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Genetic Variability, Heritability and Genetic Advance in French Bean (*Phaseolus vulgaris* L.)

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Abstract

Twelve genotypes of french bean were assessed for variability, heritability and genetic advance. Highly significant differences were observed in the genotypes for all the characters. Both genotypic and and phenotypic coefficient of variations was generally high for number of pods per plant, tenderness of pod, weight of ten pods, pod yield per plant, total yield per hectare and shelf life of pods and moderate for plant height, number of branches, days to 50% flowering, pod length, pod width and leaf miner maggots per leaf. All these characters also exhibited high heritability and genetic advance over mean except number of branches. Hence, simple selection procedure may be followed for the further improvement in these traits. Whereas, stem thickness, chlorophyll content, ovule number per pod, number of seeds per pod exhibited low genotypic and phenotypic coefficient of variation with low to moderate heritability and genetic advance over mean thus the selection in these traits would not be effective.

Key words : French bean, Variability, Heritability, Genetic advance, *Phaseolus vulgaris* L.

For any crop improvement, basic information on the variability present in the crop is essential. Yield being a complex trait, is collectively influenced by various yield attributes, which are polygenically inherited and influenced by environmental variations. The effective selection for improvement of these traits is determined by magnitude and nature of interaction between genotypic and phenotypic variability. It is therefore required to know the heritable and non-heritable components with genetic parameters such as genotypic and phenotypic coefficient of variation, heritability and genetic advance. French bean, *Phaseolus vulgaris* L. (2n = 2x = 22) also known as snap bean, kidney bean, garden bean or string bean, is one of the most important leguminous vegetables grown for its tender fleshy green pods, shelled green seeds and also dry beans. It has anti-diabetic property and is good for natural cure of bladder burns and cardiac problems, diarrhea, sciatica and tenesmus. It is a nutritive vegetable, rich in protein (1.7 g), calcium (132 mg), thiamin (0.08 mg) and vitamin C (24 mg per 100 g of edible pods). French bean originated from Central America and Peruvian Andes in South America. It spread to Europe during 16th and 17th centuries and reached England by 1594. It was introduced to India during 17th century from Europe. The statistics with respect to this crop is deficient owing to the small area of production and short duration. However, based on FAO estimates, it is grown in the world in an area of 0.83 m ha with annual production of 5.64 m t with productivity of 6.76 t per ha. In India, it is mainly grown in Himachal Pradesh Punjab, Haryana, Uttar Pradesh, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. Annually, french bean is grown in an area of 0.15 m ha with annual production of 0.42 m t and productivity of 2.8 t per ha (1). Association among genotypic and phenotypic coefficient of variation, heritability and genetic advance appears to be good criteria for selection in crop improvement program. The knowledge of genetic variability that is heritable for generation to generation has great significance in breeding programme. The heritability may give useful indication for relative value of selection among the material in hand. High heritability estimates along with high genetic advance are normally more helpful in predicting gain under selection than heritability estimates alone (2). Hence, the present investigation was initiated to assess the extent of variability, heritability and genetic advance in

Table 1. Variability, heritability and genetic advance for quantitative and qualitative parameters of french bean genotypes. GV-Genotypic variance, GCV-Genotypic coefficient of variation, h^2_{BS}-Broad sense heritability, PV-Phenotypic variance, PCV-Phenotypic coefficient of variation, GAM-Genetic advance as percent of mean, GA-Genetic advance.

	Characters	Range	Mean	GV	PV	GCV (%)
1	Days to 50% flowering	32.33-47.33	38.97	22.30	24.40	12.12
2	Plant height (cm)	34.40-52.83	46.15	27.22	33.89	11.30
3	Number of branches per plant	12.67-18.00	15.96	2.75	4.60	10.39
4	Stem thickness (mm)	6.84-8.76	7.97	0.35	0.59	7.46
5	Leaf area (cm^2)	73.44-110.83	97.11	78.58	119.16	10.13
6	Leaf area index (LAI)	24.48-36.94	32.37	8.73	13.24	9.13
7	Chlorophyll content (spad value)	28.68-35.45	32.01	4.41	7.15	6.56
8	Number of pods per plant	12.00-27.00	19.86	21.67	24.32	23.44
9	Ovule number per pod	6.47-8.2	7.25	0.25	0.41	6.89
10	Pod length (cm)	9.45-17.53	13.90	6.08	6.85	17.74
11	Pod width (mm)	6.33-10.81	9.14	1.98	2.33	15.41
12	Weight of ten pods (g)	29.53-67.47	48.11	202.71	210.06	29.00
13	Number of seeds per pod	5.47-6.90	6.25	0.14	0.34	6.07
14	Tenderness of pod (tr value)	26.83-58.25	36.78	73.71	83.55	23.24
15	Pod yield per plant (g)	64-98	75.78	202.79	218.15	18.79
16	Total yield per hector (t)	8.03-14.46	10.58	5.57	5.66	22.31
17	Shelf life of pods (days)	4.00-7.00	5.33	1.49	1.57	22.87
18	Leaf miner (maggots/leaf)	6.70-11.11	9.26	2.07	2.56	15.54

Table 1. Continued.

