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Genetic variation of horticultural traits in some indigenous and exotic genotypes of broad bean (*Vicia faba* L.) under mid hills of North-Western Himalaya

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Abstract

Systematic collection and evaluation of six indigenous and fifteen exotic genotypes were undertaken to assess the extent of genetic variability, heritability and genetic advance for pod yield per plant and six other horticultural traits in broad bean. Sufficient genetic variability was observed for marketable pod yield per plant, pods per plant, pod weight, pod length, pod width, grains per pod and plant height which was evidenced from the significant mean squares due to genotypes. The magnitude of phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits studied. High heritability estimates coupled with high genetic advance as percentage of mean was observed for pods per plant and pod length. However, pod width, plant height and pod yield per plant had high heritability associated with moderate genetic advance. The pod yield per plant ranged between 80.30 g (EC 2435) to 143.27 g (Jawali Local) and it exhibited 91.16 per cent heritability with moderate genetic advance (31.91 %) as percentage of mean. Suitable breeding strategy based on different genetic parameters for the improvement of horticultural trait in the development of an ideal plant type of broad bean has been suggested.

Key words: *Vicia faba*, horticultural traits, indigenous, exotic genotypes.

Introduction

Broad bean (*Vicia faba* L.) also called faba bean or horse bean, being native to Europe and Asia is popularly known as poor man's vegetable and remained under utilized crop especially in India. Although, broad bean plays a vital role in World Agriculture principally because of its high protein contents (23 %) and ability to grow and yield satisfactory even on marginal lands and at higher elevations. It is the only bean which is mainly cultivated in kitchen gardens during autumn-winter season in N-W Himalayas. Of late, broad bean cultivation is becoming popular amongst the farmers of hilly areas because its early produce fetches premium prices in the market. Lack of availability of high yielding genotypes and improved agro techniques are the major bottlenecks restricting its commercial cultivation. The identification of genotypes with high variability and heritability for desired characters is useful in the development of new varieties with increased yield potential (Kader et al. 1982). The polygenic characters viz., yield and its components are highly influenced by the environment and it becomes difficult to know whether the variability is heritable or environmental (non-heritable). Based on this consideration, a systematic collection and evaluation of both indigenous and exotic genotypes was undertaken to assess the extent of genetic variability available in the germ plasm for pod yield and its related traits and further its effective manipulation in the development of high yielding genotypes.

Materials and Methods

The present investigation was carried out with fifteen exotic genotypes viz., EC-2435, EC-7853, EC-10720, EC-34374, EC-117765, EC-243268, EC-243608, EC-243764, EC-251014, EC-322967, EC-329662, EC-329723, EC-343696, EC-343855 and EC-359685 from NBPGR and six indigenous collections viz., Panapar Local, Lahar Local, Jawali Local, Kunjdwar Local, Sagoor Local and Pathiar Local maintained genetically pure through self pollination. The experiment was laid out in a randomized block design with three replications on farmer field at Panapar village (30 km from University head quarter) during *rabi* 2006-07. Each experimental plot consisted of two rows of 2.25 m length and the plants were spaced at 60 x 15 cm apart between and within rows. The observations were recorded on ten randomly selected competitive plants for pod yield per plant, pods per plant, pod weight, pod length, pod width, grains per pod and plant height. The data were analysed for each character and variance components were calculated as per Panse and Sukhatme (1967). The formulae suggested by Burton (1952), Johnson et al (1955) and Comstock and Robinson (1952) were used for calculating the genotypic, phenotypic coefficient of variation, heritability (h^2) and genetic advance.

Results and Discussion

The mean performance of different genotypes and analysis of variance for experimental design indicated significant differences among treatments for all the traits studied (Table 1). The extent of variability for seven polygenic traits in 21 indigenous and exotic genotypes of broad bean, measured in terms of range, coefficient of variation, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), environmental coefficient of variation (ECV) alongwith heritability (h^2) and genetic advance (GA) are presented in Table 2.

A glance of the values in Table 2 indicated vide range of variability for pod yield per plant, pods per plant, pod length, pod width, pod weight, grains per pod and plant height. The coefficient of variation ranged from 3.47 (pod width) to 15.29 per cent (grains per pod). Almost all the traits exhibited greater phenotypic variance (V_p). The magnitude of heritable components determines to a great extent the transmissibility of a character from the parents to the off-springs. The differences between the genotypic and phenotypic variance for all the character studied were relatively low. This indicated that these characters were comparatively stable and highly heritable. The phenotypic coefficients of variation (PCV) were higher than the genotypic coefficients of variation (GCV) for almost all the traits studied. This indicated the considerable influence of environment in the expression of these traits. The GCV which provides a picture of the extent of genetic variability in the experimental material, ranged from 11.96 (pod weight) to 24.17 per cent (pods per plant). The highest GCV (24.17 %) associated with high heritability estimate (86.45 %) along with high expected genetic advance (46.29) expressed as percentage of mean was observed for pods per plant which clearly indicated the preponderance of additive genetic effects. The minimum GCV estimate of 11.96 per cent coupled with moderate to high heritability (59.37 %) and lowest genetic advance (18.99) as percentage of mean was observed for pod weight. The pod yield per plant also depicted high heritability (91.16 %) along with medium genetic

