 11.71% for number of pods/ plant. Concerning the inbreeding depression, El-Refaey (1999) reported that highly significant inbreeding depression values were observed for most traits. This investigation aimed to obtain more information about the different gene actions involved in the inheritance of nine quantitative characters in faba bean cultivars. Heterosis, inbreeding depression F_2 and back cross deviation, heritability and genetic advance were the objective of this study.

MATERIALS AND METHODS

This study was carried out during three successive winter seasons of 2001/02, 2002/03 and 2003/04 at the Experimental Farm of El-Gemmeza Agriculture Research Station, Gharbia Governorate. Five faba beans (*Vicia faba* L.) cultivars were chosen, each cv., possessed at least one or two of the characters to be studied (Table 1). The parental cultivars: Mansoura 1, Kassasin 1, Kassasin 7, Icarus and Aquadolce were used to generate the experimental materials used in this study. Three initial crosses, "Mansoura 1 X Kassasin 1"," Mansoura 1 x Icarus" and "Kassasin 7 x Aquadolce" were designated in the text as the first, the second and the third cross, respectively, and were developed in 2001/02. The F_1 plants were selfed and back crossed to their parents to produce the required F_2 and back cross seeds, respectively, in 2002/03 growing season. In the winter season of 2003/04, parents, F_1, F_2, BC_1 and BC_2 populations of the three crosses were evaluated in a randomized complete block design with three replicates.

Table 1. Name and origin of the parental cultivars.

Parent number	Cultivar	Origin
1	Mansoura 1	Egypt
2	Kassasin 1	Egypt
3	Kassasin 7	Egypt
4	Icarus	Syria
5	Aquadolce	Spain

In each replicate, three ridges were allocated to each of the non-segregating populations (P_1, P_2 and F_1), six ridges for each backcross and ten ridges for the F_2 populations. Each ridge of one side comprised of fifteen hills spaced at thirty centimeter apart within ridges of sixty five-centimeter widths. Fertilization, irrigation, disease and insect control programs were carried out as usual for the ordinary faba bean fields in the area.

Observation and measurements were recorded on an individual guarded plants of the six populations of each cross regarding the following characters: plant height, days to flowering, number of branches per plant, number of first fruiting node, number of pods per plant, number of seeds per pod, pod weight, pod length and total green pod yield.

Statistical and genetic analysis

Average degree of heterosis was expressed as the percentage increase or decrease of the F_1 performance from the mid parents (MP) and the better parental (BP) values. Inbreeding depression (ID%) was calculated as the differences between the F_1 and F_2 means expressed as a percentage of the F_1. Potence ratio (P), F_2 deviation (E_1) and backcross deviation (E_2) were measured as suggested by Mather and Jinks (1971).

The six populations' means of each cross were used to estimate the type of gene effects as illustrated by Gamble (1962). The estimated gene effects included the mean effect parameter (m), additive (a), dominance (d), additive x additive (aa), additive x dominance (ad) and dominance x dominance (dd).

Heritability was calculated in both brood and narrow sense. Broad-sense heritability h^2_b was estimated according to Burton (1951). Narrow-sense heritability h^2_n was estimated as proposed by Warner (1952). The predicted genetic advance under selection ($\Delta g\%$) was computed according to Johnson *et al* (1955). This genetic gain represented as percentage of the F_2 mean performance ($\Delta g\%$) was calculated following Miller *et al* (1958). Genotypic coefficient of variation (GCV) was estimated as the formula developed by Burton (1952). Phenotypic coefficient of variation (PCV) was estimated using the method of Johnson *et al.* (1955).

RESULTS AND DISCUSSION

Number of plants, mean and variance values of nine studied traits for parents, F_1, F_2, BC_1 and BC_2 of the three crosses are presented in Table 2. All studied characters showed significant genetic variance in F_2 plants in the three crosses, therefore, other parameters were studied.

Heterosis, inbreeding depression (I.D.%), potence ratio, F_2 deviation (E1), back cross deviation (E2) and gene action in the three crosses of faba bean are presented in Table (3).

Highly significant positive heterotic effect to mid-parents value for all studied traits in the three crosses except plant height in the first and third cross, pod weight in the second cross and pod length in the third cross. Concerning days to flowering in the first and second cross and first fruiting node in the three crosses, they gave significant negative heterotic effect to mid-parents.

