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PEDIGREE SELECTION IN EARLY SEGREGATING GENERATIONS OF FABA BEAN (*VICIA FABA* L.)

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ABSTRACT

This study was carried out at the Experimental Farm of Faculty of Agriculture, Al-Azhar University, Assiut branch during three successive winter seasons of 2010/2011, 2011/12 and 2012/213 to improve some yield components of faba bean. The used breeding materials in this experiment were the F_2, F_3 and F_4 generations of three crosses, i.e. Looza × Assiut98 (population 1), Misr × Giza 40 (population2) and Looza × Giza429 (population 3) and the check variety was Misr1. Pedigree selection method was used for number of shoots/plant, number of pods/plant, number of seed/pod, seed yield/plant and 100-seed weight to study phenotypic (PCV) and genotypic (GCV) coefficients of variability, expected gain from selection (EGS) and realized gain from selection (RGS)

Results indicated that PCV and GCV estimates decreased in sequence generations. EGS and RGS estimates were useful and decreased from generation to generation in most studied traits.

It was found that pedigree method has a good efficiency of the selection procedures to improve the studied characters. EGS estimates were in F3 (5.61, 4.43), (5.35, 5.36) and (4.49, 5.25) for seed yield /plant and 100-seed weight and RGS estimates for seed yield /plant and 100-seed weight in F4 were (53.25, 12.94), (48.81, 13.66) and (28.52, 7.29) for cross1, 2 and 3, respectively. Genetic advance estimates were observed specially cross1 and cross2. Many good families were obtained; it can be become good lines after complete selection processes.

INTRODUCTION

Faba bean *(Vicia faba* L.) plays a significant role in critical areas of food security and economic stability of most countries of the world and it is the important source of plant portein for both human and animal in Mediterranean area. It can be used as human food in developing countries and as animal feed in some other countries. Feeding value of faba bean is high, and it is considered in some areas to be superior to field peas or other legumes. It is one of the most important winter crops in the Middle East. The straw can be used for brick making and as fuel in parts of Sudan and Ethiopia. In the present work, the success of an autogamous plant-breeding program depends on the choice of populations capable of producing progeny with desired trait combinations. The promising segregating populations make it possible to select lines with superior performance. Procedures making possible early detection of unpromising populations have been the target of many investigators (Singh and Urrea, 1995 and Oliveira *et al.*, 1996). Sakai (1951) suggested that rigorous pedigree selection in early generations might result in the loss of desirable genotypes. Simmonds (1979) reported that pedigree selection method was effective in early generations only for traits with high heritability. Seed yield is a complex trait that is quantitatively inherited with low heritability value (Bond, 1966; Kambal, 1969 and Yassin, 1973). The low heritability and consequent limited genetic advance for yield in response to selection had led many scientists to search for characters which are associated with yield but which are more highly heritable (De Pace, 1979). The production of faba bean is severely limited by several constraints, which include the total lack of research emphasis on the crop, drought stress and salinity problems. El-Refaey and El-Keredy (1992) found that the effectiveness of selection between and within segregating generations varied from case to another.

The present work aims to determine the response pedigree selection criteria for some yield parameters and as a contribution to *Vicia faba* improvement programmes.

MATERIALS AND METHODS

The study was undertaken at farm of faculty of Agriculture, Al-Azhar University, Assiut, Egypt. Over three seasons, October 2010/2011, 2011/12 and 2012/213. The goal of this study was to estimate the response of pedigree selection in early segregating populations of faba bean. The used breeding materials were 1000 plants of F2 generation for each cross, i.e. Looza × Assiut98 (population 1), Misr1 × Giza 40 (population2) and Looza × Giza429 (population 3) and grown with a check variety (Misr1). The best 50 plants (5% selection intensity) were selected according to five characters, i.e. number of shoots/plant, number of pods/plant, number of seeds/pod , seeds weight/plant and 100-seed weight, then the seeds were cultivated in the next season to give F3 generation (cycle 1). F3 and F4 generations were grown in randomized complete block design with three replicats .In F3 generation, each family was represented by one row 3m long and 60 cm apart and 25 cm between plants, about 15-17 plants in the row and selected best 50 plants as 2 % selection intensity and these plants were grown in F4 generation (cycle 2) to act 50 families in three replicates such as F3 generation.

