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Comparison of Three Selection Methods for Yield and Components of Three Faba Bean (*Vicia faba* L.) Crosses

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Abstract: Three faba bean (*Vicia faba* L.) cross populations, i.e. Giza 40/Giza 3 (Cross No.1), Slaim/Giza 3 (Cross No.2) and Slaim/311/1170/81 (Cross No.3), were made for selection by three methods, i.e. Mass selection (MSM), pedigree selection (PSM) and Picking-pod (PPM) from F_2 to F_4 generation during 2005/2006, 2006/2007 and 2007/2008 seasons at Mattana Agricultural Research Station, ARC, Isna, Qena Governorate. The F_4 progenies of the three crosses were evaluated for yield and its components to compare the three selection methods. Results indicated differences ($P<0.01$) among the three methods for all measured traits in the three crosses except for 100-seed weight in Cross No.2 ($P<0.05$) and for days to maturity (Cross No.3) which was insignificant. For three selection methods, F_4 progenies had the highest means for all traits in all crosses except for days to maturity, plant height and 100-seed weight compared to F_2 progenies. The mean values for pods/plant, seeds/plant, seed yield/plant and 100-seed weight in cross No.1 and for plant height, pods/plant, seeds/plant and seed yield/plant in cross No.2 and for plant height, pods/plant, seeds/plant and seed yield/plant in cross No.3 were higher by PSM than MSM and PPM. Therefore, PSM was found to be the best method for faba bean breeding for higher yield compared to the other two methods. Correlation study indicated that, seed yield/plant was highly positive correlated with day to maturity, branches/plant, pods/plant and seeds/plant under MSM and with days to maturity and pods/plant under PSM and with pods/plant and seeds/plant under PPM. Thus, these traits could be considered as a selection criteria for higher seed yield/plant in faba bean under each of selection method. It was concluded that PSM is a preferable method for improvement yielding ability in faba bean and is recommended for faba bean breeding. Further days to maturity and pods/plant could be used as a selection criteria for higher seed yield under this method.

Key words: Faba bean · Selection methods · Correlation coefficients

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important leguminous crops worldwide as a source of plant protein. Improvement of productivity could be a basic objective of crop improvement programs conducted by plant breeders. To achieve this goal, the breeders should choose a breeding method which facilitate the simultaneous improvement of yield and components traits. The segregation generations may be conducted by any of the methods frequently used for self-fertilization crops: Mass selection, pedigree selection and picking-pod. Pedigree selection has commonly been found quite useful for handling segregating materials, however, it has its drawbacks as have such methods as mass selection. The picking-pod method is implemented by collecting a picking single pod from each plant to from the next generation. This method is an easy and economic alternative for the advance of segregating populations, aiming at a quick homozygosis [1].

Many studies have been conducted to compare the efficiency of different selection methods for segregating generations of faba bean [2], soybean [3-4], chick pea [5-7], cow pea [8], green gram [9], lentil [10], urdbean [11] and black gram [12]. The present study attempted to compare the efficiency of mass selection, pedigree selection and picking-pod methods for yield and components in faba bean and to determine the traits that

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could be used as a selection criteria for each of the selection method.

MATERIALS AND METHODS

The present investigation was carried out at Mattana Agricultural Research Station, ARC, Isna, Qena Governorate during 2005/2006, 2006/2007 and 2007/2008 seasons. The materials used were the F_2 generation of three faba bean crosses. The name and pedigree of crosses are presented in Table 1. In the agricultural year of 2005/2006, 500 plants of F_2 population in each cross were spaced-planted and three selection methods were performance as follows:

Mass Selection Method (MSM): In each cross, 50 plants (10%) were selected with desirable traits and three seeds from each plant were taken and bulks to plant the F_3.

Pedigree Selection Method (PSM): From 500 plants in each cross, 40 best plants with good agronomic traits were chosen and 30 seeds from each plant were picked out to plant the F_3 families' rows.

