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Analysis of Morpho-Agronomic Variation and Genetic Divergence of French Bean (*Phaseolus vulgaris* L.) in Mid Hills of Uttarakhand

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ABSTRACT: For parental selection in crop development initiatives, genetic diversity knowledge is crucial. In a randomized block design, 24 French bean genotypes, including the control variety (Lakshmi), were planted in the Kharif of 2018 and their genetic differentiation for 16 cultivation traits was assessed. All of the analysed characteristics exhibited a wide range of variation in experimental outcomes. The 100-seed weight was found to have significant genotypic and phenotypic coefficient of variation (GCV and PCV), with the number of days to first harvest being the lowest. Heritability is correlated with high heritability estimates. This indicates that these traits are under additive genetic influence and are more trustworthy for efficient selection. It was found to be high for seed yield per plot and lowest for days at 50% germination. The number of days before the first harvest and the length of the fruit were positively and significantly associated with yield at both genotype and phenotypic levels, according to correlation analysis, which also showed that the rind was established at pod maturity. Genotypic pathway factor analysis revealed that the days of first flowering, days of germination, seed yield per plot, fruit length, days until first harvest, 100-seed weight, number of primary seeds, branches per plant, pod set to pod maturity, and average pod weight had the most favourable direct effects on yield per plant.

Key words: Diversity, germination, Genotypic path coefficient, heritability, phenotypic coefficients of variation

French beans (*Phaseolus vulgaris* L.) are a type of legume belonging to the Fabaceae (or Leguminosae) family. They are also known as common beans, green beans, or snap beans. According to Schoonhoven and Vosyest (1991), this plant had several noticeable changes during its history, going from a climber to a dwarf form, both in the Andean domestication centres and Middle American domestication centres. French beans are annual plants, usually grown as a vegetable crop for their edible immature pods. The plant is a small erect bush with many branches, growing up to 1.5 m in height. Its flowers are white or pale purple and are borne in clusters of 2–6. Its leaves are alternate, oval-shaped, and have a smooth margin. Its pods are green, slender, and curved, typically 3–10 cm long, and contain up to 4 seeds. French beans are an important source of dietary fibre, protein, vitamins, minerals, and antioxidants. The beans are green, although they can also be yellow, purple, or streaked. The pods are up to 15 cm in length and contain up to 10 seeds. The seeds are

white, round, and flattened. The French bean is an upright, twining, annual plant that grows up to 1.5 m in height. Leaves are compound with two leaflets, each up to 7 cm long and 3 cm wide. The flowers are white, pink, or purple in color, and are up to 1 cm long. The pods are up to 15 cm long, containing up to 10 seeds. The seeds are white, round, and flattened. The French bean is widely cultivated for its edible seed, and is a major source of protein and dietary fiber. It is an important commercial crop, and is grown in many countries.

In India, the total area under French beans is estimated to be around 0.9–1.2 million hectare and the total production is estimated to be around 2.8–3.2 million tonnes. Karnataka is the major producer of French beans in India, accounting for over 60 per cent of the total production. Uttar Pradesh, Kerala and Madhya Pradesh are the other major producers of the vegetable. They are often used in salads, stews, soups, casseroles, and other dishes. France is the

leading producer of French beans, followed by Italy, Spain, Germany, and the United Kingdom. Other countries that produce French beans include the United States, Mexico, China, Brazil, and Argentina. French beans are grown in warm climates and need a lot of sunlight.

It is widely cultivated in tropics, sub tropics and temperate regions. In India and most of the tropical Asia, it is a major vegetable crop where indigenous pulses are also preferred.