Statistical analysis:-

Data of growing seasons were subjected to statistical analysis as outlined by Snedecor and Cochran (1967)

The phenotypic and genotypic coefficients of variation are computed as follow (Burton, 1952).

$$PCV = (\sqrt{VP} / \overline{X})100$$

$$GCV = (\sqrt{VG} / \overline{X})100$$

Were: PCV, GCV are phenotypic and genotypic coefficients of variation, respectively; VP, VG are corresponding variances; and x is the population mean. The relative values of these two types of coefficients give an idea about the magnitude of variability presents in a genetic population. Interpretation of variability in terms is given blow (Singh and Singh, 1975).

1- If the value of genotypic coefficient of variation (GCV) is higher than phenotypic coefficient of variation (PCV), it indicates that there is a little influence of environment on the expression of character. Selection for improvement of such character will be rewarding.

2-If the value of PCV is higher than GCV; it means that the apparent variation is not only due to genotypes but also due to the influence of environment. Selection for such traits sometimes may be misleading.

Expected gain from selection (EGS):-

$GS = K.\ \sigma Ph.\ h^2n$

Were: K is selection differential, its value equals 2.06 and 2.42 for selection intensities of 5% and 2% respectively. σ Ph is phenotypic standard deviation.

h^2n: heritability in narrow sense was calculated according to Falconer (1989).

Realized gain from selection (RGS)

$(\overline{X}_0 - \overline{x}p) \times 100 / \overline{x}p$

Where $\overline{X}_0$ is the mean phenotype of the offspring of selected parents, $\overline{x}p$ the mean phenotype of the whole parental generation, R the advance in one generation of selection.

The agronomic characters were recorded as follow:

1- Number of shoots/plant
2- Number of pods/plant
3- Number of seeds/pod
4- 100-seed weight (g).
5- Seeds yield/plant (g).

RESULTS AND DISCUSSION

Analysis of varince:

The analysis of variance indicates a highly significant between families for all studied characters in the three populations (Table 1) indicating that selection in base populations would be effective. The significant differences between means of families indicat that more types of plants represented many genotypes in the same environment which means posibility of selection (Table 2).

These results are confirmed from the genotypic (GCV) and phenotypic (PCV) coefficients of variability (Table 3).

Also, these results reflect the genetic differences among F2, F3 and F4 generations for studied characters in the three populations. Consequently, the presence of sufficient genetic variation could be used for the pedigree line selection.

Table 1: Means squares estimates for number of shoots/plant, number of pods/plant, number of seed/pod, seed yield/plant and 100-seed weight in F2, F3 and F4 generations of the three populations.

Characters		Mean squares								
		Population1			Population2			Population3		
		Families	Error	C.V	Families	Error	C.V	Families	Error	C.V
no shoots/ plant	F2	2.82**	0.15	13.22	6.22**	0.21	14.88	5.29**	0.38	14.30
	F3	1.65**	0.29	13.20	3.22**	0.29	13.63	3.99**	0.36	12.12
	F4	1.39**	0.44	14.14	2.22**	0.27	11.08	3.81**	0.53	14.33
no pods/plant	F2	919.28**	14.22	14.95	985.55**	30.00	14.91	733.77**	15.00	13.34
	F3	594.41**	18.22	10.42	570.25**	30.12	14.49	485.20**	18.23	11.25
	F4	172.18**	20.22	6.84	351.23**	23.00	11.99	445.65**	21.58	10.89
no seeds/pod	F2	1.80**	0.22	14.66	2.50**	0.21	14.32	2.22**	0.21	14.37
	F3	0.86**	0.12	9.73	1.22**	0.22	14.34	1.74**	0.30	15.39
	F4	0.62**	0.25	13.55	0.96**	0.10	8.96	1.33**	0.25	13.51
seeds yield/plant	F2	1705.22**	55.23	14.53	1130.27**	25.66	13.45	2155.34**	60.25	13.29
	F3	1350.20**	65.25	13.56	1100.22**	53.12	12.92	1451.21**	85.22	11.96
	F4	1252.14**	66.22	8.91	890.23**	65.22	9.62	1320.19**	105.38	10.35
100-seed weight	F2	602.16**	12.25	5.48	595.11**	25.25	7.82	564.25**	80.24	10.20
	F3	311.47**	19.25	5.18	522.33**	30.11	6.55	491.41**	85.42	10.31
	F4	275.25**	23.46	5.07	488.24**	35.22	6.24	463.24**	110.25	10.91

