



## Studies on variability, heritability and genetic advance for yield and yield contributing characters in french bean (*Phaseolus vulgaris* L.) germplasm under tarai region of Uttarakhand

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**Abstract:** Seventy four French bean germplasms were evaluated for twenty two quantitative traits to study the genetic variability, heritability and genetic advance during Jan-Feb in G.B. Pant University of Agriculture and Technology, Pantnagar. Significant differences were observed among all genotypes. Higher genotypic and phenotypic coefficient of variability were observed for plant height, seed yield per plant, pod yield per plant, pod yield per hectare, number of pods per cluster, number of pods per plant and 100 seed weight (42.45% and 43.30%, 39.72% and 42.34%, 27.59% and 32.12%, 27.59% and 32.12%, 25.01% and 28.14%, 24.56% and 26.76% and 22.65% and 22.96% respectively). High heritability coupled with high genetic advance over mean were observed for plant height, seed yield per plant, pod yield per plant, pod yield per hectare, number of pods per plant, 100 seed weight, number of pods per cluster, leaf length, single pod weight, pod diameter, pod length, number of pod clusters per plant, leaf width, seed length, number of seeds per pod and seed width (96.34% and 85.73%, 88.03% and 76.77%, 73.80% and 48.83%, 73.80% and 48.83%, 84.20% and 46.42%, 97.34% and 46.04%, 45.78% and 78.96%, 38.88% and 89.58%, 38.21% and 92.70%, 92.69% and 35.45%, 90.13% and 34.48%, 32.47% and 79.39%, 28.03% and 79.60%, 26.92% and 99.04%, 56.27% and 24.85%, and 97.82% and 24.01% respectively) indicate predominance additive gene action. Thus, there is ample scope for improving these characters through direct selection.

**Keywords:** French bean, GCV, Genetic variability, Heritability, PCV

### INTRODUCTION

French bean (*Phaseolus vulgaris* L.),  $2n=22$  is the most popular leguminous vegetable crop in many parts of the world. It belongs to the family Leguminosae (Fabaceae), sub-family papilionaceae, order Leguminosales (Fabales), subtribe Phaseolinae, tribe Phaseolae. It is also known by many names as kidney bean, common bean, field bean, garden bean, faras bean, bush bean, navy bean, haricot bean, pinto bean, string bean, marrow bean, snap bean and dry beans etc. The large dry seed type varieties are called as 'Rajmash' in India. It is very popular among the people due to its quality, nutritional balance and higher biological efficiency. This vegetable plays a vital role in the nourishment of human population (Ram, 2014). India has about 137.54 thousand ha area under bean cultivation and the production is 1370.21 thousand MT with an annual productivity 9.96 MT/ha green pod (Anonymous, 2015). There are three types of french bean: Bush type with short internodes, semi-pole-type with longer internodes than those in bush type and the pole-type having longer internodes than that of the semi-pole type. Over 50 species of *Phaseolus* have

been reported from the America, of these, only five, namely Common bean (*P. vulgaris* L.), year bean (*P. polyanthus*), scarlet or runner bean (*P. coccineus*), tepary bean (*P. acutifolius*) and lima bean (*P. lunatus*) are known to be domesticated. All the species are self-pollinated, except *P. coccineus* which is generally cross pollinated. French bean is domesticated in Mexico, Peru and Colombia. It is originated in new world, principally South Mexico and Central America (Vavilov, 1950). Radio carbon dates suggested that french bean was domesticated in Central America about 7000 years ago (Kaplan, 1965). In North America, the french bean spread through California. It was introduced into Europe in the 16<sup>th</sup> and 17<sup>th</sup> centuries and in England almost at the end of the 16<sup>th</sup> century (1594). It was brought to India from Europe during the 17<sup>th</sup> century (Swarup, 2012).

Success of a breeding programme is largely dependent on the extent of genetic variability present in the population of evolving promising and desired types. A detailed extent study of variability and heritability in relation to their contribution towards yield is prime requisite for an efficient plant breeding programme.