Picking-pod Method (PPM): one best pod was picked from each of the 500 plants in each cross to plant the F_3 generation.

In F_3, the MSM and PPM seeds were bulkily grown, separately for each cross. At harvest time, for each cross one pod was taken from each plant within two methods to form the materials for comparison with those from the PSM in F_4. For the PSM, 40 pants were grown in 40 spaced progeny rows (4m long). For each cross, five rows with good traits were chosen and the plants were harvested individually from each row and traits were measured, then one-best individual plant from each row were picked out. The seeds in each plant were used independently for evaluation in F_4. In F_4, the selections were evaluated in a randomized complete block design with three replications beside F_2 progenies. Each experimental plot included 4 rows, 3.5 m. in length and 60 cm apart with single seed/hill spaced 15 cm apart on one side of the row. At harvest time ten plants were taken randomly from each plot of the three replication for trait measurement. For the PSM, among 5 rows, only one row with best agronomic traits was used for trait measurement. In the three agricultural seasons, all recommended agriculture practices were applied as usual. The measured traits were: number of days to maturity (NDM), plant height (PHt), number of branches/plant (NBP), number of pods/plant (NPP), number of seeds/plant (NSP), seed yield/plant (SYP) and 100-seed weight (SI).

Table 1: The pedigree of the three faba bean crosses

Cross No.	Cross name and pedigree
1	Giza 40/Giza 3
2	Slaim/Giza 3
3	Slaim/311/1170/81

The data were subjected to statistical analysis of variance according to[13]. The mean values of F_4 generation were compared at 5% level of significance using Least Significant Differences (L.S.D.) test. Furthermore, correlation coefficients among all traits under each selection method over all crosses were calculated to [14]. The significance of the correlations was tested by t test, with n-2 degrees of freedom.

RESULTS

Means and Variance Among F4 progenies: Analysis of variance showed differences (P<0.01) among the selection methods for all studied traits for the three crosses except for SI in cross No. 2 (P<0.05) and for NDM in cross No. 3 (Table 2).

Table 2: Mean squares of the effect of selection methods on the studied traits of the three faba bean crosses in the F4 generation

	Crosses								
	Cross No. 1			Cross No. 2			Cross No.3		
S.O.V.	Reps.	S. methods	Error	Reps.	S. methods	Error	Reps.	S. methods	Error
Degree of freedom	2	2	4	2	2	4	2	2	4
Trait	Mean squares for selection methods and Error								
NDM	17.44**		0.11	2.11**		0.11	4.78		1.11
PHt (cm)	630.89**		5.90	630.89**		5.90	127.75**		3.58
NBP	3.32**		0.03	3.32**		0.03	10.36**		0.05
NPP	443.1**		9.77	541.1**		2.62	789.61**		0.27
NSP	2129.4**		9.25	2258.8**		2.71	5312.86**		6.72
SYP (g)	1231.2**		10.54	258.76**		0.22	502.03**		3.30
SI (g)	68.47**		0.78	30.17*		3.47	129.47**		0.19

* P<0.05 and ** P<0.01

Table 3: Means of seven traits in three faba bean crosses in the F4 generation obtained by advancing from F2 by mass selection, pedigree selection and picking-pod methods in comparison with the F2 generation