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

Means performance:-

Means of the three genrations of three crosses for number of shoots/plant, number of pods/plant, number of seeds/pod, seed yield/plant and 100-seed weight in F2, F3 and F4 generations of the three populations are shown in Table 2.

These results indicat that the means increased by different degrees generation after generation, The means of selected families for no. shoots/ plant were higher compared to check variety in F3 and F4 generations in three populations.

Table 2: Means estimates for number of shoots/plant, number of pods/plant, number of seed/pod, seed yield/plant and 100-seed weight in F2, F3 and F4 generations of the three populations

Means					
Characters		**Population1**	**Population2**	**Population3**	**Misr 1.**
no shoots/ plant	F2	2.93	3.08	4.31	3.63
	F3	4.08	3.95	4.95	3.75
	F4	4. 69	4.69	5.08	3.78
no pods/plant	F2	25.22	36.73	29.03	25.55
	F3	40.96	37.87	37.94	28.38
	F4	65.77	40.01	42.65	31.22
no seeds/pod	F2	3.20	3.20	3.19	3.22
	F3	3.56	3.27	3.56	3.25
	F4	3.69	3.53	3.70	3.41
seeds yield/plant	F2	51.13	37.65	58.39	45.45
	F3	59.59	56.40	77.18	48.26
	F4	91.32	83.93	99.19	51.56
100-seed weight	F2	63.85	64.22	87.79	65.23
	F3	84.62	83.73	89.67	72.58
	F4	95.57	95.17	96.21	96.24

These results indicat that the selected families possessed higher plants than check variety in no. pods/plant in all studied generations. Population3 was progressive in no. shoots/ plant than another two populations and check variety. For no. pods/plant, population1 was the best population and higher than Misrl too. While population3 was the highest crosses in no. seeds/pod, seed yield/plant and 100-seed weight traits. Also, average no. seed/pod of the check variety was less than selected families in F3 and F4 generations. The selected families average possessed higher plants than Misrl variety in seeds yield/plant in F3 and F4 generations. The means of selected families for 100-seed weight were higher compared to check variety in F3 and F4 generations in three populations.

Generally, all selected families in the three populations significantly outyielded the check variety. Falconer (1989) stated that selection reduces genotypic variance of the next generation. The result proved that the pedigree method of selection was effective in improving the studied traits in this materials of faba bean.

This result reflects effective pedigree selection method to improve these traits. The obtained results are in accordance with the conclusions of Mahmoud (1968), El-Hosary (1981), Khalil *et al* (1982) and Alghamdi (2007).

Phenotypic (PCV) and genotypic (GCV) coefficients of variability:-

Phenotypic (PCV) and genotypic (GCV) coefficients of variability were estimated from the analysis of variance of the F2, F3 and F4 are showed in tables (3).

These results clearly indicat to presence of small differents between PCV and GCV for all studied characters which means decreasing of environment influence on the expression of characters.The close estimate of PCV and GCV decreased rapidly after two cycles of pedigree selection (Singh et al 1995). The larg genetic variation in F2 generation for studied traits indicated that the materials of crosses still far from gene fixation and need more cycles of selection and selfing to reach homozygosity. The genetic coefficient variation with a heritability estimate seem to give the best picture of amount of the genetic advance expected from selection (Singh and Singh, 1975). Also, it means that selection for these traits will be effective and genetic variability was essential to improve trait through selection (Miller et al (1985).