The possibility of improvement in any crop is measured by variability available in the crop (Mohapatra *et al.*, 2007). The genetic variability in conjunction with total variability can be used in predicting the gain for a given selection intensity. The variation in the characters of any crop species is the raw material for a plant breeder and extent of variability present in the population with respect to various characters is the factor for the success of plant breeder in improvement of crop plant. Larger variability ensures better chances of producing desired crop variety. Hence, it is very essential to screen out the available germplasm for higher production of french bean.

## MATERIALS AND METHODS

The present investigation was conducted at Vegetable Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand) during Jan-May, 2014 which is located in tarai region of Uttarakhand. The experimental material comprised of seventy four genotypes of french bean (Table 1). The experiment was laid out in randomized block design with three replications. Each genotype was sown in three meter row length following plant spacing at 30 x 20 cm apart.

Observations were recorded on five randomly selected competitive plants per replication for each entry on twenty two quantitative traits namely, days to 1<sup>st</sup> flowering, days to 50% flowering, days to 50% pod setting, days to 50% maturity, days to 1<sup>st</sup> picking, days to 2<sup>nd</sup> picking, , number of pods per cluster, number of pod clusters per plant, number of pods per plant, pod diameter, pod length, leaf length, leaf width, single pod weight, plant height, number of seeds per pod, seed length, seed width, 100 seed weight, seed yield per plant, pod yield per plant and pod yield per hectare. The analysis of variance for each character was followed according to Panse and Sukhatme (1967). The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated as per Burton and De Vane (1953). Heritability (broad sense) and genetic advance as per cent of mean were computed by following the methods of Johnson *et al.* (1955) and Allard (1960), respectively.

## RESULTS AND DISCUSSION

The analysis of variance for all 22 quantitative characters of french bean showed significant difference (Table 2). The mean estimates of genotypes (Table 3) for various characters revealed that the wide range was recorded in seed yield per plant, plant height (Bhaganna *et al.*, 2015, Prakash *et al.*, 2015, Kamaluddin and Ahmed, 2011, Mukesh and Geeta, 2016 and Prakash and Ram, 2014), 100 seed weight (Bhaganna *et al.*, 2015, Prakash *et al.*, 2015, Kamaluddin and Ahmed, 2011, Mukesh and Geeta, 2016, Prakash and Ram, 2014 and Rai *et al.*, 2010), number of pods per

plant (Bhaganna *et al.*, 2015, Prakash *et al.*, 2015, Mukesh and Geeta, 2016, Prakash and Ram, 2014 and Rai *et al.*, 2010), number of seeds per pod (Bhaganna *et al.*, 2015, Mukesh and Geeta, 2016 and Prakash and Ram, 2014), pod length (Bhaganna *et al.*, 2015, Mukesh and Geeta, 2016 and Rai *et al.*, 2010), seed length, pod yield per plant (Bhaganna *et al.*, 2015, Prakash *et al.*, 2015, Mukesh and Geeta, 2016 and Prakash and Ram, 2014) and pod yield per hectare (Prakash *et al.*, 2015 and Prakash and Ram, 2014). Traits like seed length and seed yield per plant revealed wide range in study conducted by Rai *et al.* (2010). While moderate range was recorded in days to 1<sup>st</sup> flowering (Bhaganna *et al.*, 2015, Prakash and Ram, 2014 and Rai *et al.*, 2010), days to 50 % flowering (Bhaganna *et al.*, 2015, Prakash *et al.*, 2015 and Prakash and Ram, 2014), days to 50% pod setting, days to 1<sup>st</sup> picking, days to 2<sup>nd</sup> picking, days to 50 % maturity, number of pods per cluster, number of pod clusters per plant, pod diameter, seed width, leaf length, leaf width and single pod weight. Prakash *et al.* (2015) and Prakash and Ram (2014) were also reported moderate range for leaf length, leaf width and single pod weight in french bean. For seed width and days to 1<sup>st</sup> picking moderate range were reported by Rai *et al.* (2010).

Variation at phenotypic level is a combination of genetic as well as environmental variability, which does not help in effective selection. Hence, the decisive factors primarily rest on genotypic variability or more specifically, additive genetic variability in which a breeder is mostly interested. Statistics like range, mean and coefficient of variation provide basic information on the variation of a character at phenotypic and genotypic level. This also gives an indication of the influence of environment in bringing the variation. In the present investigation, phenotypic coefficient of variation was higher than that of genotypic coefficient of variation for all the characters under studied (Table 3). It may be because of the reason that the variability at phenotypic level includes both genotypic and environmental variability. For most of the characters, the differences in estimates of PCV and GCV were less, indicating that these characters were less affected by environment and therefore they were stable.