	Characters	PCV (%)	h^2_{BS} (%)	GA	GAM (%)
1	Days to 50% flowering	12.68	91.38	9.30	23.86
2	Plant height (cm)	12.62	80.30	9.63	20.87
3	Number of branches per plant	13.44	59.80	2.64	16.56
4	Stem thickness (mm)	9.67	29.52	0.95	11.86
5	Leaf area (cm^2)	11.24	65.91	14.82	15.26
6	Leaf area index (LAI)	11.24	65.91	4.94	15.26
7	Chlorophyll content (spad value)	8.35	61.59	3.39	10.60
8	Number of pods per plant	24.83	89.11	9.05	45.50
9	Ovule number per pod	8.81	61.15	0.80	11.10
10	Pod length (cm)	18.82	88.82	4.79	34.43
11	Pod width (mm)	16.71	85.04	2.67	29.27
12	Weight of ten pods (g)	30.13	96.50	28.81	59.89
13	Number of seeds per pod	9.30	42.54	0.51	8.15
14	Tenderness of pod (tr value)	24.85	88.22	16.61	45.17
15	Pod yield per plant (g)	19.49	92.96	28.28	37.32
16	Total yield per hector (t)	22.49	98.44	4.83	45.60
17	Shelf life of pods (days)	23.50	94.69	2.44	45.84
18	Leaf miner (maggots/leaf)	17.28	80.81	2.66	28.77

french bean varieties.

Methods

The field experiment was conducted on sandy loam soil in the new orchard of Main Agriculture Research Station (MARS), Raichur, which is situated in the north eastern dry zone Karnataka ; the location corresponds to at $16^0 12'$ N latitude and $77^0 20'$ E longitude with an altitude of 389 meters above the mean sea level. The daily climatological data during the study period were obtained from the meteorological observatory at MARS, Raichur. The investigation was carried out during *kharif* season of 2010. It consisted of 12 genotypes collected from different sources. The experiment was laid out by adopting randomized block design with three replications. Thirty plants per genotype per replication were maintained. The experimen-

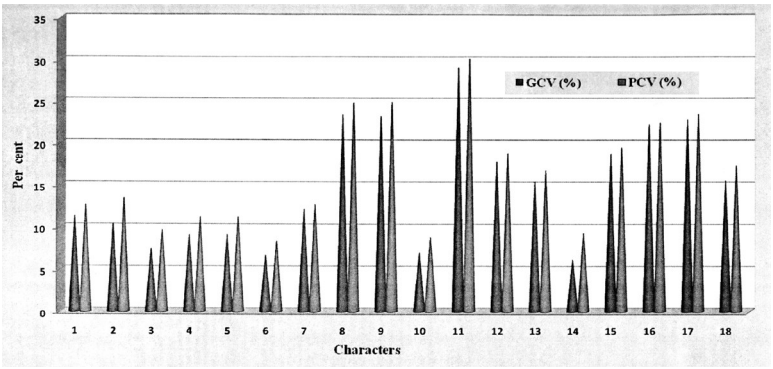

Figure 1. Genotypic and phenotypic coefficient of variation for eighteen characters in french bean. 1. Days to 50% flowering, 2. Plant height, 3. Number of branches per plant, 4. Stem thickness, 5. Leaf area, 6. Leaf area index, 7. Chlorophyll content, 8. Number of pods per plant, 9. Ovule number per pod, 10. Pod length, 11. Pod width, 12. Weight of 10 pods, 13. Number of seeds per pod, 14. Tenderness of pod, 15. Pod yield per plant, 16. Total yield per hectare, 17. Shelf life, 18. Leaf miner.

tal field was brought to fine tilth by repeated ploughing and harrowing. Twenty-five tonnes of FYM and recommended dose of fertilizers (62.5 : 100 : 75 kg NPK/ha) were inocorporated in the soil. Ridges were prepared at a distance of 30 cm. The seeds of different genotypes were sown on November 13, 2010 by dibbling two to three seeds per hill at a distance of 15 cm on one side of the ridges. The plots were irrigated immediately after the completion of sowing. Thinning of excess seedlings and gap filling was undertaken one week after germination. Plant protection practices were undertaken following the package of practice of UAS, Dharwad. The observations were recorded from five randomly selected plants from each genotype in each replication for days to 50% flowering, plant height, number of branches per plant, stem thickness, leaf area, leaf area index, chlorophyll content, number of pods per plant, ovule number per pod, pod length, pod width, weight of 10 pods, number of seeds per pod, tenderness of pods, pod yield per plant, pod yield per hectare, shelf life and leaf minor maggots per leaf using standard procedures. The collected pool data were subjected for statistical analysis. Genotypic and phenotypic coefficients of variances were calculated according to Burton (3). Heritability and genetic advance were calculated according to Hanson et al. (4) and Johnson et al. (2), respectively.