Table 1. Mean performance of different genotypes of broad bean

Trait/Genotype	Pod yield per plant (g)	Pods per plant	Pod weight (g)	Pod length (cm)	Pod width (cm)	Grains per pod	Plant height (cm)
	1	2	3	4	5	6	7
EC-2435	80.30	14.26	5.72	6.10	2.72	3.26	60.73
EC-7853	106.07	14.63	7.30	7.33	2.87	2.57	79.13
EC-10720	118.83	18.83	6.36	6.93	3.70	3.77	87.36
EC-34374	140.93	25.56	5.52	11.43	3.23	4.79	108.56
EC-117765	80.96	13.23	6.15	6.90	3.10	3.01	62.13
EC-243268	92.83	17.06	5.48	6.80	2.91	3.13	73.63
EC-243608	135.36	24.66	5.52	9.86	4.25	3.47	106.20
EC-243764	111.16	13.96	8.02	8.80	2.86	4.09	74.63
EC-251014	120.90	16.23	7.47	10.00	3.24	4.36	85.23
EC-322967	129.00	20.56	6.30	9.76	3.34	4.48	75.80
EC-329662	138.16	25.33	5.46	9.91	4.28	4.06	100.53
EC-329723	124.16	19.66	6.32	8.64	3.73	3.54	84.76
EC-343696	134.56	24.70	5.46	11.93	3.27	5.05	94.76
EC-343855	113.50	16.43	6.94	10.33	3.04	4.77	71.83
EC-359685	89.00	13.50	6.73	7.06	3.41	3.51	65.00
Panapar Local	108.56	15.20	7.18	8.20	3.13	3.39	78.86
Lahar Local	123.00	20.53	6.02	9.30	3.73	3.46	84.60
Jawali Local	143.27	27.36	5.27	12.30	3.66	5.91	112.80
Kunjdwar Local	127.36	24.26	5.26	8.13	3.63	3.86	88.63
Sagoor Local	98.00	14.93	6.62	7.03	2.59	3.27	92.73
Pathiar Local	119.33	15.93	7.52	8.63	3.16	3.90	87.36
General mean ($\overline{X}$)	115.96	18.90	6.31	8.83	3.32	3.88	84.54
F test	*	*	*	*	*	*	*
SD	18.65	4.57	0.82	1.74	0.44	0.76	14.26
SE (m) ±	3.81	1.04	0.36	0.36	0.06	0.34	1.73

*Significant mean squares due to treatments at P = 0.05

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Table 2. Estimates of mean, range, variance components, coefficient of variation, heritability and genetic advance for pod yield and related traits in broad bean

Component/Character	Mean	Range	CV (%)	V_g	V_p	V_e	GCV	PCV	ECV	Heritability (h^2)	Genetic advance	
											Per cent of mean	5 % selection intensity
Pod yield per plant (g)	115.96±3.81	80.30-143.27	5.05	353.98	388.29	34.31	16.22	16.99	5.05	91.16	31.91	37.01
Pods per plant	18.90±1.04	13.23-27.37	9.58	20.87	24.14	3.27	24.17	25.99	9.56	86.45	46.29	8.75
Pod weight (g)	6.31±0.36	5.26-8.01	9.89	0.57	0.96	0.39	11.96	15.53	9.89	59.37	18.99	1.19
Pod length (cm)	8.83±0.36	6.10-12.30	7.08	3.06	3.45	0.39	19.81	21.03	7.07	88.69	38.43	3.39
Pod width (g)	3.32±0.06	2.59-4.28	3.47	0.20	0.21	0.013	13.47	13.80	3.47	95.23	27.07	0.89
Grains per pod	3.88±0.34	2.57-5.91	15.29	0.51	0.86	0.35	18.40	23.90	15.25	59.30	29.19	1.13
Plant height (cm)	84.54±1.73	60.73-112.80	3.56	210.59	219.63	9.04	17.16	17.53	3.55	95.88	34.62	29.27

advance of 31.91 expressed as percentage of mean.

The relative amount of heritable portion of the genetic variation was estimated with the help of heritability and genetic advance expressed as percentage of mean (genetic gain). In the present investigation, all the characters displayed moderate to high heritability estimates ranging from 59.30 (grains per pod) to 95.88 per cent (plant height). The results are in accordance with the findings of Sharma *et al.* (1997) and Chadha *et al.* (2008) who had reported high heritability estimates for pod yield per plant and its associated horticultural traits in garden pea. Such high heritability estimates have been found to be helpful in making selection of superior genotypes on the basis of phenotypic performance with respect to quantitative traits. However, the heritability estimates along with genetic gain is more useful than the heritability values alone in predicting the resultant effect of selecting the best individuals. In the present study, pod yield per plant, pods per plant, pod length, pod width and plant height exhibited high heritability associated with high genetic advance as per cent of mean. However, moderate to high heritability estimates coupled with medium to low genetic advance expressed as percentage of mean were recorded for grains per pod and pod weight.

In general, the characters which depicted high heritability along with high genetic advance are controlled by additive genes and can be improved upon by simple selection procedures. The characters exhibiting moderate to high heritability estimates coupled with moderate or low genetic advance can be improved by inter mating the superior genotypes of the segregating population developed from multiple crosses and the desirable genes can be accumulated in the genotypes (Liang and Walter, 1968). Since the heritability values give an idea about the proportion of total variability that is due to genetic causes, the more confirmative decision for embarking upon any breeding procedure for improvement of any trait can only be taken up after ascertaining the type of gene action involved in the inheritance of that particular trait.

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