Trait	S. methods	Cross No.1	Cross No.2	Cross No.3	Trait	S. methods	Cross No.1	Cross No.2	Cross No.3
NDM	Mass	138.00	143.70	135.70	NSP	Mass	106.60	208.30	117.80
	Pedigree	142.00	142.00	138.00		Pedigree	159.80	220.30	194.90
	Picking-pod	137.00	142.70	136.00		Picking-pod	135.80	167.90	185.50
	L.S.D. at 5%	0.75	0.75	NS.00		L.S.D. at 5%	6.90	3.74	5.88
	F2	144.00	138.80	140.70		F2	79.30	137.80	116.70
Pht (cm.)	Mass	174.40	174.40	146.70	SYP (gm.)	Mass	67.20	98.40	71.10
	Pedigree	149.20	149.20	149.70		Pedigree	107.00	109.80	95.20
	Picking-pod	149.40	149.40	137.20		Picking-pod	80.70	91.40	91.30
	L.S.D. at 5%	5.51	5.51	4.29		L.S.D. at 5%	7.37	1.06	4.12
	F2	169.90	158.40	150.60		F2	42.90	43.00	36.90
NBP	Mass	4.40	4.40	6.30	SI (gm.)	Mass	63.10	48.30	60.70
	Pedigree	4.60	4.60	6.70					
	Picking-pod	6.30	6.30	9.70		Pedigree	68.70	50.10	49.30
	L.S.D. at 5%	0.39	0.39	0.51					
	F2	3.10	3.90	3.20		Picking-pod	59.20	54.50	49.30
NPP	Mass	47.30	63.20	45.10					
	Pedigree	69.80	88.60	73.20		L.S.D. at 5%	2.00	4.23	0.99
	Picking-pod	50.50	68.40	72.20					
	L.S.D. at 5%	7.09	3.67	1.18		F2	77.40	63.50	63.60
	F2	32.00	37.30	36.70					

Table 4: Correlation coefficients among seven traits in the F4 generation obtained by advancing from F2 by mass selection, pedigree selection and picking-pod methods over all the three faba bean crosses

Trait	NDM	PHt (cm.)	NBP	NPP	NSP	SYP (gm.)	SI (gm.)
NDM	Mass	-0.441	0.533	0.918**	0.905**	0.878**	-0.893**
	Pedigree	-0.490	-0.875**	0.336	-0.126	0.851**	0.525
	Picking-pod	-0.266	-0.843**	0.103	-0.074	0.315	0.262
PHt (cm.)	Mass		-0.930**	-0.558	-0.738*	-0.736*	0.760*
	Pedigree		0.422	-0.490	-0.409	-0.288	0.176
	Picking-pod		-0.237	-0.952**	-0.926**	-0.899**	0.823**
NBP	Mass			0.621	0.780*	0.768*	-0.827**
	Pedigree			-0.315	0.099	-0.933**	-0.525
	Picking-pod			0.430	0.570	0.202	-0.702*
NPP	Mass				0.952**	0.959**	-0.908**
	Pedigree				0.875**	0.520	-0.588
	Picking-pod				0.979**	0.934**	-0.921**
NSP	Mass					0.996**	-0.980**
	Pedigree					0.091	-0.895**
	Picking-pod					0.858**	-0.969**
SYP (gm.)	Mass						-0.966**
	Pedigree						0.354
	Picking-pod						-0.801**

* P<0.05 and ** P<0.01

Means of F4 progenies with F2 for seven traits were given in Table 3. According to this obtained data, the F4 progenies had the highest means for all traits except NDM, PHt, SI in all the crosses under the three selection methods compared to the F2 progenies. For PHt, the F4 progenies developed through mass selection method in cross No.1 and cross No. 2 and through pedigree selection method in cross No. 3 only were superior. However, the shift towards latest in maturity in F4 progenies was appeared in cross No. 2 under all selection methods.

Among three selection methods, the means of NPP (69.8), NSP (159.8), SYP (107 g) and SI (68.7 g) were higher (P<0.05) in the progenies derived by pedigree selection method than the other two selection methods in cross No. 1. Also, pedigree selection method caused increase (P<0.05) in means of NPP (88.6), NSP (220.3) and SYP (109.8 g) in cross No.2 compared to the other two methods. Furthermore, the progeny advanced by pedigree method had the highest means for PHt (149.7 cm), NPP (73.2), NSP (194.9) and SYP (95.2 g) in cross No. 3 compared to the other two methods.

