GENETIC VARIABILITY, HERITABILITY AND CORRELATION OF FABA BEAN (*VICIA FABA*., L) GROWN IN NEW DELHI

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ABSTRACT

This study was conducted to determine variability, heritability and correlation between yield and yield components in 50 faba bean germplasm accessions in the year 2012-13. Ten morphological observations were recorded which showed a significant in the study material and there is a scope for the identification of best accession which will be used in future breeding programme. The phenotypic coefficient of variation is higher than the genotypic coefficient of variation for all the characters but the difference between them is low in the characters studied. High heritability was observed for most of the characters except for number of branches, number of pods per plant and pod width. A direct and indirect effect of yield components on seed yield per plant was also observed.

Keywords: Correlation, Faba Bean, Heritability, Seed Yield, Variability

I. NTRODUCTION

Faba bean (*Vicia faba* L.) is widely used as human food, cultivated especially in Europe, Northern Africa and China. It is the fourth most important legume crop. Faba bean is having superiority in yield and feeding value over other legumes, it is also widely used as animal feed. As like other legumes, it is one of the most effective nitrogen fixing legumes [1]. It contributes to human nutrition due to its higher protein content and other essential nutrients. Immature faba bean is used as a quality vegetable, numerous antioxidants and essential vitamins including carbohydrates and proteins.

Seed yield is a complex trait that is quantitatively inherited with low heritability value [2] [3] [4]. 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 [5]. 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.The high heritability was followed by high genetic advance for fruiting branches per plant, number of pods per plant and seed yield per plant some traits indicating the scope for their improvement through selection [6]. The relationship between seed yield and its components would be of considerable value to breeders for characterising the germplasm accessions and selecting them as donor parents for breeding programs. The phenotypic correlation coefficient among number of seeds per pod and seed weight. Positive relationships were obtained between weight of seeds/pod and both seed weight and number of seeds per pod determined by [7]. The direct and indirect effects of plant height, pod number per plant and seed number per pod upon biological yield was found by [8]. A significant and positive correlation was reported

between seed yield and plant height, 100-seed weight, seed weight/plant and biological yield, but a negative correlation was determined with maturity date. [9]

The present investigation was aimed at selecting the best germplasm accession of faba bean adapted to Northern India. The faba bean germplasm accessions were characterised and the yield were compared to identify the best accession which can be used in the breeding programme for the faba bean improvement.

II. MATERIALS AND METHODS

This present investigation was carried out at the Issapur farm, NBPGR, New Delhi during 2012-13. The material used in the experiment, technique followed, data analysis and interpretation of data was determined under this heading.

2.1. Seed Material

Experimental material consisted of 50 germplasm accessions of faba bean. They are obtained from the Hisar, NBPGR gene bank, New Delhi, India. Seeds were sown at the Issapur Experimental farm, NBPGR, New Delhi, India. In total of 50 faba bean germplasm accessions, 25 species are exotic collections, four from genebank and 21 accessions from Hisar.

2.2. Design and Observations

The crop was grown in Augmented Block Design with Vikrant as a check variety. During maturity period, the qualitative traits like pod colour, pod shape, seed coat colour and seed shape were observed. The quantitative characters like, days to 50% flowering, days to 80% maturity, plant height (cm), number of branches, pod length (cm), pod width (mm), number of pods per plant, number of seeds per pod, 100 seed weight (g) and seed yield per plant (g) were determined. The data was recorded in five plants of each accession.

2.3. Statistical Analysis

The genotypic parameters like genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance were calculated as follows.

2.3.1. Phenotypic and Genotypic Coefficient of Variation (PCV and GCV)

Phenotypic and Genotypic coefficient of variation were estimated using the formula suggested by [10] and expressed in percentage.

a) Phenotypic coefficient of variation (per cent)

$$\text{Phenotypic Coefficient of Variation (PCV)} = \frac{\sqrt{\sigma^2 p}}{\text{Mean}} \times 100 \qquad 1$$

b) Genotypic coefficient of variation (per cent)

$$\text{Genotypic Coefficient of Variation (GCV)} = \frac{\sqrt{\sigma^2}}{\text{Mean}} 100 \qquad 2$$

The estimates of PCV and GCV were categorized based on the scale given below [11].

