Indian J. Hort. 67(Special Issue), November 2010: 150-153

Hierarchical analysis for genetic variability in pole type french bean

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ABSTRACT

Wide range of phenotypic variation along with high heritability values observed in 66 pole type French bean genotypes. Number of pods per plant, 100-seed weight, green pods yield per plant showed high heritability along with high genetic advance. Association studies revealed that pod yield per plant exhibited significant positive correlation with number of pods/plant, % fruit set per cluster and 100 seed weight at both genotypic and phenotypic level. Maximum direct effect was observed in number of pods/ plant followed by % fruit set/cluster, number of seeds/pod towards yield. Hence, these characters have significant effect on yield, while making selection for high yielding genotypes. Multivariate hierarchical clustering classified 66 genotypes in 2 groups with 23 and 43 genotypes. First group further divided into 2 groups with 1 and 22 genotypes (VRBFB-36 is genetically different from 22 other genotypes), while 43 genotypes divided into 2 clusters with 9 and 34 genotypes respectively.

Key words: French bean, variability, correlation, path coefficient analysis, hierarchical clustering.

INTRODUCTION

French bean originated from Central America and South Mexico, is an important vegetable legume crop used by human being as green pods and dry seeds. This crop is widely adapted to high altitude regions of the country particularly Himanchal Pradesh, Uttaranchal and North Eastern region. Besides, this crop may also be grown in Eastern part of Uttar Pradesh. Genetic variability, character association and path coefficient are pre-requisite for improvement of any crop including French bean as this assists in selection of superior genotypes and improvement for yield contributing traits, (Rai *et al*., 11). Genetic variability increases the efficiency of selection on crop plants and measured in terms of genotypic, phenotypic and environmental variation. The knowledge of correlation of yield contributing traits to yield and further partitioning to direct and indirect effects of traits are a rational approach to understand the nature and extent of such relationship (Simmonds, 13). Keeping in view the importance of these biometrical approaches, an experiment was conducted to know genetic variability, character association and path coefficient for yield and its contributing characters in pole type French bean.

MATERIALS AND METHODS

The experimental materials comprised of sixty six genotypes collected from different parts of India. All these genotypes were grown in randomized block design (RBD) consisting three replications in a plot size of 3.6 × 3.0 m with spacing of 45 cm between the rows and 20 cm between the plants during 2006-07 at the Indian Institute of Vegetable Research, Varanasi. All the recommended cultural practices were followed to raise good crop. Observations were recorded on ten randomly selected plants for eleven characters viz. days to first flowering, days to first picking, number of pods/plant, green pods yield/plant, pod length, pod width, number of seeds/pod, seed length, seed width, 100 seeds weight, % fruit set/ cluster. The variability for different quantitative characters was estimated as per procedure for analysis of variance suggested by Panse and Sukhatme (9), GCV and PCV by Burton and De Vane (4) and heritability and genetic advance by Johnson *et al.* (7), the correlation was worked out as per Al-Jibouri *et al.* (1) and path coefficient of various characters was calculated by a formulae given by Dewey and Lu (6). Multivariate clustering analysis was done a formula as given by Peter and Martinalli (10), which will help in choosing the parents for hybridization.

RESULTS AND DISCUSSION

The differences among the genotypes were observed in all the traits under study (Table 1). The data indicated that there was close relationship between GCV and PCV in all the characters under study, revealing very little influence of environment for their expression. However, the estimate of heritability for the characters under study were more than 80% in most of the characters except of pod width indicated good scope of selection in this crop on the basis of these traits. In present investigation,

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Table 1. Range, mean, variability, heritability and genetic advance for the 11 characters in pole type French bean.

