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Genetic variability, correlation and path analysis for seed yield and yield related traits in french bean (Phaseolus vulgaris L.) under Lucknow conditions.

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Abstract

Twenty five genotypes of French bean were evaluated to ascertain genetic parameters of variability, heritability and genetic advance in French bean was studied during *rabi* season involving 25 genotypes showing wider variation for all traits result revealed that highest range of variation was reported with green pod yield (q/ha) followed by green pod yield/plant (g). The coefficient of variation was minimum days to 50% flowering followed by days to first flowering whereas under pooled data analysis, it was found minimum for 100-seed weight followed by days to 50% flowering. In all the three studies, coefficient variation was maximum for leaf width (cm) and green pod yield/plot (kg). In the first year, heritability estimates were high for all the characters except 100-seed weight (g), plant height (cm) and number of pods/plant, whereas in the second year 100-seed weight (g), plant height (cm), moisture (%), number of pods/plant, green pod yield (q/ha) and number of leaves/plant attained lower heritability values. Under pooled data analysis, 100-seed weight (g), plant height (cm), moisture (%), number of pods/plant, green pod yield (q/ha) and green pod yield/plant (g) were found with lower heritability estimates. High heritability with high genetic advance were found with 100-seed weight (g), plant height (cm), green pod yield/plant (g) and green pod yield (q/ha).

Key word: French bean, Genetic Variability, Heritability, Genetic Advance.

Introduction

French bean, (*Phaseolus vulgaris* L. 2n=2x=22) belongs to family Leguminosae is a nutritious vegetable consumed as tender pods, shelled beans and dry beans. It has many synonyms like snap bean, kidney bean, haricot bean and also called “Raj mash” in Hindi. French bean originated from Central America and Peruvian Andes in South America. It spreaded to Europe during 16^{th} and 17^{th} centuries and reached England by 1594. It was introduced to India

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during 17th century form Europe. The statistics with respect to this crop is very deficient owing to the small area of production and short duration. However, as per as the FAO estimates, it is grown in the world in an area (28 m ha) with annual production (20 m t) with productivity (729 Kg/ha) (FAO STAT 2008). In India, it is mainly grown in Himachal Pradesh, UKO, J&K, Punjab, Haryana, Uttar Pradesh, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. Annually, french bean is grown in an area (0.15 m ha) with annual production (0.42 m t) and productivity (2.8 t per ha) (FAO STAT 2002). Considering the nutritive value, 100 g of green pod contains 1.7 g protein, 0.1 g fat, 4.5 g carbohydrate, 1.8 g fiber and is also rich in minerals and vitamins. It also posses medicinal properties which is useful in controlling diabetes and certain cardiac problems and it is a good natural cure for bladder burn. It has both carminative and reparative properties against constipation and diarrhoea respectively (Duke 1981). Beans, the “meat of the poor”, contribute essential protein to the undernourished people living in the hills. Being a short duration crop French bean can be grown under different cropping patterns of hills and plains of India. An important part of the tropical African production is exported to Europe: nearly 40,000 tones, the most important exporters being Senegal, Burkina Faso, Kenya and Zimbabwe. French bean is the third most important agricultural export product of Kenya, after only tea and pineapple. Pole type French bean is an important legume vegetable in Meghalaya of North Eastern Hill region has high agro economic and dietary values as compared to other legume vegetables Shah *et al*. (1986). The exploitation of variability is a pre-requisite for the effective screening of superior genotypes in all crops including French bean. The progress in breeding for the yield and its contributing characters of any crop is poly genetically controlled, environmentally influenced and determined by the magnitude and nature of their genetic variability. Hence, it is essential to partition the overall variability into its heritable and non-heritable components with the help of genetic parameters like genetic coefficient of variation, heritability and genetic advance. Knowledge of correlations among different characters and further, partitioning those direct and indirect effects are a rational approach to understand the nature and extent of such relationship. Therefore, study of genetic variability, characters association and path coefficient are pre-requisite for improvement of any crop. Therefore, genetic analysis involving inheritance system of seed yield and related traits may provide useful information on various genetic features leading to crop improvement. Hence, the present study was conducted to find out the information on nature and magnitude of gene action for yield and yield related traits. Therefore, a systematic breeding approach for

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crop improvement of French bean is highly required. Knowledge of genetic variability, heritability and genetic advance of important economic traits and their genotypic and phenotypic correlation coefficient among themselves, play an important role in farming the breeding programme of any crop .The success of breeding programme depends on the genetic variability present in the population. Therefore partitioning of the phenotypic variation into genetic and environmental variation is necessary. the extent of transmission of a quantitative character from parent to the offspring depends upon the heritability of the particular character .The heritability value alone does not have much significance as it fails to account for the magnitude of absolute variability. It's, therefore, necessary to utilize heritability along with genetic advance, while advocating for selection. 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 gemplasm.