<15%	Low
15-30%	Medium

>30% High

2.3.2. Heritability (h^2)

It is the ratio of the genetic variance to the total variance. Heritability in broad sense (h^2) was calculated according to [12] and expressed in percentage.

$$\text{Heritability in broad sense } (h^2) = \frac{\sigma^2 g}{\sigma^2 p} x100 \quad (3)$$

Where,

$\sigma^2 g$ = Genotypic variance

$\sigma^2 p$ = Phenotypic variance

The range of heritability was categorized as below. [13].

0 – 30 Low

31 – 60 Medium

>61 High

2.3.4. Genetic advance (GA)

Genetic advance was worked out based on the formula suggested by [13].

$$GA = \frac{\sigma^2 g}{\sigma^2 p} k \times \sqrt{\sigma^2 p} \quad (4)$$

K =Selection differential at 5% selection intensity = 2.06 [14].

$\sqrt{\sigma^2 p}$ = Phenotypic standard deviation.

2.3.5. Genetic Advance as Percentage of Mean

$$GA\ \% = \frac{GA}{\text{Mean}} \times 100 \quad (5)$$

This was categorized by [13]

Range

>20

10 – 20 Medium

<10 Low

2.3.6. Estimation of Correlation Coefficient

The association between any two variables, regardless of the influence of other related characters is simple correlation coefficients (r). The variance and covariance components were utilized to calculate.

It is the heritable association between two characters and was calculated by

$$r_g = \frac{Cov_g(x_1.x_2)}{\sqrt{\sigma g.x_1 . \sigma_g x_2}} \quad (6)$$

III. RESULTS AND DISCUSSION

3.1. Morphological Characterisation

An investigation was made to determine the extent of variability among the faba bean germplasm accessions. TABLE 1 shows the qualitative trait observations (Fig.1.) and TABLE 2 shows the Estimates of phenotypic (δ_{ph}),

genotypic (δ_g) and heritability (h_2) in broad sense heritability for studied trait values of ten characteristics.

3.2. Mean Performance

The mean performances for different traits of 50 faba bean germplasm accessions are given in the TABLE 2. Data revealed that there is wider range of variability observed for the traits plant height (82.80-135.60 cm), number of pods per plant (12.00 -55.80) and seed yield per plant (4.63 - 27.73). These results reflect that the selection prospects for these traits to improve the performance through breeding program.

3.3. Genetic Parameters

The genetic parameters such as phenotypic coefficient of variance, genotypic coefficient of variance, heritability and genetic advance as percent of mean were computed and presented in TABLE 2. The coefficient of variation was worked out for valid comparison between the characters which were associated with different traits. The phenotypic coefficient of variation was high for the single plant yield (41.05) followed by number of pods per plant (34.36). The estimates of PCV were low for 100 seed weight (14.98), plant height (14.04), pod length (12.33), number of branches (11.94), number of seeds per pod (10.64), pod width (6.79), days to 50% flowering (3.63) and days to 80% maturity (1.76).(Fig.2.)

The genotypic coefficient of variation was high for the traits for the single plant yield (36.66) followed by number of pods per plant (31.53). The estimates of PCV were low for 100 seed weight (14.62) followed by plant height (13.45), pod length (9.44), number of branches (6.70), number of seeds per pod (5.65), pod width(2.11), days to 50% flowering (3.23) and days to 80% maturity (1.66).

Generally the difference between PCV and GCV for all traits was small and PCV value was greater than GCV for all the characters indicating that these characters were less influenced by environment. High PCV and GCV values were supported for the traits seed yield per plant, number of pods per plant. High heritability with moderate GA and high GCV was recorded for the characters seed yield per plant and number of pods per plant.

Heritability (h2) estimates were generally low for all studied traits. The estimates of heritability and genetic advance as per cent of mean are furnished in the TABLE 2.The heritability estimate was higher for the traits , 100 seed weight (95.17%), plant height (91.79%), days to 80% maturity (89.09%), number of pods per plant (84.20%), seed yield per plant (79.76) and days to 80% maturity (79.06%) whereas the medium heritability estimates were established for the traits pod length (58.68%) and number of branches (31.50%). The heritability was low for the traits number of seeds per pod (28.20%) and pod width (9.68%). (Fig.3.) No trait has recorded the highest GA as per cent of mean. The moderate GA as percent of mean was recorded by pod length (14.95%) followed by number of pods per plant (13.66%). All other traits recorded the lowest genetic advance as per cent of mean**.** These results indicated that the environmental factors had a small effect on the inheritance of such traits. High estimates of heritability indicated that selection based on mean would be successful in improving these traits.

