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Genetic Variability for Morphological Traits and Total Phenol Content in Faba Bean (*Vicia faba* L.)

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Abstract The genetic variability for leaflet, length, breadth, shape and total phenol content was studied in 62 diverse germplasm lines in faba bean (*Vicia faba* L.). Highly significant treatment effects were observed for breadth of leaflet and phenol content in green pod. Among all the lines under study, 35-genotypes were elliptical, 15-obovate, 7-oblanceolate and 5-genotypes showed lanceolate leaf shape. Range of variability for length of leaflet, breadth of leaflet and content of total phenolics were 5.6-7.56 cm, 2.4-4.13 cm and 23.84 — 75.61 mg/100g, respectively. The genotypic coefficient of variation in the analysis for all the analysis for all the genotypes of faba beans ranged from 0.77 to 19.15%. The difference between GCV and PCV for leaf breadth was minimal which indicated negligible environmental effect on this character. The broad sense heritability estimate (31.86%) was observed for total phenol content in green pods. The estimate of genetic advance as per cent of mean was maximum in case of phenol content in pod (22.00%). The value of GCV, heritability and genetic advance as per cent of mean indicated additive gene action for phenol content in the green pod and moderate value of heritability coupled with low value of genetic advance for breadth of leaflet, suggested non-additive gene interaction.

Keywords Variation, Germplasm, Phenollics, Heritability, Genetic advance.

Introduction

Faba bean (*Vicia faba*) belong to family leguminaceae is also known as broad bean, horse bean, windor bean, english bean, tick bean, field bean winter bean and pigeon bean. Besides, poor man's vegetable it plays an important role in the world agriculture owing to its high protein content i.e. 22—41% [1], ability to fix atmospheric nitrogen and capacity to grow and yield well even on marginal altitudes. The crop is grown at limited scale in kitchen garden for use green pod as vegetable, widely grown for pulses and concentrates feed for livestock in Bihar. Uttar Pradesh, Himanchal Pradesh and North eastern states of India.

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Though the crop is very important with respect to its nutritional qualities and wide adaptability to stresses environment, very little work has been done in the improvement of this important crop in India. The role of genetic variability in a crop is of paramount importance in selecting the best genotype for making rapid improvement in qualitative and quantitative characters as well as to select the most potential parents for making the hybridization program successful for developing high yielding varieties having better nutritional qualities [2]. However, the measurement of variability appears to be the phenotypic expression which is the result of interaction between the genotype and environment and reflect the non-genetic as well as genetic influences on development. Moreover, all the genotypes do not react in the same way to given environment. Grafius [3] suggested that there may not be gene for yield per se but rather for various components, the multiplicative interaction of which result in the artefact of yield. Most of the traits of agronomic importance are polygenically inherited and so highly influenced by environment, thereby making selections for yield a rather difficult task. Heritability is an index to decipher the influence of environment on the expression of genotype. Estimates of genetic advance together with heritability would be helpful in assessing the nature of gene action and to decide the future strategy of improvement program.

Faba beans are abandoned source of natural antioxidant and properties of phenolic compounds may provide excellent dietary source for prevention of chronic disease and health promotion [4]. In this regard the quantification of antioxidant capacity is depend on the stage of the plant part used and purpose of the food products [5]. Legumin is the predominant globulin and has a larger proportion of arginine, threonine and tryptophan. Broad beans are rich in tyramine and thus should be avoided by those taking monoamine oxidase inhibitors. They contain vicine and convicine, which can induce hemolytic anaemia in patients with the hereditary condition glucose-6-phosphate dehydrogenase deficiency (G6PD). A word of caution is necessary because where these beans are eaten regularly as the main diet, as in certain tropical countries, a paralytic condition known as favism has occurred. Broad beans are rich in L-dopa, a substance used medically in the treatment of Parkinson's disease. L-dopa is also a natriuretic agent, which might help in controlling hypertension.

