Plant Archives Vol. 14 No. 1, 2014 pp. 569-573 *ISSN 0972-5210*

GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN POLE TYPE FRENCH BEAN (*PHASEOLUS VULGARIS* L.)

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Abstract

Forty four genotypes of French bean were evaluated for eighteen quantitative characters. Wide amount of variability was found for all the characters studied. Maximum variation was showed by marketable pod yield per plant followed by plant height, number of pods per plant, number of inflorescences per plant and 100 seed weight. GCV values were high for length of inflorescence, number of pods per plant, marketable yield per plant and 100 seed weight. High estimates of broad sense heritability was observed for all the characters under study this might be possible due to low impact of environment on these traits. High heritability coupled with high expected genetic advance as percentage was observed for all the traits indicating the additive gene effects. Hence, direct selection for these traits may lead to the development of high green pod yielding genotypes.

Key words : French bean, genetic advance, heritability and variability.

Introduction

French bean originated from Central America and Southern Mexico, is an important legume vegetable crop used by human being as green pods and dry seeds. This crop is widely adapted to high altitude regions of the country particularly Himachal Pradesh, Uttaranchal and North Eastern region. The exploitation of variability is a pre-requisite for the effective screening of superior genotypes in all the crops including French bean. The progress in breeding for the yield and its contributing characters of any crop is polygenically 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. Keeping in view the importance of above biometrical approaches, an experiment was conducted to know genetic variability, heritability and genetic advance in French bean germplasm.

Materials and Methods

The experimental material comprised of forty four genotypes collected from different parts of Arunachal Pradesh. All these genotypes were grown in randomised block design (RBD) consisting of three replications with the spacing of 90 cm between the rows and 60 cm between the plants during 2011-12 at Vegetable Research Station, Rajendranagar, Hyderabad (A.P.), India. All the recommended cultural practices were followed to raise good crop. Observations were recorded on ten randomly selected plants for eighteen characters *viz.*, plant height (cm), number of primary branches, days to first flowering, days to 50% flowering, length of inflorescence (cm), number of inflorescence per plant, number of flowers per inflorescence, number of pods per inflorescence, days to first pod harvest, days to last post harvest, pod length (cm), pod width (cm), pod weight (g), number of pods per plant, number of seeds per pod, 100 seed weight (g), protein content (%) and marketable pod yield per plant. Data on twelve qualitative characters was recorded on stem pigmentation, pod colour, pod beak shape, pod pubescence, pod shape, pod curvature, parchment layer, seed colour, seed molting, brilliance of seed and seed shape as per the minimal descriptors of NBPGR (National Bureau of Plant Genetic Resources). The variability for different quantitative characters was estimated as per the procedure for analysis of variance suggested by Panse

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Table 1: Analysis of variance for eighteen quantitative traits in forty four genotypes of French bean

Character	Mean sum of squares		
	Replications (df = 2)	Treatments (df = 43)	Error (df=86)
Plant height (cm)	0.283	1712.342**	43.098
Number of primary branches per plant	0.073	1.699**	0.182
Days to first flowering	0.295	111.848**	1.574
Days to 50% flowering	0.068	121.549**	3.137
Length of inflorescence (cm)	0.023	34.305**	0.784
Number of inflorescences per plant	0.016	409.024**	6.998
Number of flowers per inflorescence	0.064	8.567**	0.585
Number of pods per inflorescence	0.085	1.431**	0.099
Days to first pod harvest	0.090	137.751**	4.579
Days to last pod harvest	0.234	231.928**	6.079
Pod length (cm)	0.690	11.275**	0.491
Pod width (cm)	0.006	0.088**	0.004
Pod weight (g)	0.1635	5.870**	0.056
Number of pods per plant	23.310	1002.303**	15.277
Number of seeds per pod	0.559	3.626**	0.275
100 seed weight (g)	0.004	252.292**	1.370
Protein content (%)	0.008	70.243**	1.266
Marketable po.d yield per plant (g)	19.259	19248.646**	334.468

and Sukatme (1985), genotypic and phenotypic coefficient of variation by Burton and De Vane (1953) and heritability and genetic advance by Johnson *et al*. (1955).

Results and Discussion

Forty four genotypes exhibited wide variation for twelve qualitative characters studied. The frequency distribution of these traits is presented in table 1. The analysis of variance for 18 quantitative characters revealed that mean sum of squares were highly significant for all the characters both at 5% and 1% level of significance indicating enough variability (table 1). Mean values for eighteen quantitative characters in forty four genotypes indicates wide amount of variability for all the characters studied (table 2). However, absolute variability in different characters does not permit in deciding as to which character is showing the highest degree of variability. Therefore, estimation of phenotypic and genotypic variances and coefficient of variations become necessary. Maximum variation was showed by marketable pod yield per plant followed by plant height, number of pods per plant, number of inflorescences per plant and 100 seed weight both at phenotypic and genotypic levels, respectively (table 3). Low variance was observed for pod width followed by number of pods per inflorescence, number of primary branches per plant and number of seeds per pod. Similar results were earlier reported by Gnanesh (2005) and Rai *et al*. (2010).