Materials and Methods

The present investigation was carried out at the Horticultural Research Farm of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar Central University, Vidya Vihar, Rae Bareli Road Lucknow (U. P.) India, *Rabi* season during 2012-13 and 2013-14. The data of both the years were pooled and analysed. Geographically, Lucknow is situated at an elevation of 111m above the mean sea level in the subtropical tract of central U.P. at $26^0$56' North latitude and $80^0$52' East longitude. The place experiences winter and very hot summer with average rainfall. Agro climatically, the location represent Central Zone of the state of Uttar Pradesh, India, and is characterised by sub-tropical climate. The experimental material comprising of twenty five genotypes of French bean was collected from different sources and maintained in the Horticultural Research Farm. All recommended package of practices were followed to raise good crop. Experimental field was laid out in randomized block design with 25 genotypes/lines and replicated thrice. Each block was further subdivided into 25 unit plots. The twenty five genotypes were allotted to the 25 unit plots of each block. The plots were raised by 15cm from the ground level to avoid water-logging, if occurred. The unit plot size was 1.80mX1.00m, and the row-row and plant – plant spacing were 30cm and 20cm, respectively. The plot to plot (1.00m) and block to block (1.80m) distances were 30cm and 1.0m, respectively. Fertilizers as 100 kg N, 60 kg P_2O_5 and 30 kg K_2O kg/ha were applied to rise good crop. All necessary cultural operations were done as and when required during the

growing period. Data was recorded on 5 randomly selected plants per entry per replication for various horticultural characters namely, germination (%), plant height (cm), primary branches/ plant, secondary branches/ plant, number of leaves /Plant, size of leaves (length and width cm), days to first flowering, days to 50 percent flowering, flower colour, number of pods/ plant, number of grains/ pod, green pod length (cm), green pod width (cm), green pod breadth (cm), single green pod weight (g), green pod yield per plant (g), green pod yield per plot (kg), green pod yield (q/ ha), 100- seed weight (g), moisture(%), total sugars(%) and protein(%). The data were analysed for estimation of genotypic and phenotypic coefficient of variation following Burton (1952). Heritability in broad sense and genetic advance were calculated according to the methods of Allard (1960).simple correlation coefficient among the characters at phenotypic and genotypic levels were analysed following Hayes *et al*. (1955) Singh and Chaudhary (1985). Path analysis at genotypic level was done following Deway and Lu (1959). Heritability (h^2) in the broad sense (in per cent) was computed by the formula given by Johnson *et al*. (1955). The genotypic and phenotypic coefficient of variation was estimated according to the method of Panse and Sukhatme (1969).

Result and Discussion

The analysis of variance Table 1, 2 and 3 revealed that mean squares of treatments were significant for most of the characters indicating varietal differences for all the characters studied. The estimates of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient variation (GCV) for all the characters under consideration. Highest range of variation was reported with green pod yield (q/ha) followed by green pod yield/plant (g). The coefficient of variation was minimum days to 50% flowering followed by moisture (%) and maximum for 100-seed weight (g). Heritability estimates for all the characters were high except 100-seed weight (g), plant height (cm) and number of pods/plant Table 1. High heritability with high genetic advance was observed for 100-seed weight (g), plant height (cm), green pod yield/plant (g) and green pod yield (q/ha). Estimates of variance and other genetic parameters in French bean studied under second year 2013-14 revealed that highest range of variation was reported with green pod yield (q/ha) followed by green pod yield/plant (g). The coefficient of variation was minimum days to 50% flowering parameters followed by germination (%) and maximum 100-seed weight (g). The magnitude of phenotypic coefficient of variation was in general higher than corresponding genotypic coefficient of variation indicating the influence of environmental factors in their expression. Johanson *et al*. (1955) also reported similar result while studying seven

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inbreed lines of diverse origin and their 21 hybrids of French bean. Heritability estimates for all the characters were high except 100-seed weight (g), plant height (cm), moisture (%), number of pods/plant (g) and number of leaves/ plant Table 2. High heritability with high genetic advance was observed for green pod yield (q/ha), green pod yield/plant (g), plant height (cm), 100-seed weight (g), and number of leaves/plant. High genetic advance coupled with high heritability could be resulted are in accorandance with the findings of Liang and Waltre (1969).