Character	Range mean	Grand	Variability		Heritability (%)	Genetic advance	Genetic advance as % of mean
			PCV	GCV			
							Days to first flowering
54.00 -66.33	61.01	4.40	4.29	95.0	5.25	8.61	
Days to first picking	80.00-109.00	92.99	8.28	8.23	98.6	15.65	16.83
Number of pods/plant	13.33 -79.67	39.95	41.03	40.81	98.9	33.41	83.63
% fruit set/cluster	32.00 -67.33	53.10	18.36	18.13	97.5	19.58	36.87
Pod length (cm)	7.20 -13.37	9.96	13.19	13.14	99.2	2.68	26.91
Pod width (cm)	0.92 -1.43	1.11	11.17	8.97	64.6	0.17	15.32
Number of seeds/pod	3.00 -5.67	4.59	15.85	14.67	85.9	1.29	28.10
Seed length (cm)	0.83 -1.81	0.47	13.85	12.99	88.2	0.30	63.83
Seed width (cm)	0.55 -0.95	0.74	12.01	11.04	84.5	0.15	20.27
100 seeds weight (g)	11.33 -67.0	26.97	41.68	41.61	99.7	23.08	85.58
Pods yield/plant (kg)	97.00 -470.00	279.77	36.18	36.12	99.6	207.75	74.26

characters namely number of pods per plant, per cent fruit set/cluster, 100-seed weight, green pods yield/plant shows high GCV accompanied with high heritability indicating good scope for selection. High heritability along with high values of genetic advance was observed for green pods/plant followed by number of pods/plant and 100 seeds weight. Genetic advance as per cent of mean was observed maximum for number of pods/plant, seed length, 100 seeds weight and green pods/plant. Burton (5) and Johnson *et al.* (7) also suggested that high GCV along with high heritability and genetic advance gave better picture for the selection of the genotypes. Similar result was also reported by Rai *et al*. (11 and 12).

In general, genotypic correlations were observed higher than the corresponding phenotypic correlation for mostly the characters under study in present investigation, thus indicating the superiority of phenotypic expression under the influence of environmental factors (Table 2). Pod yield/plant showed maximum positive and significant association with number of pods/plant (0.82), % fruit set/cluster (0.47), number of seeds/pod (0.43) at both genotypic and phenotypic levels. The number of pods/plant observed high positive correlation with % fruit set/cluster (0.62), number of seeds/pod (0.43) and negative correlation with pod width (-0.45), seed length (-0.39) and seed width (-0.39). The pod length showed positive correlation with seed length (0.34), the number of seeds/pod observed negative correlation with seed width (-0.31). The positive correlation obtained pod width with seed length (0.38), seed width (0.52) and 100-seed weight (0.42), while negative correlation width seeds/pod (-0.361). The seed length also showed positive correlation with seed width (0.57) and 100 seeds weight (0.64) the positive and significant correlation showed days to first flowering with days to first picking (0.50)

Path analysis revealed that number of pods/plant, and pod length had positive, while pod width had negative direct effect on green pods yield/plant (Table 3) indicated that these are main contributors to yield which was similar with the findings of Baswana *et al*. (2), Biju *et al*. (3), and Lal *et al*. (8) in Indian bean and Rai *et al*. (11) in French bean. High positive indirect effect of number of pods/plant on green pods yields was obtained through number of seeds/pod (0.034), seed length (0.014) and % fruit set/cluster (0.010) and 100 seeds weight (0.007). The highest indirect effect of pod width was exhibited through pod length (0.047) and days to first picking (0.002). A positive indirect effect of pod length was obtained high through pod width (0.095), days to first picking (0.006) and number of seed/pod (0.011). On contrary, seed width (-0.160) exhibited maximum negative direct effect followed by days to first flower (-0.127). Thus the path coefficient analysis reveled that the characters such as number of pods/plant, % fruit set/cluster and number of seeds/pod should be take into consideration while making in selection of superior genotypes for green pods yield/plant.

The multivariate approach increases the precision and at the same time decreases the complexity introduced otherwise by increasing replications or by increasing the number of variables. Multivariate hierarchical clustering was carried for eleven different morphological characters (Fig. 1). Distance between all pairs of genotypes was calculated using squared Euclidean distance method and genotypes were clustered based on Ward's method. Figure 1 depicts the classification of 66 genotypes in 2 groups with 23 and 43 genotypes. First group further divided into 2 groups with 1 and 22 genotypes (VRFBP-36 is genetically different from 22 other genotypes)., while 43

Table 2. Phenotypic and genotypic correlation coefficients for 11 characters in pole type French bean.