In the three crosses, total green pod yield , number of seeds per pod, number of branches per plant and days to flowering(in the second and third crosses) and number of pods per plant(in the first and second crosses) expressed significant positive heterotic effects relative to the better parent. These results are in close harmony with El-Hosary (1981 and 1983 a), El-Hosary *et al.* (1986), El-Refaey (1987 and 1999), Hendawy (1994 a and b),

Table 2. Number of plants, mean (x) and variance (S^2) values for six populations of the faba bean crosses for the studied characters .

Cross	Population	No. of plant	Plant height (cm)		No. of branches/ plant		Days to flowering		First fruiting node		No. of pods / plant		No. of seeds/ pod		Pod weight (g)		Pod length (cm)		Total green pod yield (g)	
			x	s^2	x	s^2	x	s^2	x	s^2	x	s^2	x	s^2	x	s^2	x	s^2	x	s^2
Mansoura 1 X Kassasin 1	P_1	40	104.65	5.26	6.23	0.18	48.85	1.67	5.50	0.26	20.28	1.82	4.13	0.11	14.23	0.81	14.33	0.33	287.35	36.54
	P_2	40	114.28	6.51	7.30	0.22	43.48	1.64	6.33	0.23	26.98	3.56	3.08	0.07	17.16	0.97	15.18	0.30	461.63	32.39
	F_1	40	110.03	9.46	6.90	0.50	40.20	3.60	5.35	0.23	31.38	4.34	4.20	0.16	17.01	2.55	15.20	0.52	530.50	34.36
	F_2	350	109.84	19.03	6.86	0.62	47.41	5.42	5.89	0.55	30.26	8.70	3.75	0.50	16.11	3.69	14.43	1.20	486.60	117.09
	BC_1	150	107.88	13.81	6.99	0.47	45.51	4.44	5.49	0.51	27.08	7.15	4.46	0.36	14.62	2.56	14.63	0.88	392.31	109.09
	BC_2	150	119.97	14.85	7.39	0.50	43.68	3.84	5.90	0.32	32.25	5.65	3.60	0.40	16.26	2.80	15.35	0.82	523.83	77.01
Mansoura 1 X Icarus	P_1	40	104.65	5.26	6.38	0.24	48.85	1.67	5.50	0.26	20.28	1.82	4.13	0.11	14.23	0.81	14.33	0.33	280.35	36.54
	P_2	40	116.08	5.40	7.25	0.50	58.53	5.64	6.43	0.25	27.10	1.73	3.07	0.06	16.93	0.2	13.15	0.13	455.28	38.56
	F_1	40	113.20	7.29	7.70	0.68	49.83	6.25	5.20	0.22	29.90	3.73	4.27	0.20	15.78	1.67	14.33	0.48	470.13	18.16
	F_2	350	110.12	23.41	7.26	1.33	54.85	19.35	5.29	1.30	27.82	7.63	3.94	0.43	12.74	2.49	13.87	0.86	351.41	103.77
	BC_1	150	106.67	14.98	6.47	0.64	48.41	13.69	4.85	0.91	29.21	5.74	4.59	0.24	14.71	1.91	14.91	0.62	427.56	87.14
	BC_2	150	117.42	17.04	7.29	1.28	54.27	14.21	6.52	0.76	30.43	5.64	4.21	0.39	17.23	1.99	14.15	0.65	520.24	69.19
Kassasin 7 X Aquadolce	P_1	40	113.98	4.38	6.40	0.35	33.28	2.05	5.45	0.25	26.45	3.28	3.17	0.14	11.31	0.91	11.33	0.53	298.50	24.15
	P_2	40	105.35	4.29	7.23	0.33	39.88	3.60	7.10	0.30	19.65	2.08	4.03	0.17	19.27	0.74	12.65	0.34	377.40	18.30
	F_1	40	111.33	4.84	7.55	0.51	37.48	2.97	5.38	0.24	24.18	1.99	4.27	0.27	18.20	0.52	12.33	0.53	440.35	21.98
	F_2	350	107.33	13.38	6.83	1.29	38.13	7.40	5.68	0.67	24.00	12.72	3.84	0.58	16.60	2.36	12.29	1.37	397.61	73.36
	BC_1	150	115.57	8.52	6.91	0.94	32.87	6.94	4.65	0.43	30.95	8.62	3.68	0.38	12.33	1.59	11.69	1.01	379.85	52.56
	BC_2	150	107.84	10.83	7.27	1.00	37.99	5.13	6.76	0.61	21.52	9.33	4.08	0.52	18.47	1.92	12.92	1.00	395.53	62.26

Table 3. Heterosis, inbreeding depression, potence ratio (P), F_2 deviation (E_1), back cross deviation (E_2) and different types of gene actions for studied characters in three crosses of faba bean (*Vicia faba* L.).