In pooled analysis, highest range of variation was reported that highest range of variation was reported with green pod yield (q/ha) followed by green pod yield/plant (g). The coefficient of variation was minimum days to 50% flowering parameters followed by germination (%) and maximum 100-seed weight (g) Table 3. This suggested the presence of wide range of variability for different characters and it is the most important aspect while selecting a genotypes. The coefficient of variation was maximum for 100-seed weight (g) among all the genotypes of french bean, phenotypic and genotypic coefficients were high for 100-seed weight (g) and plant height (cm). Narrow differences between phenotypic and genotypic coefficients variation revealed that variability existing among different genotypes of french bean was mainly due to genetic makeup and there is less environmental influence of the expression of these traits. The same results have bean also reported by Johanson *et al*. (1955) in french bean. GCV is helpful in the assessment of inherent variability. GCV and PCV detect the amount of variability in the available genotypes. Heritability estimates give a measure of transmission of characters from one generation to another, thus given an idea of heritable portion of variability and enabling to the plant breeder in isolating the elite selection in the crop. Heritability and genetic advance increase the efficiency of the selection in breeding programme by assessing the influence of environmental factors and additive gene action. Heritability estimates for all the characters were high except 100-seed weight (g), plant height (cm), moisture (%), number of pods/plant , green pod yield (q/ha) and green pod yield/ plant (g). (Table 3). The magnitude of heritable variability is the most important aspect of genetic constitution of the genetic material which has close bearing on the response to selection Panse (1957).

Heritability along with genetic gain is more useful criterion in predicting the resultant effect for selecting the best individual Johanson *et al*. (1955). High heritability with high genetic advance was observed for 100-seed weight (g), green pod yield (q/ha), green pod yield/plant (g), plant height (cm) and number of leaves/plant. High heritability with high genetic advance tells that the character is governed by the additive gene action and for this simple selection is

advocated. The results are in accordance with Rai *et al*. (2004) Singh *et al*. (2000).

High heritability with medium genetic advance suggests that the character is governed by the dominant and epistatic gene action and for this hybridization is done. In all the studies, characters like days taken to first flowering and days taken to 50 % flowering were found with high heritability and medium genetic advance. In the present investigation, primary branches/ plant, secondary branches/ plant, number of leaves /Plant, size of leaves (length and width cm), number of pods/ plant, number of grains/ pod, green pod length (cm), green pod width (cm), green pod breadth (cm), single green pod weight (g), green pod yield per plant (g), green pod yield per plot (kg), green pod yield (q/ ha), 100- seed weight (g), are governed with non additive gene action Rai *et al*. (2004) and Singh *et al*. (2000). A relative comparison of heritability and genetic advance given an idea of gene action governing a particular character. This was with higher values in 100-seed weight (g), green pod yield (q/ha), green pod yield/plant (g), plant height (cm) and number of leaves/plant in both the years of studies.

Conclusion – Based above results, it was concluded that 100-seed weight (g), plant height (cm), moisture (%), number of pods/plant , green pod yield (q/ha), green pod yield/ plant (g) and number of leaves/plant are the important traits for selection for yield improvement in French bean.

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Table-1: Estimates of variance and other genetic parameters in French bean in first year (2012-13).

S.No.	Characters	Range		General Mean	SEm±	Co-efficient of variation			Heritability in broad sense (%)	Genetic advance (GA)	Genetic advance in % of mean
		Min.	Max.			CV	PCV (%)	GCV (%)			
1	X1	68.87	100.00	88.13	3.821	5.31	10.12	8.62	72.50	13.32	15.11
2	X2	34.47	128.21	49.54	3.260	8.05	41.71	40.92	96.50	40.98	82.72
3	X3	41.51	86.54	53.01	3.499	8.08	20.11	18.42	83.80	18.42	34.74
4	X4	7.24	13.12	10.60	0.836	9.65	16.94	13.92	67.50	2.50	23.58
5	X5	4.99	12.49	9.87	1.155	14.34	22.04	16.73	57.60	2.58	26.13
6	X6	2.45	5.10	3.83	0.339	10.84	18.20	14.62	64.50	0.93	24.28
7	X7	4.24	9.57	7.23	0.537	9.10	22.81	20.91	84.10	2.86	39.55
8	X8	29.67	43.33	36.56	1.384	4.63	11.36	10.37	83.30	7.13	19.50
9	X9	35.33	47.67	40.97	1.608	4.80	8.50	7.02	68.00	4.88	11.91
10	X10	10.11	29.87	20.75	0.916	5.41	23.54	22.91	94.70	9.53	45.92
11	X11	8.32	13.86	11.03	0.646	7.17	16.12	14.44	80.20	2.94	26.65
12	X12	0.48	0.95	0.66	4.346	7.96	19.34	17.62	83.00	0.22	33.33
13	X13	0.82	1.05	0.94	7.075	9.14	10.70	5.54	26.80	0.06	6.38
14	X14	4.55	7.93	6.20	0.384	7.60	12.76	10.25	64.5	1.05	16.93
15	X15	54.91	148.87	92.16	5.934	7.88	28.33	27.21	92.30	49.62	53.84
16	X16	1.65	4.47	2.76	0.237	10.50	28.89	26.92	86.80	1.43	51.81
17	X17	3.58	5.72	4.76	0.438	11.26	13.46	7.36	29.9	0.40	8.40
18	X18	12.46	55.28	32.19	0.812	3.09	43.22	43.11	99.50	28.52	88.59
19	X19	91.50	248.09	153.52	9.563	7.62	28.27	27.23	92.7	82.92	54.01
20	X20	9.47	12.90	10.98	0.571	6.36	9.58	7.16	55.90	1.21	11.02
21	X21	5.07	8.92	6.96	0.457	8.03	13.68	11.07	65.50	1.29	18.53
22	X22	17.09	30.38	23.11	0.981	5.17	18.71	17.97	92.30	8.22	35.56