Characters		Days to first picking	No. of pods /plant	% fruit set per cluster	Pod length (cm)	Pod width (cm)	No. of seeds/ pod	Seed length (cm)	Seed width (cm)	100 seeds wt. (g)	Green pods yield /plant(kg)
Days to first flowering	P	0.503**	0.131	0.217	0.055	0.021	0.116	0.004	-0.122	-0.035	0.077
	G	(0.508**)	(0.137)	(0.231)	(0.055)	(-0.017)	(0.127)	(0.002)	(-0.127)	(-0.034)	(0.079)
Days to first picking	P		-0.110	0.036	0.157	0.042	-0.072	0.046	0.028	0.023	-0.093
	G		(-0.109)	(0.040)	(0.158)	(0.050)	(-0.081)	(0.047)	(0.032)	(0.023)	(-0.094)
Number of pods/plant	P			0.620**	-0.281	-0.452**	0.416*	-0.386*	-0.391*	-0.295	0.821**
	G			(0.623**)	(-0.283)	(-0.569**)	(0.457**)	(-0.417*)	(-0.424*)	(-0.296)	(0.825**)
% fruit set/cluster	P				-0.300	-0.250	0.164	-0.143	-0.153	-0.084	0.468**
	G				(-0.303)	(-0.306)	(0.183)	(-0.157)	(-0.167)	(-0.085)	(0.474**)
Pod length (cm)	P					0.152	0.130	0.336*	-0.009	0.093	0.033
	G					(0.184)	(0.142)	(0.357*)	(-0.007)	(0.094)	(0.034)
Pod width(cm)	P						-0.302	0.383*	0.521**	0.418 *	-0.178
	G						(-0.361*)	(0.488**)	(0.738**)	(0.525**)	(-0.224)
Number of seeds/ pod	P							-0.180	-0.309*	-0.277	0.433**
	G							(-0.195)	(-0.361*)	(-0.298)	(0.472**)
Seed length(cm)	P								0.572**	0.641 **	-0.255
	G								(0.641**)	(0.685**)	(-0.274)
Seed width(cm)	P									0.641**	-0.262
	G									(0.696**)	(-0.287)
100 seeds weight(g)	P										-0.199
	G										(-0.287)

*, ** Significant at 5 and 1 % levels.

Table 3. Direct and indirect effects of different traits on yield in pole type French bean.

Characters		Days to first flowering	Days to first picking	No. of pods/ plant	% fruit set/ cluster	Pod length (cm)	Pod width (cm)	No. of seed/ pods	Seed length (cm)	Seed width (cm)	100 seeds wt. (cm)	Correlation with pod yield/ plant
Days to first flowering	G	**-0.127**	-0.065	-0.018	-0.029	-0.007	0.002	-0.016	0.000	0.016	0.004	0.079
	P	**-0.077**	-0.039	-0.010	-0.017	-0.004	-0.002	-0.009	0.000	0.009	0.003	0.077
Days to first picking	G	0.018	**0.035**	-0.004	0.001	0.006	0.002	-0.003	0.002	0.001	0.001	-0.094
	P	0.001	**0.002**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.093
Number of pods/plant	G	0.149	-0.118	**1.081**	0.673	-0.306	-0.616	0.494	-0.451	-0.459	-0.320	0.825
	P	0.128	-0.107	**0.978**	0.607	-0.274	-0.442	0.407	-0.378	-0.383	-0.288	0.821
% fruit set per cluster	G	0.004	0.001	0.010	**0.017**	-0.005	-0.005	0.003	-0.003	-0.003	-0.001	0.474
	P	0.003	0.001	0.009	**0.015**	-0.005	-0.004	0.002	-0.002	-0.002	-0.001	0.468
Pod length (cm)	G	0.014	0.040	-0.072	-0.077	**0.254**	0.047	0.036	0.091	-0.002	0.024	0.034
	P	0.017	0.047	-0.085	-0.090	**0.301**	0.046	0.039	0.101	-0.003	0.028	0.033
Pod width (cm)	G	-0.009	0.026	-0.296	-0.159	0.095	**0.519**	-0.188	0.253	0.383	0.272	-0.224
	P	0.005	0.010	-0.113	-0.062	0.038	**0.249**	-0.075	0.096	0.130	0.104	-0.178
Number of seeds /pod	GP	0.009	-0.006	0.034	0.014	0.011	-0.027	**0.074**	-0.014	-0.027	-0.022	0.472
		0.008	-0.005	0.029	0.012	0.009	-0.021	**0.071**	-0.013	-0.022	-0.020	0.433
Seed length (cm)	GP	0.000	-0.002	0.014	0.005	-0.012	-0.016	0.006	**-0.033**	-0.021	-0.023	-0.274
		0.000	-0.004	0.036	0.013	-0.031	-0.035	0.017	**-0.092**	-0.053	-0.059	-0.255
Seed width (cm)	GP	0.020	-0.005	0.068	0.027	0.001	-0.118	0.058	-0.102	**-0.160**	-0.111	-0.287
		-0.008	0.002	-0.026	-0.010	-0.001	0.035	-0.021	0.038	**0.067**	0.043	-0.262
100 seeds weight (g)	GP	0.001	-0.001	0.007	0.002	-0.002	-0.013	0.007	-0.016	-0.017	**-0.024**	-0.287
		0.000	0.000	0.003	0.001	-0.001	-0.004	0.003	-0.006	-0.006	**-0.009**	-0.199