Character	Cross	Heterosis %		Inbreeding depression (I.D)	Potence ratio	F_2 deviation (E_1)	BC deviation (E_2)	Gene action (six parameters) Gamble					
		MP	BP					a	d	aa	ad	dd	m
Plant height	I	0.51	-3.72**	0.17	0.12	0.099	8.359**	-12.09**	16.88**	16.32**	-7.27**	-33.04**	109.84**
	II	2.57**	-2.48**	2.72**	0.50	-1.661**	0.524	-10.75**	10.53**	7.69**	-5.04**	-8.74**	110.12**
	III	1.52	-2.33*	3.59**	0.39	-3.165**	2.419**	7.73**	19.16**	17.50**	3.41**	-22.34**	107.33**
No. of branches/ plant	I	2.03**	-5.48**	0.58	0.26	0.029	0.717**	-0.41**	1.46**	1.32**	0.13	-2.76**	6.86**
	II	13.03**	6.21**	5.71**	2.03	0.004	-0.753**	-0.83**	-0.63	-1.52**	-0.39**	3.03**	7.26**
	III	10.83**	4.50**	9.59**	1.79	-0.356**	-0.189	-0.36**	1.78**	1.04**	0.05	-0.67	6.83**
Days to flowering	I	-12.92**	-7.53**	-17.95**	2.22	4.233**	2.831**	1.83**	-17.23**	-11.27**	-0.85**	5.61**	47.41**
	II	-7.19**	2.00**	-10.08**	-0.80	3.092**	-0.826	-5.86**	-17.88**	-14.02**	-1.02*	15.67**	54.85**
	III	2.46**	12.62**	-1.74	0.27	1.104**	-3.197**	-5.12**	-9.91**	-10.81**	-1.82**	17.20**	38.13**
First fruiting node	I	-9.51**	-2.73**	-10.36**	-1.36	0.263**	0.131	-0.41**	-1.35**	-0.79**	0.01	0.53	5.89**
	II	-12.79**	-5.45**	-1.76	-1.65	-0.290**	0.211	-1.67**	0.82**	1.85**	-1.20**	-2.00**	5.29**
	III	-14.34**	-1.38*	-5.62**	-1.09	-0.148*	-0.243	-2.11**	-0.80**	0.10	-1.29**	0.38	5.68**
No. of pods/ pod	I	32.79**	16.31**	3.55**	2.31	2.759**	4.324**	-5.17**	5.36**	-2.39**	-1.82**	-6.26**	30.26**
	II	26.21**	10.33**	6.97**	1.82	1.022**	6.050**	-1.21**	14.22**	8.01**	2.20**	-20.11**	27.82**
	III	4.88**	-8.60**	0.74	0.33	0.385	5.242**	9.43**	10.07**	8.94**	6.03**	-19.43**	24.00**
No. of seeds/ pod	I	16.67**	1.82	10.82**	1.14	-0.154**	0.260*	0.86**	1.74**	1.14**	0.34**	-1.66**	3.75**
	II	18.66**	3.43**	7.72**	1.27	0.006	0.938**	0.38**	2.52**	1.85**	-0.15*	-3.73**	3.94**
	III	18.52**	5.79**	10.12**	1.54	-0.098	-0.107	-0.40**	0.85**	0.18	0.03	0.03	3.84**
Pod weight	I	8.40**	-0.87	5.30**	0.90	-0.242	-1.826**	-1.64**	-1.37*	-2.69**	-0.17	6.34**	16.11**
	II	1.28	-6.79**	19.24**	0.15	-2.936**	0.613*	-2.54**	13.17**	12.97**	-1.19**	-14.20**	12.74**
	III	19.05**	-5.55*	8.79**	0.73	-0.144	-2.691**	-6.14**	-1.89**	-4.81**	-2.15**	10.19**	16.60**
Pod length	I	3.05**	0.16	5.09**	1.06	-0.549**	0.030	-0.71**	2.71**	2.26**	-0.29**	-2.32**	14.43**
	II	4.28**	0.00	3.21**	1.00	-0.166*	0.998**	0.77**	3.24**	2.66**	0.18	-4.65**	13.87**
	III	2.82	-2.57	0.30	0.51	0.132	0.301	-1.23**	0.41	0.07	-0.56**	-0.67	12.29**
Total green pod yield	I	41.66**	14.92**	8.28**	1.79	34.103**	11.153**	131.53**	41.90**	114.11**	-44.39**	91.80**	486.60**
	II	26.61**	3.26**	25.25**	1.18	69.313**	106.45**	-92.59**	588.98**	490.16**	-8.62**	703.08**	351.41**
	III	30.30**	16.68**	9.71**	2.60	8.459**	-2.913*	-15.68**	62.74**	-39.66**	23.77**	45.49**	397.61**