MATERIALS AND METHODS

The present experiment was conducted at Vegetable Research and Demonstration Block, Department of Vegetable Science, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal, Uttarakhand, in Mid Hills of Uttarakhand." Located between 29° 20' and 29° 75' N latitude and 78° 10' and 78° 80' E longitude. The experimental site, is 1950 meters above sea level. The entire region is thought to be a component of the North-Western Himalaya because it is between the Kumaon and Himachal Pradesh Himalaya. The experimental location is located near Bharsar, which is about 60 kilometres (km) away from the district headquarters (Pauri) in an east-south direction along National Highway 121/41. Bharsar is situated between latitude 29° 30.050 North and longitude 78.990 East at an altitude of 1900 m above mean sea level. After removing the border plants, observations were taken on five randomly selected plants for 17 quantitative traits *viz.*, days to germination, days to 50% germination, days to first flowering, days to 50% flowering, first flowering to pod set, pod set to pod maturity, days to first harvest, plant height (cm), number of primary branches per plant, average pod weight (g), number of seeds per pod, pod length (cm), seed yield per plant (g), seed yield per plot (g), seed weight (g), protein content (%). The statistical analysis was carried out for each observed character under the study using MS-Excel, SPSS 16.0 and SPAR 2.0 packages. The mean values of data were subjected to analysis of variance and ANOVA was set as per Gomez and Gomez (1983) for Randomized Block Design.

RESULTS AND DISCUSSION

For all the investigated features, the analysis of variance indicated highly significant variations among the genotypes employed in the current study. Yield range of mean values was observed for dry pod yield per plot (165.00 to 454.11). From the present investigation, on the basis of mean performance it can be concluded that six genotype *viz.*, Solan LC-1, LC-2, EC-755444, Harsil LC-1, EC- 755477 and LC-1 recorded higher fruit yield and also performed better for other yield attributing traits than check cultivar Lakshmi. These genotypes need further testing and to be released as a substitute of already existing French bean varieties. They can also be involved in further breeding programme for development of superior varieties or hybrids for yield and quality improvement in French bean under hilly regions of Uttarakhand. The phenotypic coefficients of variation (PCV) and genotypic coefficients of variation (GCV) were found high for 100 seed weight whereas moderate phenotypic coefficients of variation (PCV) were recorded for average pod weight and days to 50% germination. It indicated that there was a great variation present in the experimental material used. High heritability estimates coupled with high genetic gain were observed for seed yield per plot, whereas lowest heritability was recorded for days to 50% germination. Therefore, these traits also show some opportunity for improvement through selection. The correlation studies revealed that seed yield per plant had positive and significant association with pod set to pod maturity, pod length and yield per plot. Hence, these traits should be taken into consideration, while making the selection for yield improvement in French bean. The material for present study includes 24 genotypes and grouped into four clusters. There is no any direct relationship between geographical distribution and genetic distance. Similar result for this trait were also reported by Devi *et al.* (2014), Patil (2014) and Prakash and Ram (2014).

CONCLUSION

The investigation was concluded that the seed yield of pole type of French beans can be improved by

