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Variability, correlation and path analysis for seed yield and yield related traits in common beans

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ABSTRACT

Ten common bean genotypes were used to study their performance, genetic variability, heritability and genetic advance, correlation and path analysis for yield and yield contributing characters *viz.,* days to 50% flowering, plant height (cm), number of pods/plant, pod length (cm), number of seeds/pod, 100-seed weight (g) and seed yield (q/ha). Significant variations were observed for all the characters in all the genotypes used in the experiment. Highest genotypic and phenotypic variations were observed for plant height followed by No. of pods/ plant and pod length. Plant height, 100-seed weight and days to 50% flowering showed high heritability with high genetic advance. Seed yield was found to be positively correlated with days to 50% flowering, plant height and number of seeds/ pod. Path coefficient analysis revealed that days to 50% flowering, No. of pods/ plant, pod length and 100-seed weight showed positive direct effects on seed yield. Hence, selection for these traits for improving seed yield in French bean is suggested.

Key words: *Phaseolus vulgaris* L., correlation coefficient, path analysis, seed yield.

INRODUCTION

Common bean (*Phaseolus vulgaris* L.) is the most important and widely cultivated among other Phaseolus species. Dry edible beans, or field beans, come in a wide variety of market classes, including kidney bean, navy bean, pinto bean and black bean. These beans, although differing in the size and colouring of the seed are all just different types of a single species, *Phaseolus vulgaris* L. Its seed contain 22% protein, 2% fat, 61% carbohydrate (includes 5% fibres) as well as adequate level of all vitamins and minerals. Field bean is grown as dried seeds, green pod vegetable and for processing as a frozen vegetable (Biswas *et al*., 2; Singh, 15). Yield is a complex dependent character and is contributed by several component characters. Direct selection for yield is often not very effective and indirect selection for some of the component traits associated with it may be useful. Knowledge of genotypic and phenotypic correlations of yield components and path analysis will be valuable in making breeding strategy to develop elite genotypes through selection in advance generations.

Keeping above facts in view, the present investigation was therefore carried out to evaluate the genetic variability, association among yield contributing traits and direct and indirect effects of each of the component traits towards yield in rajmash germplasm.

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MATERIALS AND METHODS

Ten red type germplasm lines of rajmash beans namely, Uri-Red, Red Dwarf, Local Red, Jir-Ala, EC-285549, EC-285550, EC-285551, EC-285553, EC-285555 and EC-285558 were evaluated in randomized block design with three replications during *kharif* 2004 and 2005 at Plant Breeding and Genetics Farm of Regional Research Station and Faculty of Agriculture, SKUAST-K, Wadura, Sopore, Kashmir. These entries comprised the local genotypes collected from different part of the Kashmir Valley as well as exotic germplasm lines. Each line was accommodated in a row of 5 m length with 30 cm line-line and plant-plant spacing of 10 cm. Fertilizers as 60 kg N, 80 kg P_2O_5 and 40 kg K_2O were applied to raise good crop. The data were recorded on five randomly selected plants in each plot for 7 quantitative traits, *viz.* days to 50% flowering, plant height (cm), number of pods / plant, pod length (cm), number of seeds /pod, 100-seed weight (g) and seed yield (q/ha).

Average values were subjected to standard statistical procedures, namely, analysis of variance as per procedure suggested by Panse and Sukhatme (7), genotypic and phenotypic coefficient of variation by Burton and De Vane (1) and heritability and genetic advance by Johnson *et al.* (5). Correlation coefficient was calculated using the formula given by Singh and Chaudhary (11) and path analysis was carried out following the method suggested by Dewey and Lu (3).

RESULTS AND DISCUSSION

The analysis of variance revealed significant variability for all the traits studied. The character like

Table 1. Mean performance of red type rajmash bean germplasm lines for yield and yield contributing characters.