El-Tabbakh and Ibrahim (2000), and Farag and Helal (2004). Number of branches per plant, number of pods per plant, number of seeds per pod and pod weight are the main components for total yield per plant. Hence, heterotic increase shown in any of the four components may lead to considerable yield increase in hybrids, as shown in Table (3) .

As to inbreeding depression, highly significant positive values were obtained for number of seeds per pod, pod weight and total green pod yield in the three crosses, plant height and number of branches in the second and third crosses and number of pods per plant and pod length in two crosses (the first and the second). This is logic and expected since the expression of heterosis in F_1 will be followed by a considerable reduction in F_2 performance.

Over dominance for high or low parent was detected for total green pod yield, number of seeds per pod and first fruiting node in the three crosses, number of branches per plant in the second and third crosses, number of pods per plant in the first and second crosses and days to flowering and pod length in the first cross. Complete dominance for the high parent was found for pod length in the second cross, while partial dominance toward the better parent was found for pod weight in the first and third crosses, pod length in the third cross, plant height and days to flowering in the second cross and number of branches in the first cross. No dominance was found for plant height in the first and third crosses, number of branches in the first cross, pod weight in the second cross and days to flowering and number of pods per plant in the third cross. The potence ratio values indicated that there were all types of dominance , i.e., over, complete, partial and no dominance for all traits under study. Generally, potence ratio values were found to follow the same pattern of the heterosis degree in all traits of the three crosses. These results of heterosis, inbreeding depression and potence ratio were supported by similar findings obtained by El-Hosary (1983 a), El-Refaey (1987 and 1999), Bargale and Billore (1990), Hendawy (1994 a and b) Melchinger *et al.* (1994) and Farag and Helal (2004).

Significant F_2 deviations (E_1) were obtained for all studied traits, except for plant height in the first cross, number of branches per plant in the first and second cross, pod weight in the first and third cross, number of seeds per pod in the second and third cross and number of pods per plant and pod length in third cross. This result reveals that the epistatic gene effects might have a major contribution in the inheritance of these characters.

For estimating various types of gene effects, the variety with a large mean value in each trait was usually considered as P_1. In all traits the mean effect of parameters (m) was highly significant (Table 3). The estimates of parameter (a) are quite small in magnitude relative parameter (d) in most crosses under studies (Table 3). Additive gene effects (a) were highly significant for all studied traits in all crosses. These results indicated the potentiality of improving the performance of these traits by using pedigree selection program. The dominance effect (d) was almost highly significant for all studied traits in all crosses except number of branches per plant in the second cross and pod length in the third one. Moreover, the additive gene effects were more important and greater than the dominance gene effects (Table 3). Dominance gene action would tend to favor the production of hybrids, while, for additive gene action, the significant standard selection procedures would be effective in bringing about advantageous changes in the characters.

The estimated value of additive x additive (aa) epistatic type was almost highly significant for all traits, except for first fruiting node, number of seeds per pod and pod length in the third cross. Also, the additive x dominance gene effect (ad) was significant for all traits except for number of branches per plant in the first and third crosses, first fruiting node and pod weight in the first cross, pod length in the second cross and number of seeds per pod in the third cross. Generally, significant one or more of the three types of epistatic gene effects were exhibited in the three crosses for all studied traits (Table 3). The epistatic type of dominance x dominance was found to be significant for all traits under study except number of branches/plant in the third cross, first fruiting node in the first and third cross, number of seeds/pod and pod length in the third cross.

The type of gene action reported by El-Hosary (1981 and 1983 b), Hendawy *et al* (1988), Hendawy (1994 a and b) and El-Refaey (1999) in faba bean were rather confirmed by the type of variation which found in this investigation.