In the present investigation, all the characters except number of primary branches per plant showed narrow differences between the values of GCV and PCV (table 3), implying variability due to genetic constitution. The GCV values were high for length of inflorescence, number of pods per plant, marketable yield per plant and 100 seed weight. These results indicated that high magnitude of genetic variability existed for the above traits, offering a good opportunity for improvement through selection. This is in consonance with the findings of Gnanesh (2005) Savitha (2008) and Upadyay and Mehta (2010).

Although, genotypic coefficient of variation helps to measure the genetic variability in a character, it is not possible to partition the heritable variation with this alone. Burton (1951) suggested that GCV together with heritability estimates would give the best result of the amount of genetic advance to be expected from selection. High estimates of broad sense heritability was observed for all the characters under study this might be possible due to low impact of environment on these traits. Similar results was reported by Rai *et al.* (2009) and Upadhayay and Mehta (2010). Days to last pod harvest had high heritability in spite of low GCV, which might be due to introduction of replication into the system (Burton and DeVane, 1953).

The heritable variation can be estimated with greater degree of accuracy when heritability is studied along with genetic advance. A high heritability coupled with genetic

Table 2 : Mean values of eighteen quantitative traits in forty four genotypes of French bean.

Accession number	Plant height (cm)	No. of primary branches per plant	Days to first flower-ing	Days to 50 percent flowering	Length of inflo-rescence (cm)	No. of inflorescence-nces per	No. of flowers per inflo-rescence	No. of pods per inflo-rescence	Days to first pod harvest	Days to last pod harvest	Pod length (cm)	Pod width (cm)	Pod weight (g)	No. of pods per plant	No. of seeds per pod	100 seed weight (g)	Protein content (%)	Marketable pod yield pod yield per plant (g)
SRS-13429	166.73	2.22	39.00	45.00	3.35	15.33	3.44	2.77	58.66	107.00	9.27	1.30	5.08	12.90	3.55	36.10	19.62	65.32
SRS-13430	150.66	2.77	37.00	42.00	5.36	30.10	3.77	2.44	49.33	109.33	9.39	0.98	5.08	28.20	4.77	23.90	29.47	141.97
SRS-13443	123.46	3.33	37.33	41.33	4.06	39.66	4.77	2.88	49.33	85.33	11.03	1.26	5.16	60.08	5.21	26.16	31.65	307.68
SRS-13444	173.26	2.99	37.33	42.00	15.49	36.66	5.21	3.44	53.00	91.66	10.37	1.04	4.20	40.54	5.77	18.73	26.68	168.35
SRS-13449	170.22	2.55	39.33	41.33	3.71	35.88	4.11	3.22	56.33	98.00	9.16	1.14	2.71	47.77	5.44	14.80	22.61	136.08
SRS-13451	161.66	2.77	41.33	42.66	10.17	56.99	5.99	3.55	56.66	106.66	8.39	0.75	2.36	104.03	6.22	11.16	19.51	317.59
SRS-13454	183.11	2.11	39.33	42.66	8.00	65.99	4.99	3.44	53.33	98.66	10.57	1.02	3.26	73.47	5.55	16.26	28.82	259.22
SRS-13456	124.52	3.18	40.33	42.00	5.19	49.00	4.99	3.77	52.33	81.66	13.97	1.25	6.94	52.43	4.33	22.63	25.83	358.98
SRS-13459	170.11	3.44	42.66	45.33	6.11	56.99	3.88	2.99	56.00	108.33	10.22	0.87	3.82	74.53	6.22	9.20	29.48	283.08