Genotype	Days to 50% flowering	Plant height (cm)	No. of pods /plant	Pod length (cm)	No. of seeds /pod	100-seed weight (g)	Yield (q/h)
Uri-Red	58.67	98.33	8.67	12.33	4.00	43.00	12.00
Red Dwarf	44.00	52.33	9.67	13.33	4.00	63.33	11.33
Local Red	60.67	132.67	11.67	10.33	5.00	45.00	26.00
Jir-Ala	45.00	45.67	8.33	13.00	4.67	51.33	8.00
EC-285549	45.00	55.67	13.33	13.33	5.00	53.00	13.67
EC-285550	50.67	50.00	9.33	11.00	4.00	58.33	22.00
EC-285551	45.00	63.00	8.67	14.33	4.00	62.33	9.00
EC-285553	46.00	50.67	9.33	13.33	4.00	63.00	10.00
EC-285555	45.00	61.00	10.00	11.33	4.00	58.33	9.67
EC-285558	45.67	58.33	8.33	15.00	4.00	63.00	17.67
Mean	48.56	66.76	9.73	12.73	4.26	56.06	13.93

plant height exhibited very high variability, whereas days to 50% flowering, 100-seed weight and seed yield (q/ha) showed moderate and number of pods / plant, pod length and number of seeds/pod showed low variability. Mean values, range, GCV and PCV, heritability, genetic advance and genetic advance as percent of mean for yield and other yield contributing characters are presented in Table 2. Maximum coefficient of variation was observed for seed yield (q/ha) with moderate variability, whereas number of pods/plant and pod length showed 15.68 and 11.44% coefficient of variation besides a low variability as indicated by range in Table 2. The plant height showed maximum variability but it has low coefficient of variation. The relative amount of variation expressed by different traits can be properly judged through estimates of phenotypic and genotypic coefficient of variation. The deviation of genotypic coefficient of variation from phenotypic coefficient of variation in case of days to 50% flowering, plant height, number of seeds/pod and 100-seed weight was observed to be very low and a major portion of phenotypic coefficient of variation may be due to genetic causes, whereas seed yield, number of pods/plant and pod length showed moderate variation. Nehvi *et al.* (6), and Rafi and Nath (8) have reported sufficient genetic variability for different quantitative traits in beans.

It becomes very important to know that how much of this variation is due to phenotypic, genotypic and environmental causes. So the estimates of environmental, genotypic and phenotypic components of variation, heritability and genetic advance and genetic advance as per cent of mean are presented in Table 2. The environmental component of variance is comparatively low for traits like number of seeds /pod, days to 50% flowering, pod length, number of pods/ plant and 100-seed weight. This indicates that their respective genotypic variance contributed maximum to phenotypic variance.

Partitioning of total phenotypic variance into heritable and non-heritable components is very useful because only heritable portion of variation is exploitable through selection. It is a property not only of a character but also of the population and of the environment to

Table 2. Estimation of genetic variability parameters in red type rajmash bean germplasm lines.

Character	Mean	Range	PCV (%)	GCV (%)	h^2 (%)	GA	GA (%)
Days to 50% flowering	48.56	44-60.67	12.66	12.64	99.76	12.63	26.01
Plant height (cm)	66.76	45.67-132.67	41.36	40.96	98.06	55.79	83.55
No. of pods/ plant	9.73	8.33-13.33	20.91	18.83	43.74	1.83	18.84
Pod length (cm)	12.73	10.33-15.00	14.92	9.57	41.17	1.61	12.65
No. of seeds /pod	4.26	4-5	10.86	9.98	84.48	0.81	18.91
100-seed weight (g)	56.06	43-63.33	14.02	13.39	91.12	14.76	26.32
Seed yield (q/ha)	13.93	12-26	48.27	40.67	70.99	9.84	70.59