Keeping in view the importance of different aspects of variability stated above, it was considered important to evaluate wide germplasm lines of faba bean for improvement through selection of superior types by studying the variability. The present investigation was therefore undertaken to study the variability for various qualitative and quantitative traits viz. length of leaflets, breadth of leaflets, shape of leaflets and content of total phenol in the immature pod.

Materials and Methods

Plant material

Present experiment was carried out at the Research field of Horticulture and Agro-Ferestry Research Program (ICAR Research Complex for Eastern Region), Palandu, Ranchi during 2006-2007. The experimental material was comprised of 62 germplasm of faba bean lines collected from different part of Bihar. The experiment was conducted in randomized block design with three replications and recommended agronomical practices were adopted to have a good crop. Observations were recorded for the length of the leaflets, breadth of the leaflets, shape of leaflets and total phenol content in green pods.

Chemical analysis

The phenol content was estimated spectrophotometrically using folin-ciocalteau reagent [6]. To investigate the total phenol content 100.00 g of green pod was taken to grind and from them 2.0 g sample was taken and mixed with 5 ml of 80% ethanol with the help of mortar and pestle. The homoginate was centrifuged at 10,000 rpm fo 20 minutes and collected supernatant was evaported up to dryness. The residue was dissolved in the 5 ml 0f distilled water; 50 ml aliquots of different samples were transferred into test tubes and standard solution of pyro-catechol was pipette out (0.2 to 1.0 ml) into the test tubes and volume was made up to 3.0 ml in each tube with

Table 1. Mean performance of 62 germplasm of faba bean.

Sl. No.	Entries	Leaflet length (cm)	Leaflet breadth (cm)	Leaflet shape	Phenol content in pod (%)
1.	Muzaffarpur local	6.36	2.96	Lanceolate	59.62
2.	VFB-1	6.46	3.00	Elliptic	53.07
3.	VFB-2	6.33	3.10	Obovate	35.54
4.	VFB-5	6.76	2.60	Elliptic	75.62
5.	VFB-6	6.60	2.90	Elliptic	46.95
6.	VFB-7	6.46	3.10	Obovate	31.79
7.	VFB-8	6.53	2.80	Elliptic	50.04
8.	VFB-9	6.40	3.03	Obovate	25.52
9.	VFB-10	7.16	2.70	Obovate	45.19
10.	VFB-11	6.56	2.93	Elliptic	66.97
11.	VFB-12	7.26	3.26	Elliptic	28.59
12.	VFB-13	6.76	3.06	Obovate	66.76
13.	VFB-14	7.03	3.33	Elliptic	23.84
14.	VFB-15	6.66	2.76	Elliptic	35.82
15.	VFB-16	6.10	2.40	Elliptic	52.65
16.	VFB-17	6.33	3.00	Obovate	71.34
17.	VFB-18	5.60	2.43	Elliptic	42.70
18.	VFB-19	6.53	2.90	Lanceolate	56.14
19.	VFB-20	6.26	3.03	Elliptic	48.86
20.	VFB-21	6.76	2.56	Lanceolate	45.23
21.	VFB-22	6.16	2.66	Elliptic	78.51
22.	VFB-24	6.73	2.53	Elliptic	41.29
23.	VFB-26	6.23	2.80	Elliptic	45.94
24.	VFB-27	6.60	3.06	Oblanceolate	35.70
25.	VFB-29	6.46	3.06	Elliptic	44.70
26.	VFB-30	6.76	2.06	Oblanceolate	50.25
27.	VFB-31	6.96	3.20	Obovate	34.83
28.	VFB-32	6.36	2.73	Lanceolate	52.01
29.	VFB-33	6.56	2.83	Elliptic	38.46
30.	VFB-34	6.43	2.73	Elliptic	48.45
31.	VFB-35	6.06	2.63	Oblanceolate	42.98
32.	VFB-36	6.36	3.03	Elliptic	32.74
33.	VFB-37	6.90	3.20	Obovate	36.05
34.	VFB-38	6.83	3.20	Elliptic	63.55
35.	VFB-39	6.60	2.90	Oblanceolate	40.18
36.	VFB-40	6.46	3.13	Elliptic	45.98
37.	VFB-42	6.33	2.63	Elliptic	38.44
38.	VFB-43	6.13	2.76	Elliptic	41.32
39.	VFB-44	6.23	2.86	Oblanceolate	30.52
40.	VFB-45	6.70	3.00	Obovate	40.64
41.	VFB-48	6.06	2.36	Obovate	46.27
42.	VFB-49	6.23	2.90	Oblanceolate	47.74
43.	VFB-53	6.30	2.50	Elliptic	41.05
44.	VFB-54	6.70	3.00	Obovate	59.35
45.	VFB-55	7.53	3.03	Obovate	44.14
46.	VFB-56	6.63	2.83	Obovate	47.41
47.	VFB-57	6.50	2.73	Obovate	45.05
48.	VFB-58	6.63	2.76	Lanceolate	37.92
49.	VFB-59	6.73	2.76	Elliptic	43.68
50.	VFB-60	6.86	3.00	Elliptic	42.31
51.	VFB-61	6.63	2.86	Obovate	44.30
52.	VFB-62	6.76	3.36	Elliptic	33.03
53.	VFB-63	6.30	2.70	Elliptic	40.26
54.	VFB-64	7.56	4.13	Elliptic	57.15