Lush (1948) gave the term heritability to define the relation between genotypic and phenotypic variances as broad sense heritability, and the relation between additive and phenotypic variance as narrow sense heritability. Heritability values are important to the breeder since it quantifies the expected improvement upon selection. To achieve genetic improvement through selection, heritability must be reasonably high. In the present investigation, heritability estimates in broad sense h^2_b were moderate to high in magnitude with values ranging between 51.73% for number of branches per plant, in the first cross, to 81.42 for first fruiting node, in the second cross. For plant height, days to flowering, and first fruiting node in the second cross, number of seeds per pod in the first and second crosses, number of pods per plant in the third cross and total green pod yield in the three crosses, high estimates of broad sense heritability were detected. However, number of branches per plant, pod weight and length in the three crosses, number of pods per plant in the first and second crosses, plant height, days to flowering and first fruiting node in the first and third crosses and number of seeds per pod in the third cross, moderate values in broad sense were obtained.

Narrow sense heritability h^2_n estimates ranged from 37.03% for days to flowering in the third cross to 71.45% for first fruiting node in the second cross (Table 4). Such results agreed with those obtained from gene action studies (Table 3). Similar results were obtained by El-Hosary (1983 a and b), El-Hosary and Nawar (1984), Guo (1986), El-Refaey (1987 and 1999), Dawwam and Abdel-Aal (1991), Hendawy (1994 a and b) and Ramgiry (1997).

Genetic coefficient of variation (GCV) showed moderate values for number of seeds per pod in the three crosses, number of branches per plant and first fruiting node in the second and third crosses and number of pods per plant in the third cross. The other traits had low values of GCV% (Table 4). It is used alone, this will be easier when the heritability estimates and genetic gain were available (Swarup and Chavgal 1962). The genetic advance under selection (Table 4) depends on the amount of genetic variability, the magnitude of masking effect of the environment and in density of selection that is practiced. In terms of the progress expected, the effect in future generations, due to the non-additive variance, is included in study was derived by using heritability in narrow sense. The predicted genetic advance was rather moderate for all studied traits except for number of branches and first fruiting node in the first cross and pod length in the second cross was low.

In the present investigation, moderate heritability values were detected for all studied traits in the three crosses. Therefore, selection for these traits could be affective and satisfactory for successful breeding purposes. These results are in agreement with those find by Dawwam and Abdel-Aal (1991), El-Refaey (1992 &1999), Gayanendra *et al.* (1993) and Ramgiry (1997).

Table 4. Heritability estimates, , genetic advance (Δ g) and genetic advance expressed as percentage of the F2 mean (g%) and genotypic and phenotypic of variation of the three crosses of faba bean for the studied characters.

Character	Cross	Heritability		Genetic advance		GCV%	PCV%
		Broad since	Narrow since	Δ g	Δ g%		
Plant height	I	62.81	49.40	19.37	17.63	3.148	3.972
	II	74.43	63.23	30.49	27.69	3.790	4.393
	III	66.34	55.38	15.26	14.22	2.776	3.408
No. of branches/ plant	I	51.73	44.20	0.56	8.22	8.251	11.472
	II	64.57	55.83	1.53	21.12	12.780	15.905
	III	69.22	49.16	1.31	19.15	13.846	16.643
Days to flowering	I	57.64	47.29	5.28	11.14	3.726	4.912
	II	76.27	53.47	20.98	38.25	6.949	7.957
	II	61.16	37.03	5.65	14.81	5.580	7.135
First fruiting node	I	56.94	50.80	0.58	9.82	9.522	12.619
	II	81.42	71.45	1.91	36.05	19.412	21.514
	III	60.39	43.22	0.59	10.45	11.173	14.378
No. of pods/ pod	I	62.71	52.85	9.47	31.29	7.718	9.746
	II	68.15	50.80	7.98	28.70	8.196	9.929
	III	80.73	58.94	15.44	64.35	13.352	14.861
No. of seeds/ pod	I	76.82	47.86	0.49	13.15	16.540	18.871
	II	70.35	51.08	0.45	11.38	13.901	16.575
	III	66.35	44.97	0.54	14.03	16.185	19.870
Pod weight	I	61.02	54.74	4.16	25.84	9.316	11.927
	II	54.51	42.78	2.19	17.19	9.135	12.373
	III	69.44	51.52	2.51	15.10	7.714	9.257
Pod length	I	68.04	58.87	1.46	10.11	6.270	7.601
	II	63.40	52.07	0.92	6.62	5.312	6.672
	III	65.89	53.47	1.51	12.27	7.729	9.522
Total green pod yield	I	70.59	41.06	99.04	20.35	1.868	2.224
	II	70.04	49.35	105.50	30.02	2.426	2.899
	III	71.72	43.48	65.70	16.52	1.812	2.154

The expected response to selection, which varies with the phenotypical standard deviation of population means, and which is a measure of the total variability of the trait, could therefore, reflects the total response that could be realized by breeding techniques.