1 = Germination percentage 2 = Plant height (cm) 3 = No. Of leaves/plant 4 = Leaf length (cm) 5 = Leaf width (cm)
6 = Primary branches /plant 7 = Secondary branches/plant 8= Days to first flowering 9 = Days to 50% flowering 10 = No. Of pods /plant
11 = Green pod length (cm) 12 = Green pod width (cm) 13 = Green pod breadth (cm) 14 = Single green pod weight (g) 15 = Green pod yield /plant (g)
16 = Green pod yield /plot (kg) 17 = No. Of seeds /pod 18=100-seed weight (g) 19 = Green pod yield (q/ha) 20 = Moisture (%)
21= Total sugars (%) 22= Protein (%)

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Table-2: Estimates of variance and other genetic parameters in French bean in second year (2013-14)

S.No.	Characters	Range		General Mean	SEm±	Co-efficient of variation			Heritability in broad sense (%)	Genetic advance (GA)	Genetic advance in % of mean
		Min.	Max.			CV	PCV (%)	GCV (%)			
1	X1	71.43	100.00	89.06	4.004	5.50	9.15	7.30	63.70	10.70	12.01
2	X2	34.78	130.10	50.77	2.583	6.23	40.60	40.12	97.60	41.47	81.68
3	X3	42.75	87.68	54.03	2.666	6.04	19.17	18.19	90.10	19.22	35.57
4	X4	7.52	13.00	10.78	0.909	10.32	17.20	13.75	64.00	2.44	22.63
5	X5	5.04	12.56	9.86	0.641	7.95	18.34	16.52	81.20	3.03	30.73
6	X6	2.69	5.11	3.89	0.443	13.94	18.80	12.61	45.00	0.68	17.48
7	X7	4.25	9.61	7.25	0.529	8.94	22.62	20.77	84.40	2.85	39.31
8	X8	31.00	43.67	37.13	1.400	4.62	11.27	10.28	83.20	7.17	19.31
9	X9	36.67	49.33	42.61	1.252	3.60	7.96	7.09	79.50	5.55	13.02
10	X10	10.80	30.58	21,18	1.133	6.55	23.41	22.48	92.20	9.42	26.20
11	X11	8.33	13.71	11.24	0.696	7.58	15.74	13.79	76.80	2.80	24.91
12	X12	0.50	0.96	0.69	0.070	12.42	20.09	15.79	61.80	0.18	26.08
13	X13	0.84	1.12	0.97	0.074	9.34	10.50	4.78	20.70	0.04	4.12
14	X14	4.57	7.95	6.23	0.452	8.88	13.25	9.83	55.00	0.94	15.08
15	X15	55.21	149.36	92.58	0.696	9.21	28.52	26.99	89.60	48.72	52.62
16	X16	1.67	4.55	2.78	0.325	14.31	28.11	24.19	74.10	1.19	42.80
17	X17	3.70	6.19	4.85	0.384	9.69	13.49	9.39	48.40	0.65	13.40
18	X18	12.51	60.32	32.33	0.830	3.14	42.91	42.79	99.50	28.43	87.93
19	X19	91.97	248.94	153.85	10.824	8.61	28.50	27.17	90.90	82.08	53.35
20	X20	9.58	12.95	11.18	0.648	7.09	10.44	7.65	53.70	1.29	11.53
21	X21	5.15	9.06	7.08	0.495	8.56	14.53	11.74	65.30	1.38	19.49
22	X22	17.21	30.91	23.60	0.807	4.18	19.41	18.95	95.30	9.00	38.13