Table 1. Continued.

Sl.No.	Entries	Leaflet length (cm)	Leaflet breadth (cm)	Leaflet shape	Phenol content in pod (%)
55.	VFB-65	7.10	3.20	Elliptic	41.61
56.	VFB-66	6.83	3.03	Elliptic	43.99
57.	VFB-67	6.76	2.90	Oblanceolate	31.70
58.	VFB-68	6.66	3.10	Elliptic	44.86
59.	VFB-69	7.16	3.00	Elliptic	44.72
60.	VFB-70	6.83	3.16	Elliptic	33.07
61.	VFB-71	7.06	2.86	Elliptic	47.05
62.	Pusa Sumeet	7.06	2.80	Elliptic	46.60
	General mean	6.61	2.91		45.29
	SEm±	0.35	0.17		7.33
	CV (%)	9.33	10.60		28.00
	CD (5%)	NS	0.49		18.60
	CD (1%)	NS	0.65		34.86

water. 0.5 ml of folin-ciocalteau reagent was added to each test tube and ml of 20 % sodium carbonate solution was added and contents were mixed thoroughly. The tubes were placed in boiling water bath for exactly one minute and then cooled gradually. The absorbance of the blue color solution was recorded at 650 nm UV rays against a reagent blank using spectrophotometer (UV 5704SS make of ECIL). The content of total phenol in the tissue was estimated by using the standard curve obtained by plotting the absorbance of standard samples.

Statistical analysis

The collected data were subjected for statistical analysis of variances. Phenotypic coefficient of variations and genotypic coefficient of variations were calculated with the help of formula given by Burton [7]. Heritability was computed with the help of method used by Lush [8] and Genetic advance was also worked out with the equation given by Johnson et al. [9].

Results and Discussion

The variability is the pre-requisite for any plant breeding program and for this total of 62 genotypes of faba bean (*Vicia faba*) lines used for the experiment including 61 indigenous collections made from different part of Bihar and one commercial variety Pusa Sumeet release from IARI, New Delhi (Table 1). These lines showed much variability in their qualitative and quantitative characters. Table 2 shows that analysis of variance for treatment effects were highly significant for breadth of leaflet and content of phenol content in immature pods while length of leaflets did not differ significantly ranging from 5.60 to 7.56 cm with mean value of 6.61 cm. This indicates that naturally occurring sufficient genetic variability, except for leaflet length, may be exploited in the crop improvement program. The range of wideness was 2.36-4.13 cm and widest leaf breadth was recorded in the genotype VFB-64 (4.13 cm) followed by VFB-62 (3.36 cm), VFB-14 (3.33 cm), VFB-31, VFB-37, VFB-38, VFB-65 (3.20 cm). These genotypes can effectively be utilized in breeding program for development of varieties having higher photosynthetic surface area.