Table 1: Showing mean character values of French Bean genotypes

Sl. No.	Genotypes	DG	D50%G	DFF	D50%F	DFFPD	PSPM	NPBPP	DFH	AWP	PH	SW	PL	NSPP	PC	SYPP	SYPT
1	Solan LC-1	14.67	16.00	31.67	35.00	5.47	33.07	8.53	73.40	4.96	220.07	22.60	18.35	6.60	19.27	63.66	451.59
2	Bean no.-2	16.00	17.67	32.67	35.33	5.80	31.73	8.07	71.13	5.39	194.27	19.40	19.47	8.00	18.56	32.80	206.47
3	EC-755510	12.33	14.67	39.67	42.33	4.20	27.67	7.47	78.43	6.21	188.33	22.83	11.55	5.35	23.94	23.23	166.17
4	IC- 84337	12.67	14.33	36.00	38.67	5.60	25.87	6.30	85.30	4.89	211.73	26.48	11.21	6.11	23.28	23.53	165.00
5	EC- 755478	12.00	13.67	27.67	31.33	5.93	29.67	6.27	88.50	4.77	189.07	28.14	12.04	4.55	22.37	35.28	244.32
6	EC- 755480	14.00	15.33	28.33	34.33	5.00	26.00	8.03	78.70	4.87	251.33	24.09	11.11	4.21	23.17	35.48	249.84
7	IC 049810	11.33	14.00	38.00	41.00	6.67	29.27	5.63	91.07	5.73	223.87	24.63	11.87	6.44	24.73	39.33	273.67
8	LC-2	10.33	13.00	32.00	35.67	3.67	38.87	6.20	89.80	6.31	206.60	49.99	12.58	7.22	20.90	62.71	439.49
9	IC-199211	12.33	14.00	33.33	35.00	6.33	34.63	4.80	77.77	4.76	240.73	24.71	13.80	6.53	22.71	54.33	377.10
10	EC- 755408	14.67	16.00	35.67	41.33	4.27	28.67	4.33	74.80	5.50	202.00	22.00	12.48	5.58	17.62	54.67	381.00
11	EC-755409	14.33	16.33	38.00	41.67	4.87	29.00	6.20	88.07	6.47	201.00	19.10	8.85	3.77	18.55	55.73	392.33
12	IC- 47841	13.00	14.33	40.00	44.33	5.53	36.20	4.87	86.30	5.66	243.53	22.59	8.39	3.77	16.19	43.57	299.93
13	EC- 755542	13.33	14.33	40.67	43.67	5.07	37.53	4.33	76.63	6.79	214.87	26.47	12.40	6.33	24.69	54.33	387.00
14	EC- 755444	14.33	15.33	40.33	43.67	3.53	29.73	6.60	73.00	7.26	254.40	30.76	10.43	4.46	19.35	65.00	454.11
15	EC- 755508	13.00	14.67	41.33	45.00	3.53	27.40	5.67	78.07	5.73	230.93	25.41	11.24	6.23	20.62	30.46	248.85
16	EC 755509	14.67	15.67	40.33	43.00	6.00	30.47	4.63	80.80	4.73	191.00	26.16	9.10	4.08	22.95	38.99	272.93
17	IC- 199208	10.00	11.67	37.33	41.33	5.00	29.27	7.07	67.83	5.94	279.13	31.43	18.37	7.87	19.45	41.50	352.89
18	EC- 755484	11.00	12.33	42.00	45.00	4.73	39.67	5.53	69.20	5.89	290.67	25.10	10.43	4.88	21.72	52.13	364.27
19	Harsil LC-1	12.00	13.67	33.33	39.00	4.73	38.73	11.73	77.80	7.01	208.17	61.56	11.45	5.76	25.40	60.62	424.16
20	EC- 755477	15.00	16.67	38.67	43.33	4.40	32.27	8.17	63.60	5.77	197.53	23.33	12.19	5.30	22.43	63.21	438.07
21	EC- 755455	14.00	15.67	40.00	43.33	6.47	29.40	10.00	77.87	5.21	216.40	21.03	10.97	4.84	19.22	34.36	239.76
22	IC- 84376	13.00	14.00	24.00	28.67	5.00	37.33	6.33	76.70	5.62	248.53	24.46	11.77	6.36	21.52	34.18	241.44
23	LC-1	10.00	11.00	25.67	30.33	3.20	39.37	9.60	75.96	6.50	204.87	44.41	11.80	5.82	22.53	61.27	434.73
24	Lakshmi	9.33	10.33	30.67	33.33	3.60	29.90	9.03	64.87	5.32	187.45	23.60	12.59	5.63	22.42	58.91	417.88
	Mean	12.81	14.36	35.31	38.99	4.94	32.15	6.89	77.73	5.72	220.69	27.93	12.27	5.65	21.40	46.64	330.12
	Range (Min)	9.33	10.33	24.00	28.67	3.20	25.87	4.33	63.60	4.73	187.45	19.10	8.39	3.77	16.19	23.23	165.00
	Range (Max)	16.00	17.67	42.00	45.00	6.67	39.67	11.73	91.07	7.26	290.67	61.56	19.47	8.00	25.40	65.00	454.11
	SE(d)	0.51	0.60	1.05	0.86	0.28	0.94	0.18	0.78	0.16	5.31	1.93	0.25	0.18	0.37	0.83	4.75
	C.D.at 5%	1.02	1.22	2.11	1.73	0.57	1.90	0.36	1.58	0.33	10.71	3.90	0.51	0.37	0.75	1.68	9.60
	C.V.	4.84	5.15	3.63	2.69	6.94	3.58	3.20	1.23	3.52	2.94	8.47	2.51	3.93	2.13	2.19	1.76