These results were also reported by several authors such as El-Hosary and Nawar (1984) and Bakheit and Metwali (2011).

Similarly, El-Hosary and Nawar (1984), Abul-Naas et al. (1989) and Bakheit and Metwali (2011). estimated different levels of GCV in faba bean. Moreover, the differences between PCV and GCV were very narrow which indicate to the importance of genetic variance in the inheritance of the studied characters.

Table 3: Phenotypic (PCV) and genotypic (GCV) coefficients of variability estimates for number of shoots/plant, number of pods/plant, number of seed/pod, seed yield/plant and 100-seed weight in F2, F3 and F4 generations of the three populations.

Characters		Population1		Population2		Population3	
		PCV	GCV	PCV	GCV	PCV	GCV
no shoots/ plant	F2	33.09	32.20	46.75	45.95	30.81	29.68
	F3	18.18	16.50	26.23	25.02	23.30	22.22
	F4	14.46	12.06	18.34	17.19	22.18	20.58
no pods/plant	F2	69.41	68.87	49.35	48.59	53.87	53.32
	F3	34.37	33.83	36.41	35.43	33.52	32.88
	F4	11.52	10.82	27.04	26.14	28.58	27.88
no seeds/pod	F2	24.21	22.68	28.53	27.30	26.97	25.66
	F3	15.04	13.95	26.89	25.59	21.39	19.46
	F4	12.32	9.52	16.03	15.17	18.00	16.22
seeds yield/plant	F2	46.63	45.87	51.55	50.97	45.90	45.26
	F3	35.60	34.73	33.95	33.12	28.50	27.65
	F4	22.37	21.77	20.52	19.76	21.15	20.29
100-seed weight	F2	22.19	21.96	21.93	21.46	15.62	14.47
	F3	12.04	11.66	15.76	15.30	14.27	12.97
	F4	10.02	9.59	13.40	12.91	12.92	11.27

The expected (EGS) and realized (RGS) gain from selection:

The expected (EGS) and realized (RGS) gain from selection in three crosses are showed in Table (4).

The results indicated that both of realized gain from selection and expected gain from selection values were observed for all the studied characters. But the realized gain from selection values were greater than that expected gain from selection values for most the studied characters. These results are in agreement with means estimate of generations for studied characters. The effectiveness of selection in raising the mean value of selected progenies depends mainly on the initial mean value and the amount of genetic variability presented in the materials and how far the character under reference is influenced by the environment. This result may be due to that heritability values for these characters were underestimated (Hamada (1988))

Generally, the amount of response for selection is depending upon the available genetic variance (Hutchinson and Manning (1943)).

The results are in agreement with results of Mahmoud (1968), El-Hosary (1981) and Khalil *et al.* (1982).

Table 4: Expected genetic advance under selection (EGS) and realized genetic advance (RGS) estimates for number of shoots/plant, number of pods/plant, number of seed/pod, seed yield/plant and 100-seed weight in F2, F3 and F4 generations of the three populations.

Characters		Population1		Population2		Population3	
		EGS	RGS	EGS	RGS	EGS	RGS
no shoots/ plant	F2	10.42	-------	14.72	-------	9.70	-------
	F3	5.01	39.25	7.22	28.25	6.42	14.85
	F4	-------	14.95	-------	18.73	-------	2.63
no pods/plant	F2	29.30	-------	25.91	-------	28.28	-------
	F3	10.53	62.41	11.15	3.10	10.26	30.69
	F4	-------	60.57	-------	5.65	-------	12.41
no seeds/pod	F2	6.35	-------	7.47	-------	7.08	-------
	F3	2.32	11.25	4.11	2.19	3.27	11.60
	F4	-------	3.65	-------	7.95	-------	3.93
Seed yield/plant	F2	7.34	-------	8.12	-------	7.23	-------
	F3	4.91	16.55	4.68	49.80	3.93	32.18
	F4	-------	53.25	-------	48.81	-------	28.52
100-seed weight	F2	7.58	-------	7.49	-------	5.33	-------
	F3	3.88	32.53	4.69	30.38	4.59	2.14
	F4	-------	12.94	-------	13.66	-------	7.29