The variability for the same species from the Maghreb collection (161 lines accessions) and demonstrated variability in this parameter [15]. Accordingly [16] confirmed that faba bean genotype determines the number of seeds per plant. Nevertheless [17] found no significant variability of seed number/ pod between twelve studied faba bean genotypes.

3.4. Correlation Studies

The inter relationship among the seven characters was estimated through correlation coefficient at phenotypic levels and are presented in the TABLE 3. Significant positive correlation values were detected between seed yield per plant and plant height (0.301), number of pods per plant (0.299), pod length (0.284) and hundred seed weight/plant (0.511). There is strong association of these characters can be give importance during selection to improve the yield potential of the crop.

Positive and significant correlation was observed between number of seeds per pod and plant length (0.446) and with number of pods per plant (0.433), between pod width and hundred seed weight (0.371), plant length (0.486), plant height (0.462). Similarly, positive and highly significant correlation was recorded between days to 50% flowering and plant height (0.485) but significantly correlated with pod length (0.355). There is a negative but significant correlation was observed between days to 80% maturity and plant height (-0.345) and pod length (-0.287). Plant height had a positive and highly significant correlation with pod length (0.622) and pod width (0.462) but it had a positive and significant correlation with hundred seed weight (0.283) and single plant yield (0.301).Pod length had recorded positive and highly significant correlation with number of seeds per pod (0.433) and pod width (0.486). Hundred seed weight had a positive and highly significant correlation with pod weight (0.371) and seed yield per plant (0.511).There is no correlation between number of seeds per plant and pod weight and hundred seed weight and seed yield per plant. Likewise number of branches also not correlated with any traits.

Thus, correlation helps breeders to identify the characters that could be used as selection criteria in breeding programme. These results suggested that improvement of grain yield in faba bean is linked with these traits and selection of these traits might have good impact on yield per plant. These results are in agreement with those obtained by [2] [7] [8] [9] [18] [19]

IV. FIGURES AND TABLES

TABLE 1.Quality Traits Observed in Faba Bean Germplasm Accessions

S.No.	Traits	Mean	Minimum	Maximum
1.	Number of leaflets per leaf	5	4	6
2.	Pod colour	2	2	2
3.	Pod shape	3	3	3
4.	Seed coat colour	7	2	8
5.	Seed shape	3	2	3

Table 2. Estimates of Phenotypic (δph), Genotypic (δg) and Heritability (h2) in Broad Sense Heritability for Studied Traits Values of Ten Characteristics

S.No.	Traits	Mean	Range	PCV	GCV	ECV	H^2 %	GA%
1.	Days to 50% flowering	68.56	64.00-75.00	3.63	3.23	1.69	79.06	2.54
2.	Days to 80% maturity	144.13	140.00-150.00	1.76	1.66	0.58	89.09	3.23
3.	Plant height (cm)	107.07	82.80-135.60	14.04	13.45	4.13	91.79	3.67
4.	Number of branches	4.92	4.00-6.40	11.94	6.70	9.48	31.50	9.24
5.	Pod length (cm)	5.22	3.90-6.70	12.33	9.44	7.77	58.68	14.95

6.	Pod width (cm)	9.11	7.76-11.11	6.79	2.11	6.65	9.68	1.68
7.	Number of pods per plant	21.90	12.00-55.80	34.36	31.53	12.90	84.20	13.66
8.	Number of seeds per pod	3.53	2.80-4.60	10.64	5.65	8.78	28.20	9.32
9.	100 seed weight (g)	21.24	14.84-27.24	14.98	14.62	3.66	95.17	7.71
10.	Seed yield per plant (g)	13.68	4.63-27.73	41.05	36.66	15.71	79.76	19.00