The shape of leaf is also an important param-

Table 2. Analysis of variance for design of experiment in 62 germplasms of faba bean.

		Mean sum of squares		
Sources	df	Leaflet length (cm)	Leaflet breadth (cm)	Phenol content (mg/100 g)
Replication	2	5.28	1.19	60.95
Treatment	61	0.38	0.22**	387.44**
Errors	122	0.38	0.09	161.24

Table 3. Mean, range, parameters of variance, heritability and genetic advance for four characters of 62 entries of faba bean.

Sl. No.	Characters	Mean	Range	GCV (%)	PCV (%)	Herita-bility (%)	Genetic advance (x = 2.06)	GA as % of mean
1.	Leaflet length (cm)	6.61	5.60-7.56	0.77	9.36	0.68	0.008	0.12
2.	Leaflet breadth (cm)	2.91	2.40-3.36	7.09	12.76	30.89	0.23	7.90
3.	Phenol content (mg/100g)	45.29	23.84-78.51	19.15	33.92	31.86	10.09	22.00

eter for distinguishing them from other genotypes qualitatively. the genotypes used under investigation were differed markedly with respect to leaf shape and in this respect out of 62 genotypes , 35 genotypes were elliptical, 15 obovate, 7 oblanceolate and 5 genotypes showed lanceolate leaf shape which is novel itself.

The content of phenolics contribute towards nutritional value of the pod with respect to its antioxidant properties (Table 3). A large variation among the genotypes was observed with respect to the total phenols in immature pods. The genotype VFb-22 recorded the maximum content of total phenols in the pod (78.51 mg/100g). The genotypes in which phenol content were higher than general mean value (45.29mg/100g) were Muzaffarpur Local, VFB-1,5,6,8,11,13,16,17,19,20,22,26,30,32, 34,38,40,48,49,54,56,64,71 and Pussa Sumeet. These genotypes can effectively be utilized in breeding program to develop varieties with higher content of total phenolics. Our results are also in corroboration of the findings obtained by other workers [10].

It is important to evaluate the heritable and non-heritable variations of the various economic characters present in the genotypes included in the study for improvement work. In this respect phenotypic and genotypic coefficient of variation (GCV) were worked out and found that means range from 0.77 to 19.15%. From the selection point of view it is quite obvious that if the component characters are positively correlated with the targeted characters, the trait is highly heritable and would be an ideal trait for selection. The maximum value 19.15% of GCV was observed for content of total phenols in the pod followed by leaflet breadth with 07.09%.

Likewise, similar pattern was also evident for phenotypic coefficient of variation (PCV) having higher estimates for all the characters [11]. The difference between GCV and PCV for leaf length indicated highly affected by environmental factor, smaller for leaflet breadth and phenol content. It is indicated that selection may be effective for the trait under investigation. The knowledge of heritability of any character helps the breeder in predicting the genetic advance for any quantitative character and aids in exercising necessary selection pressure. Johnson et al. [9] suggested that hertability along with genetic advance would be more useful in predicting the gain under selection than heritability alone. Heritability (31.86%) accompanied with genetic advance (22.00%) for phenol content indicated that most likely the heritability is due to additive gene effects and direct selection may be more effective for genetic improvement of the trait. More heritability (30.89%) coupled with low genetic advance (7.9%) for leaflet breadth is indication of non-additive gene interaction and hence hybridization breeding program may be rewarding for the trait under study. Similar pattern of gene interaction has been also observed by different workers [12, 13]. Selection for leaflet length will be ineffective because estimate of heritability and gebnetic advance both were lower.

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