Results and Discussion

High genotypic and phenotypic coefficients of variation were observed for weight of 10 pods (29.00 and 30.13), number of pods per plant (23.44 and 24.83), tenderness of pod (23.24 and 24.85), shelf life (22.87 and 23.50), pod yield per hectare (22.31 and 22.49) and pod yield per plant (18.79 and 19.49). Moderate values of genotypic and phenotypic coefficient of variation were observed for pod length (17.74 and 18.82), pod width (15.41 and 16.71), days to 50% flowering (12.12 and 12.68), plant height (11.30 and 12.62), number of branches per plant (10.39 and 13.44), leaf area (10.13 and 11.24), indicating that selection for these traits will be effective (Table 1 and Fig. 1). All other characters however exhibited low genotypic and phenotypic coefficient of variation ; the selection therefore, may be comparatively less effective. The results obtained in the present study are confirmed with the findings of Korla et al. (5), Shah et al. (6) and Alemayehu (7). The phenotypic coefficient of variation was higher than the genotypic coefficient of variation for all the characters indicating greater role played by environment in the manifestation of these characters. Moderate genotypic coefficient of variation indicating the heritable portion of the total variance existed in the population. The coefficient values indicating considerable amount of variability existing for all the characters studied except for stem thickness, chlorophyll content, ovule number per pod and number of seeds per pod indicating little influence of environment on the expression of these characters. Environmental factor has moderate influence on other character. The coefficient of variation detects the

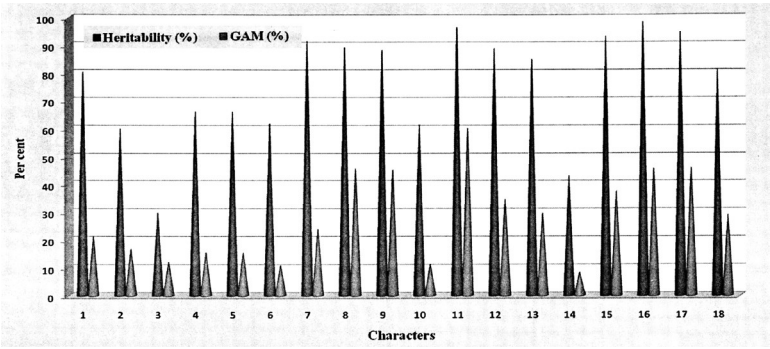

Figure 2. Heritability estimates and genetic advance over mean for eighteen characters in french bean. 1. Days to 50% flowering, 2. Plant height, 3. Number of branches per plant, 4. Stem thickness, 5. Leaf area, 6. Leaf area index, 7. Chlorophyll content, 8. Number of pods per plant, 9. Ovule number per pod, 10. Pod length, 11. Pod width, 12. Weight of 10 pods, 13. Number of seeds per pod, 14. Tenderness of pod, 15. Pod yield per plant, 16. Total yield per hectare, 17. Shelf life, 18. Leaf miner.

extent of variability present for different characters and it does not indicate the heritable portion to obtain the magnitude of heritable portion of variability, it is essential to know the heritability estimates for different characters.

Heritability estimates in the broad sense include both additive and non-additive gene effects and in the narrow sense include only additive gene effects. Since, heritability estimates fluctuate in interaction with environment as well as genetic background ; it should be studied only along with genetic advance for characters in concern for effective selection (2, 4).In the present study, high heritability was observed for most of the characters like days to 50% flowering, plant height, number of pods per plant, tenderness of pods, weight of 10 pods, pod length, pod width, pod yield per plant, pod yield per hectare, shelf life of pods and leaf miner incidence. High heritability coupled with high genetic advance over mean was recorded for plant height, days to 50% flowering, number of pods per plant, tenderness of pod, weight of 10 pods, pod length, pod width, pod yield per plant, yield per hectare and shelf life (Table 1 and Fig. 2). High heritability coupled with high genetic advance over mean for above traits indicates the predominance of an additive gene effects and these provides ample scope for further improvement of these characters through selection. These findings are reported earlier (5, 6, 8, 9). Moderate heritable values captured with moderate genetic advance suggests the role of both additive and non-additive gene action in the expressing traits.

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