which individuals are subjected. In the experiment, high heritability estimates were obtained for the traits like days to 50% flowering, plant height, 100-seed weight, number of seeds /pod and seed yield, thereby suggesting the usefulness of making selection based on phenotypic observations. This high heritability may be due to additive gene effects hence these traits are likely to respond to direct selection. Since broad sense heritability represents the upper limit that can be achieved through selection, such estimates should be used judiciously for evaluation studies. Moderate heritability estimates were observed for number of pods/plant and pod length. Heritability in conjunction with genetic advance is more useful than heritability alone in predicting the resultant effect for selecting the best genotype for a given trait. In the present study, high heritability estimates coupled with high genetic advance (Table 2) was observed for plant height, 100-seed weight and days to 50% flowering**.** This suggested that genotypic variation for these traits may be possibly due to high additive gene effects and direct selection for such traits would prove effective. Rest of the traits like seed yield, number of pods /plant, pod length and number of seeds /pod showed low genetic advance besides moderate heritability so in case of such traits, non-additive gene effects appears to be of considerable importance. Singh *et al*. (14), and Rai *et al*. (9) also reported high heritability along with high genetic advance for seed weight. Dahiya *et al*. (4) observed high heritability along with high genetic advance for plant height and days to 50% flowering.

The importance of genetic advance lies in providing an idea about the amount of progress that can be achieved by selecting the concerned trait. The expected genetic advance, expressed as percent of means (Table 2) varied from 12.65 percent for pod length to 83.55 percent for plant height. A very high value of percent genetic advance for plant height followed by seed yield, 100-seed weight, days to 50 percent flowering, number of seeds /pod and number of pods/ plant was observed. From the forgoing discussion it would be inferred that there was good variation for all the traits studied and simple selection among germplasm accessions can bring about significant improvement in yield and its component traits.

Correlation and path coefficient analysis revealed that in general the genotypic correlation coefficients were higher in magnitude than phenotypic correlation coefficients (Tables 3 & 4) showing the efficiency of genotypic estimates over phenotypic ones. There might be a strong inherent association between the traits and the phenotypic expression was lessened under the influence of environment. Correlation coefficient studies indicated that days to 50% flowering is significantly positively correlated with plant height and seed yield while it showed negative significant correlation with pod length and 100-seed weight. Plant height is significantly positively correlated with seed yield and number of seeds /pod (genotypic level) and it showed negative significant correlation with pod length and 100-seed weight. The number of pods/plant is positively correlated with number of seeds/pod and seed yield (at phenotypic level) and it showed negative significant correlation with pod length (at genotypic level). It was also observed that pod length is positively correlated with 100-seed weight and number of seeds/pod is positively correlated with seed yield (at genotypic level) and it showed negative significant correlation with 100-seed weight. At genotypic level the highest positive correlation was observed in between characters, number of pods/ plant and number of seeds/pod followed by days to 50 percent flowering and plant height, whereas at phenotypic level the highest positive correlation was observed in between characters days to 50 percent flowering and plant height. The highest negative

Table 3. Estimates of genotypic (upper diagonal) and phenotypic (lower diagonal) correlation coefficients for yield and yield related traits in ten red type germplasm lines of rajmash beans.

Character	Days to 50% flowering	Plant height (cm)	No. of pods/ plant	Pod length (cm)	No. of seeds/ pod	100-seed weight (g)	Yield (q/ha)
Days to 50% flowering	0.00	0.900**	0.152	-0.763**	0.263	-0.805**	0.663**
Plant height (cm)	0.891**	0.00	0.351	-0.618**	0.390*	-0.732**	0.615**
No. of pods/ plant	0.122	0.202	0.00	-0.551**	0.946**	-0.351	0.322
Pod length (cm)	-0.488**	-0.418*	-0.159	0.00	-0.288	0.674**	-0.783**
No. of seeds/ pod	0.236	0.350	0.475**	-0.273	0.00	-0.591**	0.369*
100-seed weight (g)	-0.772**	-0.698**	-0.218	0.420*	-0.542**	0.00	-0.293

*, ** Significant at the 0.05 and 0.01 probability levels, respectively.

Table 4. Estimates of direct (diagonal) and indirect (off-diagonal) effects of yield and yield related characters on seed yield of ten red type rajmash beans germplasm lines.