CONCLUSION

It can be concluded that differences between means of three genrations of three crosses were highly significant, PCV and GCV estimates in F4 for seed yield /plant (22.37, 21.77), (20.52, 19.76) and (21.15, 20.29) and for 100-seed weight were (10.02, 9.59), (13.40, 12.91) and (12.92, 11.27) for population 1, 2 and 3, respectively. EGS estimates were in F3 (5.61, 4.43), (5.35, 5.36) and (4.49, 5.25) for seed yield /plant and 100-seed weight and RGS estimates for seed yield /plant and 100-seed weight in F4 were (53.25, 12.94), (48.81, 13.66) and (28.52, 7.29) for cross1, 2 and 3 respectively. Genetic advance estimates were observed specially cross1 and cross2. Many good families were obtained which may become good lines after complete selection processes.

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Pedigree selection in early segregating generations of faba bean

انتخاب النسب في الأجيال الانعزالية المبكرة للفول البلدي

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أجرى هذا البحث في مزرعة كلية الزراعة جامعة الأزهر فرع أسيوط خلال أعوام ٢٠١٠/٢٠١١ و٢٠١١/٢٠١٢ و ٢٠١٢/٢٠١٣ لتحسين بعض صفات محصول الفول البلدي حيث استخدم الباحث ثلاثة هجن بداية من الجيل الثاني وهى لوزا × أسيوط ٩٨ ومصر١ × جيزة ٤٠ و لوزا × جيزة ٤٢٩ واستخدم أيضاً للمقارنة الصنف مصر١ .

تم عمل الانتخاب المنسب بداية من الجيل الثاني وحتى الجيل الرابع وذلك بانتخاب النباتات الفردية المتميزة في عدد الأفرع/النبات وعدد القرون /النبات و عدد البذور بالقرن ومحصول البذور/النبات ووزن المائة بذرة.

وقد تم حساب المقاييس الوراثية في كل جيل وهى معامل الاختلاف الوراثي ومعامل الاختلاف المظهري والتقدم المتوقع للانتخاب والتقدم الحقيقي للانتخاب.

وقد أظهرت النتائج الآتي:

وجود فروق معنوية بين متوسطات الثلاثة أجيال لكل عشيرة في كل الصفات.

وجود قيم ملحوظة لمعامل الاختلاف المظهري ومعامل الاختلاف الوراثي حيث بلغت بالجيل الرابع لصفته محصول البذور/النبات ٢٢,٣٧ ، ٢١,٧٧ و ٢٠,٥٢ ، ١٩,٧٦ و ٢١,١٥ ، ٢٠,٢٩جم وبلغت في صفة ووزن المائة بذرة ١٠,٠٢ ، ٩,٥٩ و ١٣,٤٠ ، ١٢,٩١ و ١٢,٩٢ ، ١١,٢٧ جم للثلاث عشائر على التوالي.

وجود قيم ملحوظة من التقدم المتوقع للانتخاب حيث بلغت بالجيل الثالث لصفتي البذور/النبات ووزن المائة بذرة ٥,٦١ ، ٤,٤٣ و ٥,٣٥ ، ٥,٣٦ و ٤,٤٩ ، ٥,٢٥ للثلاثة هجن على التوالي.

وجدت قيم ملحوظة ومرتفعة للتقدم الحقيقي للانتخاب حيث بلغت بالجيل الرابع لصفتي البذور/النبات ووزن المائة بذرة ٥٣,٢٥ ، ١٢,٩٤ و ٤٨,٨١ ، ١٣,٦٦ و ٢٨,٥٢ ، ٧,٢٩ للثلاث عشائر على التوالي.

أوضحت النتائج أن التقدم الوراثي من خلال الانتخاب كان مرتفع في كل الهجن وبخاصة بالهجين الأول والثالث وقد خلص البحث إلى الحصول على عدد كبير من العائلات المتميزة من كل هجين يمكن أن تصبح سلالات مبشرة بعد استكمال عمليات الانتخاب في الأجيال المتأخرة.