Table 3. Correlation Coefficients Among Studied Traits of Faba Bean Genotypes

Characters	Days to 50% flowering	Days to 80% maturity	Plant height (cm)	No. of branches	Pod length (cm)	Pod width (cm)	Number of pods per plant	Number of seeds per pod	100 seed weight (g)	Seed yield per plant (g)
Days to 50% flowering	1	-0.286*	0.485**	0.067	0.355*	0.221	0.124	0.147	0.066	0.156
Days to 80% maturity		1	-0.345*	0.188	-0.287*	-0.276	-0.106	-0.065	-0.193	-0.040
Plant height (cm)			1	0.171	0.622**	0.462**	0.249	0.183	.0283*	0.301*
Number of branches				1	0.201	-0.028	-0.007	0.125	0.073	0.009
Pod length (cm)					1	0.486**	0.271	0.446**	0.185	0.284*
Pod width (cm)						1	0.486**	0.187	0.371**	0.107
No. of pods per plant							1	0.433**	0.033	0.299
No.r of seeds per pod								1	-0.114	0.067
100 seed weight (g)	`								1	0.511**
Seed yield /plant (g)										1

* Significance at 5% level

** Significance at 1% level

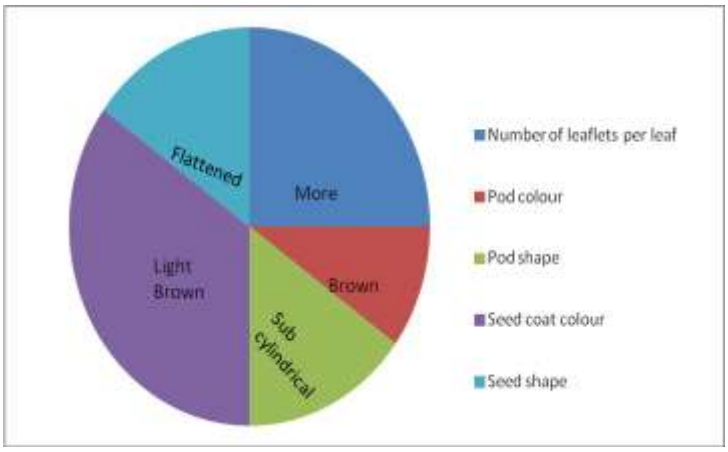

Figure 1: Diagrammatic Representation of Mean of Qualitative Traits Observed in 50 Faba Bean Accessions

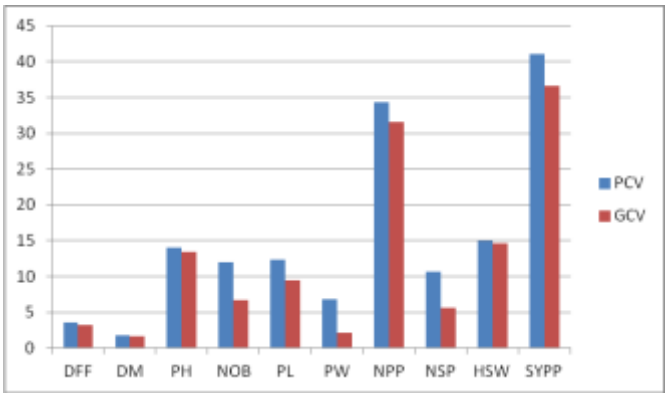

Figure 2. Comparision between PCV and GCV

DFF: Days to 50% flowering; DM: Days to 80% maturity; PH: Plant Height; NOB: Number of branches; PL: Pod length; PW: Pod width; NPP: Number of Pods per plant; NSP: Number of seeds per pod; HSW: Hundred seed weight; SYPP: Seed yield per plant

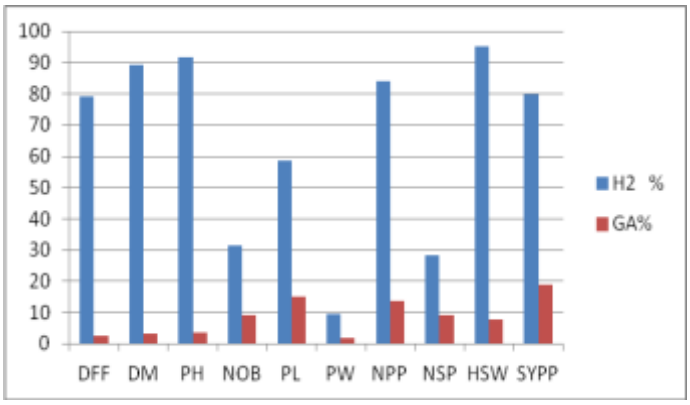

Figure 3. Graph Shows the Expression of Heritability and Genetic Advance in Percentage

DFF: Days to 50% flowering; DM: Days to 80% maturity; PH: Plant Height; NOB: Number of branches; PL: Pod length; PW: Pod width; NPP: Number of Pods per plant; NSP: Number of seeds per pod; HSW: Hundred seed weight; SYPP: Seed yield per plant.