1 = Germination percentage 2 = Plant height (cm) 3 = No. Of leaves/plant 4 = Leaf length (cm) 5 = Leaf width (cm)
6 = Primary branches /plant 7 = Secondary branches/plant 8= Days to first flowering 9 = Days to 50% flowering 10 = No. Of pods /plant
11 = Green pod length (cm) 12 = Green pod width (cm) 13 = Green pod breadth (cm) 14 = Single green pod weight (g) 15 = Green pod yield /plant (g)
16 = Green pod yield /plot (kg) 17 = No. Of seeds /pod 18=100-seed weight (g) 19 = Green pod yield (q/ha) 20 = Moisture (%)
21= Total sugars (%) 22= Protein (%)

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Table-3 Estimates of variance and other genetic parameters in French bean in pooled study (2012-13 and 2013-14)

S.No.	Characters	Range		General Mean	SEm±	Co-efficient of variation			Heritability in broad sense (%)	Genetic advance (GA)	Genetic advance in % of mean
		Min.	Max.			CV	PCV (%)	GCV (%)			
1	X1	70.15	100.00	88.60	2.767	5.40	10.03	8.44	70.90	12.97	14.63
2	X2	34.62	129.16	50.16	2.079	7.18	41.21	40.58	97.00	41.29	82.31
3	X3	42.13	87.11	53.52	2.199	7.11	20.05	18.75	87.40	19.33	36.11
4	X4	7.38	12.86	10.69	0.617	10.00	17.99	14.95	69.10	2.74	25.63
5	X5	5.02	12.53	9.86	0.661	11.60	20.78	17.24	68.80	2.91	29.51
6	X6	2.57	5.11	3.86	0.279	12.51	19.85	15.40	60.20	0.95	24.61
7	X7	4.24	9.58	7.24	0.377	9.02	23.29	21.47	85.00	2.95	40.74
8	X8	30.33	43.50	36.84	0.984	4.62	11.51	10.54	83.80	7.32	19.86
9	X9	36.00	48.50	41.79	1.019	4.22	8.54	7.42	75.50	5.55	13.28
10	X10	10.46	30.22	20.96	0.728	6.02	23.72	22.94	93.60	9.58	45.70
11	X11	8.33	13.76	11.14	0.475	7.38	16.42	14.67	79.80	3.01	27.01
12	X12	0.49	0.95	0.68	0.041	10.51	20.64	17.76	74.00	0.21	30.88
13	X13	0.83	1.10	0.96	0.051	9.25	11.80	7.33	38.50	0.09	9.37
14	X14	4.56	7.94	6.21	0.297	8.27	13.86	11.12	64.40	1.14	18.35
15	X15	55.06	149.11	92.37	4.574	8.57	28.85	27.55	91.20	50.05	54.18
16	X16	1.66	4.51	2.77	0.201	12.56	28.95	26.08	81.20	1.34	48.37
17	X17	3.64	5.96	4.81	0.291	10.49	14.53	10.05	47.80	0.69	14.34
18	X18	12.49	60.28	32.26	0.580	3.11	43.10	42.99	99.50	28.50	88.34
19	X19	91.73	248.51	153.69	7.222	8.13	28.77	27.60	92.00	83.82	54.53
20	X20	9.53	12.92	11.08	0.432	6.74	10.32	7.81	57.30	1.35	12.18
21	X21	5.13	8.99	7.02	0.337	8.30	14.69	12.12	68.00	1.45	20.65
22	X22	17.15	30.53	23.35	0.635	4.71	18.65	18.05	93.60	8.40	35.97

1 = Germination percentage
2 = Plant height (cm)
3 = No. Of leaves/plant
4 = Leaf length (cm)
5 = Leaf width (cm)
6 = Primary branches /plant
7 = Secondary branches/plant
8= Days to first flowering
9 = Days to 50% flowering
10 = No. Of pods /plant
11 = Green pod length (cm)
12 = Green pod width (cm)
13 = Green pod breadth (cm)
14 = Single green pod weight (g)
15 = Green pod yield /plant (g)
16 = Green pod yield /plot (kg)
17 = No. Of seeds /pod
18=100-seed weight (g)
19 = Green pod yield (q/ha)
20 = Moisture (%)
21= Total sugars (%)
22= Protein (%)