Highest genotypic as well as phenotypic coefficient of variations (Table 3) were exhibited by plant height (Kamaluddin and Ahmed, 2011, Prakash and Ram, 2014 and Prakash *et al.*, 2015), followed by seed yield per plant (Kamaluddin and Ahmed, 2011), pod yield per plant (Prakash and Ram, 2014, Prakash *et al.*, 2015 and Pandey *et al.*, 2013), pod yield per hectare (Prakash and Ram, 2014 and Prakash *et al.*, 2015), number of pods per cluster, number of pods per plant (Prakash and Ram, 2014, Prakash *et al.*, 2015 and Pandey *et al.*, 2013) and 100 seed weight (Prakash and Ram, 2014 and Prakash *et al.*, 2015), while lowest in days to 2<sup>nd</sup> picking, followed by days to 1<sup>st</sup> picking,

**Table 1.** List of germplasm of French bean (*Phaseolus vulgaris* L.).

S. N.	Genotype	S.N.	Genotype	S.N.	Genotype	S.N.	Genotype
1.	Pant Anupama	20.	FB-206	39.	FB-225	58.	FB-244
2.	Pant Bean-2	21.	FB-207	40.	FB-226	59.	FB-245
3.	Pant Bean-3	22.	FB-208	41.	FB-227	60.	FB-246
4.	Arka Anoop	23.	FB-209	42.	FB-228	61.	FB-247
5.	Arka Komal	24.	FB-210	43.	FB-229	62.	FB-248
6.	Arka Suvidha	25.	FB-211	44.	FB-230	63.	FB-249
7.	Contender	26.	FB-212	45.	FB-231	64.	FB-250
8.	Chitra	27.	FB-213	46.	FB-232	65.	FB-251
9.	VL Bean-2	28.	FB-214	47.	FB-233	66.	FB-252
10.	IIHR-909	29.	FB-215	48.	FB-234	67.	FB-253
11.	VLFB-130	30.	FB-216	49.	FB-235	68.	FB-254
12.	VLFB-510	31.	FB-217	50.	FB-236	69.	FB-255
13.	VLFB-628	32.	FB-218	51.	FB-237	70.	FB-256
14.	VLFB-629	33.	FB-219	52.	FB-238	71.	FB-257
15.	FB-201	34.	FB-220	53.	FB-239	72.	FB-258
16.	FB-202	35.	FB-221	54.	FB-240	73.	FB-259
17.	FB-203	36.	FB-222	55.	FB-241	74.	FB-260
18.	FB-204	37.	FB-223	56.	FB-242		
19.	FB-205	38.	FB-224	57.	FB-243		

**Table 2.** Analysis of variance for twenty two quantitative characters in french bean.

S. N.	Characters	Mean sum of squares			
		df	Replication	Genotype	Error
1	Days to 1 <sup>st</sup> flowering		2	73	146
2	Days to 50% flowering	1.27	31.58**	1.93	
3	Days to 50% pod setting	0.22	37.81**	1.64	
4	Days to 50% maturity	1.23	40.21**	2.36	
5	Days to 1 <sup>st</sup> picking	0.29	42.41**	0.54	
6	Days to 2 <sup>nd</sup> picking	1.15	34.71**	0.51	
7	Number of pods/ cluster	0.66	29.67**	0.53	
8	Number of pod clusters/ plant	0.01	0.88**	0.07	
9	Number of pods/ plant	0.07	1.67**	0.13	
10	Pod dia. (mm)	1.35	12.89**	0.76	
11	Pod length (cm)	0.05	10.46**	0.27	
12	Leaf length (cm)	0.86	11.33**	0.40	
13	Leaf width (cm)	0.43	10.21**	0.38	
14	Single pod weight (g)	0.91	3.44**	0.27	
15	Plant height (cm)	0.00	2.69**	0.07	
16	Number of seeds/ pod	6.83	1016.23**	13.56	
17	Seed length (mm)	0.50	1.20**	0.41	
18	Seed width (mm)	0.07	9.92**	0.03	
19	100 seed weight (g)	0.05	1.93**	0.01	
20	Seed yield/plant (g)	0.55	169.58**	1.53	
21	Pod yield/ plant (g)	0.46	74.72**	3.24	
22	Pod yield/ ha (q)	12.01	370.28**	39.18	
		48.03	1481.14**	156.72	

df : degree of freedom, \*\* : Significant at 1% level

days to 50% maturity, days to 50% pod setting and days to 50% flowering (Prakash and Ram, 2014 and Prakash *et al.*, 2015) in french bean.