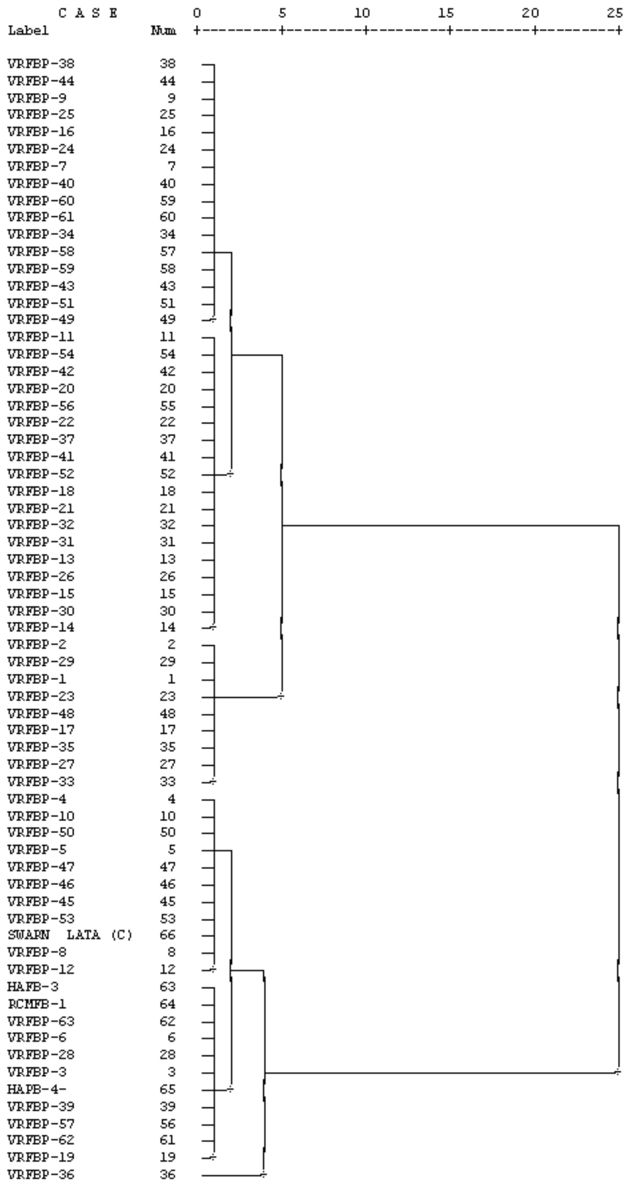

Fig. 1. Hierarchical multivariate clustering of 66 pole type French bean genotypes by Ward's method.

genotypes divided into 2 clusters with 9 and 34 genotypes respectively. Since these clusters are group of individuals possessing similar characters mathematically gathered into the same cluster, these individuals are supposed to exhibit higher external heterogeneity. It is inferred from the present investigation that hybridization involving the inter-cluster representatives of clusters would be more useful in French bean breeding programme.

ACKNOWLEDGEMENT

The authors are grateful to the Director of Indian Institute of Vegetable Research, Varanasi for providing all facilities.

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Received: August, 2008; Revised: February, 2010
Accepted: July, 2010