*Significant at 5% level of significance, **Significant at 1% level of significance

Where,

DG= Days to germination, D50%G= Days to 50% germination. DFF= Days to first flowering, D50%F=Days to 50% flowering, DFFPS= Days to first flowering to pod set, PSPM= Pod set to pod maturity, PH= Plant height, NPB= Number of primary branches per plant, DFH= Days to first harvest, APW= Average pod weight, PL= Pod length, NSP= Number of seed per pod, SW= 100 Seed weight, SYPP= Protein content, SYPT= Seed yield per plant, SYPPt= Seed yield per plot

Table 2: Estimates of phenotypic and genotypic coefficients of variation, heritability, genetic advance and genetic advance as per cent over mean for different traits in French bean

Sn.	Characters	Mean	Range Min–Max	Coefficient of variation		Heritability (%)	GA	GA as % mean
				GCV as %	PCV as %			
1	Days to germination	12.81	9.33 -16.00	13.77	14.59	89.02	3.43	26.76
2	Days to 50% germination	14.36	10.33 -17.67	12.05	13.11	84.57	3.28	22.83
3	Days to first flowering	35.31	24.00 -42.00	14.82	15.26	94.34	10.47	29.65
4	Days to 50% flowering	38.99	28.67 -45.00	12.81	13.09	95.78	10.07	25.82
5	Days to first flowering to pod set	4.94	3.20 -6.67	19.83	21.01	89.09	1.91	38.55
6	Pod set to pod maturity	32.15	25.87 -39.67	13.79	14.25	93.69	8.84	27.50
7	Plant height (cm)	220.69	187.45 -290.67	12.89	13.23	95.04	57.14	25.89
8	Number of primary branches per plant	6.89	4.33 -11.73	28.01	28.19	98.71	3.95	57.33
9	Days to first harvest	77.73	63.60 -91.07	9.73	9.81	98.42	15.46	19.88
10	Average pod weight (g)	5.72	4.73 -7.26	12.67	13.15	92.84	1.44	25.15
11	Pod length (cm)	12.27	8.39 -19.47	22.72	22.85	98.79	5.71	46.51
12	Number of seeds per pod	5.65	3.77 -8.00	20.90	21.27	96.58	2.39	42.32
13	Seed weight (g)	27.93	19.10 -61.56	35.74	36.73	94.68	20.41	71.65
14	Protein content (%)	21.40	16.19 -25.40	11.27	11.47	96.56	4.88	22.81
15	Seed yield per plant (g)	46.64	23.23 -65.00	29.15	29.23	99.44	27.92	59.87
16	Seed yield per plot (g)	330.12	165.00- 454.11	28.79	28.85	99.63	195.44	59.20

selecting genotypes having early days to 1st flowering to pod set, the number of primary branches per plant, plant height, and days to 1st harvest which are major yield contributing traits. High heritability estimates coupled with high genetic gain were observed for seed yield per plot, whereas the lowest heritability was recorded for days to 50% germination. Therefore, these traits also show some opportunity for improvement through selection. The high-yielding genotypes can be further assessed for stability by evaluating them in different agro-climatic conditions before using them for commercial cultivation.

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