The study of genotypic coefficient of variation helps to measure the range of genotypic variation existing at specified environmental site for a particular character and to compare the variability existing in various characters. However, it cannot measure the heritable variation; the genotypic coefficient of variation together with heritability estimates would give reliable indication of the expected improvement through selection as

reported by Burton and Devane (1953). Days to 1<sup>st</sup> flowering, days to 50% flowering, days to 50% pod setting, days to 1<sup>st</sup> picking, days to 2<sup>nd</sup> picking and days to 50 % maturity had low GCV, which indicates the existence of narrow genetic variability. It could be therefore, suggested that for the improvement of these characters, there is a need to create variability.

High heritability coupled with high genetic advance as per cent of mean (Table 3) was recorded in plant height, seed yield per plant, pod yield per plant, pod yield per hectare, number of pods per plant, 100 seed

**Table 3.** Range, coefficient of variation, heritability, genetic advance, genetic advance as per cent of mean and genetic parameters for different quantitative characters of french bean.

S. N.	Characters	Range	GM	Sem	Variability		Heritability (h <sup>2</sup> %)	Genetic advance as per cent of mean
					GCV (%)	PCV (%)		
1	Days to 1 <sup>st</sup> flowering	40.33 - 57.67	44.71	0.8016	7.03	7.69	83.68	13.25
2	Days to 50% flowering	44.00 - 60.00	48.18	0.7385	7.21	7.68	88.05	13.93
3	Days to 50% pod setting	47.00 - 63.67	52.09	0.8873	6.82	7.43	84.23	12.89
4	Days to 50% maturity	59.00 - 74.33	63.98	0.4258	5.84	5.95	96.25	11.80
5	Days to 1 <sup>st</sup> picking	57.00 - 71.33	61.86	0.412	5.46	5.58	95.72	11.00
6	Days to 2 <sup>nd</sup> picking	61.00 - 76.00	66.65	0.4202	4.68	4.80	94.83	9.38
7	Number of pods/ cluster	01.13 - 03.50	2.08	0.1549	25.01	28.14	78.96	45.78
8	Number of pod clusters/ plant	02.20 - 05.53	4.05	0.2109	17.69	19.86	79.39	32.47
9	Number of pods/ plant	03.80 - 13.43	8.19	0.503	24.56	26.76	84.20	46.42
10	Pod dia. (mm)	07.37 - 14.24	10.31	0.2988	17.87	18.56	92.69	35.45
11	Pod length (cm)	06.69 - 15.60	10.83	0.3647	17.63	18.57	90.13	34.48
12	Leaf length (cm)	05.23 - 12.53	9.08	0.3563	19.94	21.07	89.58	38.88
13	Leaf width (cm)	04.20 - 09.80	6.74	0.3002	15.25	17.09	79.60	28.03
14	Single pod weight (g)	02.53 - 06.67	4.85	0.1513	19.27	20.01	92.70	38.21
15	Plant height (cm)	25.23 - 119.6	43.07	2.1258	42.45	43.30	96.34	85.73
16	Number of seeds/ pod	02.17 - 06.10	4.53	0.3703	16.08	21.43	56.27	24.85
17	Seed length (mm)	08.24 - 16.74	13.82	0.1032	13.13	13.20	99.04	26.92
18	Seed width (mm)	04.81 - 08.55	6.79	0.069	11.78	11.91	97.82	24.01
19	100 seed weight (g)	12.47 - 46.47	33.04	0.7144	22.65	22.96	97.34	46.04
20	Seed yield/plant (g)	03.44 - 27.84	12.29	1.0394	39.72	42.34	88.03	76.77
21	Pod yield/ plant (g)	13.48 - 62.59	38.08	3.6139	27.59	32.12	73.80	48.83
22	Pod yield/ ha (q)	26.95 - 125.19	76.15	7.2277	27.59	32.12	73.80	48.83