V. CONCLUSION

This faba bean characterisation and evaluation which was carried out in NBPGR, New Delhi is with the purpose of assessing the variability on faba bean germplasm accessions. The planting materials tested can serve as a good resource of donor parent in the faba bean breeding programme. The positive and significant correlation was observed between single plant yield and hundres seed weight, plant height, pod length and number of pods. So, these traits are likely to be successfully employed for the selection of high yielding faba bean germplasm accessions.

REFERENCES

[1] E Bremer, D A Rennie, and R J Rennie.. Dinitrogen fixation of lentil, field pea and fababean under dryland conditions. Can. J. Soil Sci. 68, 1988, 553-562.

[2] D A Bond, Yield and components of yield in diallel crosses between inbred lines of winter beans (Vicia faba L.) J. Agric. Sci. Camb. 657, 1966, 325-336.

[3] A A Kambal, Components of yield in field beans (Vicia faba L.). J. Agric. Sci. Camb. 72, 1969, 359-363.

[4] T E Yassin,. Genotypic and phenotypic variances and correlations in field beans (Vicia faba L.). J.Agric. Sci. Camb. 81, 1973, 445-448.

[5] C De Pace, Characteristics with significant correlation to seed yield and broad bean population grown in Southern Italy. In: Semi Current research on Vicia faba in Western Europe. Ed BABND, GR Scarascia Mugnozza and M.H. Poulsen, Pub. EECEUR, 6244 En., Luxembourg, 1979, 144-167.

[6] G C Bora, S N Gupta, Y S Tomer and S Singh, Genetic variability, correlation and path analysis in faba bean (Vicia faba). Indian J. Agric. Sci. 68(4), 1998, 212-214.

[7] M H Poulsen and J C N Knudsen, Breeding for many small seeds/pod in Vicia faba L. FABIS Newsletter 2, 1980, 26-28.

[8] H Ulukan, M Culer and S Keskin, A path coefficient analysis of some yield and yield components in faba bean (Vicia faba l.) genotypes. Pak. J. Biol. Sci. 6(23), 2003, 1951-1955.

[9] S S Alghamdi and Kh A Ali, Performance of several newly bred faba bean lines. Egypt. J. Plant Breed.8, 2004, 189-200.

[10] G W Burton, Quantitative inheritance in grasses. 6th International Grassland Congress 1, 1952, 277-283. [11] S Sivasubramanian and P Madhavamenon, Combining ability in rice.Madras Agricultural Journal 60, 1973, 419- 421.

[12] J K Lush, Intra-sine correlations or regressions of offspring on dam as a method of estimating heritability of characteristics. Am. Soc. Anim. Prod. Proc. 33, 1940 : 293-301.

[13] H W Johnson, H F Robinson, and R E Comstock, Estimates of genetic and environmental variability in soybean. Agronomy Journal 47(7), 1955, 314-318.

[14] D S Falconer, Introduction to Quantitative Genetics, 1981, 2rid ed., Longman, London. [15] A Sadiki, S J Bouhlassa, J Auajjar, A Faleh and J J Macaire, Utilisation d'un SIG pour l'évaluation et lacartographie des risques d'érosion par l'équation universelle des pertes en sol dans le Rif oriental (Maroc)cas du bassin versant de l'oued Boussouab, Bulletin de l'Institut Scientifique, Rabat, section Sciences de laTerre, 26, 2004, 69-79.

[16] D A Bond, D A Lawes, G C Hawtin, M C Saxena, and J S Stephens. Faba Bean (Vicia faba L.)In: R.J. Summerfield and E.H. Roberts (eds.), Grain Legume Crops. William Collins Sons Co. Ltd. 8 Grafton Street, London, WIX 3LA, UK.1985, 199- 265.

[17] I Daur, H Sepetoğlu , K B Marwat an M N Geverek.Nutrient removal, performance of growth and yield of faba bean (Vicia faba., L) Pakistan Journal of Botany, 42(5),2010, 3477-3484.

[18] D A Lawes, Field beans: improving yield and reliability. Span, 17, 1974 , 21-23.

[19] T A Shalaby and Y S Katta, Path coefficient analysis of seed yield and some agronomic charactersin field beans (Vicia faba L.). J. Agric. Res. Tanta Univ. 2(2), 1976, 70-79.