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طبيعة فعل ألجين لبعض الصفات الاقتصادية في الفول الرومي

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أجرى هذا البحث بالمزرعة البحثية لمحطة البحوث الزراعية بالجميزة ـــ محافظـــة الغربيـــة والتابعة لمركز البحوث الزراعية خلال المواســـم (٢٠٠١/٢٠٠٢ ، ٢٠٠٢/٢٠٠٣ ، ٢٠٠٣/٢٠٠٤) على ثلاث هجــن من الفول الرومي . الأول "منصورة ١ × قصاصين ١ " والثـــاني " منصـــورة ١ × ايكاروس " والثالث " قصاصين ٧ × اكوادولسى "، وشملت الدراسة في كل منهم على ست عشائر هـي الأبوان والجيلان الأول والثاني وجيلا الهجينين الرجعيين لتسع صفات هي ارتفاع النبات ، عدد الفروع بالنبات ، عدد الأيام حتى الإزهار ، ارتفاع أول قرن ، عدد القرون بالنبات ، عدد البذور في القـــرن ، وزن القرن ، طول القرن ، محصول القرون الخضراء للنبات.

ويمكن تلخيص أهم النتائج المتحصل عليها كآلاتي:

كانت قوة الهجن معنوية وموجبة لمعظم الصفات تحت الدراسة لمتوسط الآباء للثلاث هجــن. بالنسبة لدرجة السيادة فقد كانت السيادة فائقة للأب الأعلى وذلك لصفات عـــدد البــذور فـــي القـــرن ومحصول القرون خضراء بينما كانت السيادة فائقة للأب الأدنى لصفة ارتفاع أول قرن على النبـــات وذلك للثلاث هجن.

بالنسبة لمعامل التربية الداخلية فقد ظهر نقصا موجبا ومعنويا لمعظم الصفات المدروســـة ، كانت قيم الانحراف الراجع إلى التفاعل الجينى E2 , E1 معنوية لمعظم الصفات

بالنسبة لطبيعة فعل الجينات كان أثر فعل الجينات من النوع المضيف معنويا لكـــل الصفـــات المدروسة . بينما كان فعل الجينات من النوع السيادي معنويا لكل الصفات عدا عدد الفروع للنبات فـــي الهجين الثاني و متوسط وزن القرن في الهجين الثالث.

.كان فعل الجينات من النوع التفوقى (المضيف × المضيف) معنويا لكل الصفات عدا ارتفـــاع أول قرن ، عد البذور في القرن ومتوسط وزن القرن في الهجين الثالث ، وأيضا كان فعل الجينات مـــن النوع (المضيف × السيادي) أو) السيادي × السيادي) معنويا لمعظم الصفات المدروسة.

كانت قيم معامل التوريث بمعناها الواسع متوسطة إلى عالية وتراوحت من ٥١,٧٣ لصفه عدد الفروع للنبات في الهجين الأول إلى ٨١,٤٢ لصفة ارتفاع أول قرن في الهجين الثاني بينما كانت قيم معـــامل التوريث بمعناها الضيق متوسطة إلى عالية وتراوحت من ٣٧,٠٣ لصفه عدد الأيام حتى الإزهار فـــي الهجين الثالث إلى ٧١,٤٥ لصفه ارتفاع أول قرن في الهجين الثاني.

كانت النسبة المئوية للتحسين الوراثي المتوقع متوسطة لصفات عدد الفروع بالنبات وارتفــاع أول قرن ، عدد القرون للنبات ، عدد البذور في القرن ،متوسط وزن القرون لجميع الهجن ، بينمـــا كـــانت منخفضة في الحالات الأخرى.

من النتائج السابقة يمكن ملاحظة تفوق الهجين" منصورة ١ × قصاصين ١ " على الـــــهجينين الآخرين.