GM : Grand Mean GCV : Genotypic Co-efficient of variability, PCV : Phenotypic Co-efficient of variability

weight, number of pods per cluster, leaf length, single pod weight, pod diameter, pod length, number of pod clusters per plant, leaf width, seed length, number of seeds per pod and seed width indicated that most likely the heritability is due to additive gene effects interns these traits were less influenced by environment and selection may be effective for further improvement. Similar results of high heritability and high genetic advance as per cent of mean for french bean were also reported earlier for plant height (Kamaluddin and Ahmed, 2011; Singh and Singh, 2013; Prakash and Ram, 2014; Bhaganna *et al.*, 2015; Prakash *et al.*, 2015 and Mukesh and Geeta, 2016), for seed yield per plant (Kamaluddin and Ahmed, 2011; Singh and Singh, 2013), for pod yield per plant (Rai *et al.*, 2010; Singh and Singh, 2013; Prakash and Ram, 2014; Jyoti *et al.*, 2015; Prakash *et al.*, 2015; and Mukesh and Geeta, 2016), for pod yield per hectare (Singh and Singh, 2013; Prakash and Ram, 2014; Singh *et al.*, 2014 and Prakash *et al.*, 2015), for number of pods per plant (Rai *et al.*, 2010; Prakash and Ram, 2014; Singh *et al.*, 2014; Bhaganna *et al.*, 2015; Jyoti *et al.*, 2015 and Prakash *et al.*, 2015), for 100 seed weight (Rai *et al.*, 2010; Kamaluddin and Ahmed, 2011; Singh and Singh, 2013; Prakash and Ram, 2014; Singh *et al.*, 2014; Prakash *et al.*, 2015 and Mukesh and Geeta, 2016), for number of pods per cluster (Mukesh and Geeta, 2016), for leaf length (Prakash and Ram, 2014

and Prakash *et al.*, 2015), for single pod weight (Singh and Singh, 2013; Singh *et al.*, 2014 and Jyoti *et al.*, 2015), for pod length (Rai *et al.*, 2010; Kamaluddin and Ahmed, 2011; Singh and Singh, 2013; Prakash and Ram, 2014; Singh *et al.*, 2014; Bhaganna *et al.*, 2015; Prakash *et al.*, 2015 and Mukesh and Geeta, 2016) for number of pod clusters per plant (Mukesh and Geeta, 2016), for leaf width (Prakash and Ram, 2014 and Prakash *et al.*, 2015), for seed length (Rai *et al.*, 2010), for number of seeds per pod (Rai *et al.*, 2010; Kamaluddin and Ahmed, 2011; Singh *et al.*, 2014 and Bhaganna *et al.*, 2015) and for seed width (Rai *et al.*, 2010) in french bean.

High heritability coupled with moderate genetic advance (Table 3) was found in french bean for days to 50 per cent flowering (Kamaluddin and Ahmed, 2011, Prakash and Ram, 2014, Singh *et al.*, 2014, Prakash *et al.*, 2015), days to first flowering (Prakash and Ram, 2014, Prakash *et al.*, 2015), days to 50 per cent pod setting, days to 50 per cent maturity and days to 1<sup>st</sup> picking revealed additive gene action, hence selection for such traits may be rewarding but there is slight influence of environment on these characters for further improvement. High heritability coupled with low genetic advance was found in days to 2<sup>nd</sup> picking indicating the presence of non-additive gene action, therefore selection for such traits may not be rewarding and it suggests the creation of new variability for further

improvement of this trait through other means.

## Conclusion

The present study on french bean revealed that highest genotypic as well as phenotypic coefficient of variations were exhibited by plant height, followed by seed yield per plant, pod yield per plant, pod yield per hectare and number of pods per cluster indicating that the accessions possess a wide range of variation for these traits. High heritability coupled with high or moderate high genetic advance was recorded in plant height, seed yield per plant, 100 seed weight, number of pods per plant, pod dia, pod length, leaf length, single pod weight and seed yield per plant indicated that most likely the heritability is due to additive gene effects and selection may be effective for these traits.

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