Trait	Days to 50% flowering	Plant height (cm)	No. of pods /plant	Pod length (cm)	No. of seeds /pod	100-seed weight (g)	Correlation with seed yield
Days to 50% flowering	**2.793**(G) **1.595**(P)	-1.007(G) -0.475(P)	0.163 (G) 0.035(P)	-0.340(G) -0.075(P)	-0.039(G) 0.096(P)	-0.905(G) -0.605(P)	0.663**(G) 0.571**(P)
Plant height (cm)	2.515(G) 1.423(P)	**-1.118**(G) **-0.532**(P)	0.376(G) 0.058(P)	-0.275(G) -0.064(P)	-0.058(G) 0.142(P)	-0.823(G) -0.547(P)	0.615**(G) 0.479**(P)
No. of pods /plant	0.426(G) 0.195(P)	-0.392(G) -0.107(P)	**1.072**(G) **0.290**(P)	-0.245(G) -0.024(P)	-0.142(G) 0.192(P)	-0.395(G) -0.171(P)	0.322(G) 0.374*(P)
Pod length (cm)	-2.131(G) -0.779(P)	0.691(G) 0.222(P)	-0.590(G) -0.046(P)	**0.446**(G) **0.154**(P)	0.043(G) -0.110(P)	0.758(G) 0.329(P)	-0.783**(G) -0.230(P)
No. of seeds /pod	0.735(G) 0.377(P)	-0.436(G) -0.186(P)	1.014(G) 0.138(P)	-0.129(G) -0.042(P)	**-0.150**(G) **0.405**(P)	-0.665(G) -0.425(P)	0.369*(G) 0.267(P)
100-seed weight (g)	-2.250(G) -1.233(P)	0.819(G) 0.372(P)	-0.377(G) -0.063(P)	0.301(G) 0.064(P)	0.089(G) -0.220(P)	**1.124**(G) **0.783**(P)	-0.293(G) -0.296(P)

*, ** Significant at the 0.05 and 0.01 probability levels, respectively.

significant correlation was observed in between characters days to 50 percent flowering and 100-seed weight both at genotypic and phenotypic level. The seed yield showed direct and significant correlation with traits like days to 50 percent flowering and plant height while negative correlation with pod length and 100-seed weight both at genotypic and phenotypic levels. The number of pod/plant and number of seeds /pod showed positive correlation with seed yield. These results are in agreement with the findings of Rafi and Nath (8), Singh *et al.* (13), Shinde and Dumbre (10), and Singh and Mishra (12).

Positive correlation of a particular character with yield does not necessarily mean a direct, positive effect of that trait on yield. Therefore, path coefficient analyses which analyses cause and effect relationships and partitions the correlation into direct and indirect effects were carried out for different characters on seed yield. The perusal of path analysis (Table 4) reveled that days to 50 percent flowering had maximum positive direct effect on seed yield followed by 100-seed weight, number of pods/plant and pod length indicating true and perfect relationship among these characters at genotypic level. At phenotypic level again the days to 50 percent flowering had maximum positive direct effect on seed yield followed by 100-seed weight, number of seeds/pod and number of pods/plant. The highest positive correlation between days to 50 percent flowering and grain yield was obtained largely by its direct effect. Plant height and number of seeds /pod had negative direct effect on grain yield. The high positive correlation between plant height and grain yield was obtained mainly through indirect effect via days to 50 percent flowering and number of pods /plant. The positive correlation of grain yield with number of seeds / pod was obtained largely through indirect effect of number of pods / plant and days to 50 percent flowering. The positive correlation of grain yield with number of seeds /pod was obtained largely through direct effect and indirect effect via days to 50 percent flowering. Earlier, positive direct effect on seed yield has been reported by Rai *et al.* (9) for pod weight and pod length; Shinde and Dumbre (10) for 100-seed weight and number of seeds/ pod; Rafi and Nath (8) for number of pod / plant and pod length. Thus, most of these studies support the present findings. Thus it can be concluded that days to 50% flowering, 100 seed weight, number of pods/ plant and pod length were the major seed yield contributing traits and selection for these traits should be done for enhancing seed yield in French bean.

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