However, the progenies advanced through Picking-Pod method exhibited favorable performance in NDM (137) and NBP (6.3) in cross No.1 and for NBP (6.3) and SI (54.5 g) in cross No. 2 and for NBP (9.7) in cross No. 3 compared to the other two methods. On the other hand, mass selection method was superior only for PHt in cross No.1 (174.4 cm) and cross No.2 (174.4 cm) and for SI (60.7 g) in cross No.3.

Correlation Study: Calculated correlation coefficients among all traits over all crosses are presented in Table 4. The results obtained showed that, seed yield/plant under mass selection method appears to have positive correlation (P<0.01) with each of NDM (0.878), NPP (0.959) and NSP (0.996), while it was (P<0.05) only with NBP (0.768). In contrast, it was negatively correlated (P<0.01) with SI (-0.966) while, (P<0.05) only with PHt (-0.736). Further seed yield/plant under pedigree selection method was found to be positive correlated (P<0.01) with NDM (0.851) only but it showed insignificant positive correlations with NPP (0.520), NSP (0.091) and SI (0.354).

However, it was negatively correlated (P<0.01) with NBP (-0.933), while was insignificant with PHt (-0.288). On the other hand, positive correlations (P<0.01) recorded between seed yield/plant under picking-pod method and NPP (0.934) and NSP (0.858). Meanwhile, insignificant positive correlations were observed with NDM (0.315) and NBP (0.202). In contrast, it was negatively correlated (P<0.01) with PHt (-0.899) and SI (-0.801).

DISCUSSION

In attempt to determine which the best selection method would facilitate improvement of faba bean yielding ability among mass selection, pedigree selection and picking-pod methods and the degree and direction of correlations of agronomic traits with seed yield, the results showed obvious differences among the selection methods for the most measured traits of the three crosses. In this connection, significant differences among picking-pod, 5, 10 and 25% Mass selection and pedigree selection methods in some measured traits were reported earlier by [3].

Concerning the superiority of means of F4 progenies which advanced through the three selection methods compared to F2 progenies for all traits except NDM in cross No.2, PHt in cross No.2 and cross No.3 and SI in all crosses, it indicate that these traits could be improved by artificial selection.

Among three selection methods, pedigree selection came in the first followed by picking-pod, whereas pedigree selection was superior for yield traits in all crosses. While, picking-pod method was superior only for NDM and NBP in cross No.1, SI in cross No.2 and NBP and NPP in cross No.3. However, mass selection was not effective method for most traits in all crosses. These findings were agreement with [8] who reported that pedigree selection for high yield (PS (HY)) scheme of F3 recorded the highest pods/plant and seed yield/plant, while the progenies developed through single pod descent method had slightly higher than mean for the number of fruiting branches and number of pods per plant. Furthermore, [11] found that pedigree selection method was most efficient method as it gave the highest number of high yielding progenies and it was superior for SI and yield per plant. According to the current investigations, it appears that pedigree selection method is the best method for faba bean breeding for higher yield under this work condition. Furthermore, determine the degree and direction of the association between seed yield and the other traits is very important. In this respect, the high positive correlations with NDM, NBP, NPP and NSP under mass selection, NDM and NPP under pedigree selection and NPP and NSP under picking-pod method, indicate that these traits could be used as a selection criteria for higher seed yield/plant.

A point of interest that the expected positive association between seed yield/plant and SI was changed to be negative under mass and picking-pod methods. The reason of this case might to be due to the high positive correlation between seed yield/plant and number of seeds/plant whereas, increasing of number of seeds related with small in seed size. In this connection, negative correlations of seed yield with number of days to maturity and plant height under mass selection, pedigree selection and picking-pod methods have been reported by [3]. In contrast, opposite data were found with other selection methods by [1].

It was concluded that PSM is a preferable method for improvement yielding ability in faba bean and is recommended for faba bean breeding. Further, days to maturity and pods/plant could be used as a selection criteria for higher seed yield under this method.

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