SRS-13460	139.10	3.44	41.33	44.66	6.23	40.33	6.77	3.22	56.66	109.00	11.75	1.13	6.25	31.69	5.44	18.50	34.47	194.36
SRS-13461	123.95	2.76	42.33	44.66	3.01	21.66	3.77	2.77	58.00	95.00	10.63	1.21	7.04	19.46	4.44	19.83	34.74	131.33
SRS-13462	150.42	2.22	38.00	43.66	5.51	26.00	3.99	2.99	54.33	93.00	9.01	0.95	3.05	35.95	3.88	26.13	33.39	109.93
SRS-13463	152.44	2.33	40.00	46.66	9.86	31.32	5.88	3.77	54.33	88.66	11.73	1.02	4.45	49.06	5.55	17.36	23.86	216.93
SRS-13470	127.10	3.33	38.00	42.00	3.76	23.88	5.44	2.88	52.33	87.66	12.38	1.12	4.54	27.84	4.33	20.86	26.49	124.14
SRS-13471	110.99	3.33	39.33	43.33	13.86	29.70	7.55	3.66	55.66	90.00	12.25	1.25	5.84	40.31	3.44	27.46	27.51	235.76
SRS-13480	164.88	2.66	37.33	42.33	4.11	28.64	4.66	2.11	49.00	100.33	14.22	1.10	5.90	29.86	5.44	38.80	23.58	176.38
SRS-13481	124.88	2.44	36.33	41.33	2.07	20.93	3.44	1.77	49.33	108.00	13.78	1.15	5.81	23.17	4.55	43.76	22.87	134.87
SRS-13482	175.26	2.84	51.33	53.33	4.08	31.66	4.33	2.55	64.33	91.33	12.41	0.93	5.27	38.79	4.66	7.10	19.82	216.33
SRS-13483	128.25	2.66	37.33	38.66	2.80	14.66	3.88	1.44	56.00	104.33	11.14	1.11	4.27	19.74	2.99	7.10	22.61	84.04
SRS-13491	128.54	4.33	48.33	49.33	6.67	34.33	5.22	1.66	62.33	95.33	11.60	1.33	7.97	28.98	4.77	20.69	23.62	226.30
SRS-13494	201.32	3.10	60.33	62.66	6.72	34.66	5.99	3.21	75.33	106.66	15.20	1.12	4.88	34.03	3.22	18.76	20.56	187.32
SRS-13496	147.49	4.22	39.00	41.33	6.40	44.00	4.99	2.11	50.33	90.66	12.56	1.21	4.62	47.7	4.10	22.16	32.86	218.35
SRS-13497	130.62	4.55	39.33	42.33	8.48	34.66	5.77	1.66	56.33	92.66	9.16	1.04	1.95	40.58	4.22	24.06	21.40	77.92
SRS-13498	116.75	3.22	56.33	58.00	2.48	16.33	3.44	2.11	76.33	107.33	8.71	1.31	2.75	23.88	3.10	22.66	18.84	65.13
SRS-13499	187.25	2.77	41.66	43.66	2.42	17.00	3.12	1.77	52.33	103.33	10.73	1.06	4.58	22.39	4.44	28.43	24.31	109.20
SRS-13500	126.99	4.66	34.33	36.33	3.54	17.66	4.33	1.55	49.33	93.66	11.93	0.81	4.58	35.46	4.55	25.60	32.73	161.83
SRS-13504	187.70	4.21	34.33	37.33	4.62	39.00	4.44	1.33	50.33	105.33	9.19	1.12	3.03	52.03	4.66	27.73	23.32	157.67
SRS-13505	152.32	3.99	35.33	36.66	11.93	33.66	5.33	2.33	50.00	91.00	11.03	1.05	5.89	30.22	4.32	15.16	22.24	196.10
SRS-13522	166.95	4.55	32.33	34.33	9.97	44.66	8.77	2.77	45.33	90.33	8.99	1.05	4.12	54.71	3.66	27.86	27.68	239.02
SRS-13525	183.18	3.33	34.33	35.33	6.50	26.00	9.10	1.77	51.00	104.66	9.06	0.95	2.34	32.59	3.99	22.73	25.43	69.17
SRS-13526	151.13	3.77	35.33	37.33	2.89	39.66	3.66	2.55	48.66	115.33	9.99	1.14	4.16	46.07	5.21	23.40	22.62	191.40
SRS-13527	145.59	3.55	44.33	52.33	1.92	24.22	3.10	1.66	69.33	103.33	8.12	1.19	3.67	21.21	3.44	19.36	29.65	84.62
SRS-13530	137.68	4.33	34.66	36.00	7.45	28.00	10.10	2.33	48.33	87.00	12.42	1.17	4.58	46.08	4.00	31.50	27.34	210.64
SRS-13536	123.05	3.55	32.00	34.33	10.56	26.33	3.44	2.11	45.33	80.66	7.76	1.25	3.59	34.84	2.99	41.33	20.49	127.87
SRS-13546	121.77	3.77	34.33	39.33	9.54	45.00	7.11	2.44	49.33	97.33	13.05	1.10	4.47	59.03	5.33	37.70	20.36	264.23

Table 2 continued....

Table 2 continued....

SRS-13547	171.88	4.33	39.33	43.33	3.84	46.88	3.88	1.88	53.33	103.33	13.44	0.90	3.95	38.88	4.55	20.80	23.65	152.61
SRS-13552	167.76	4.33	53.33	59.33	5.53	33.66	6.44	2.88	65.33	101.66	11.04	0.83	4.90	46.84	5.77	24.30	15.68	284.29
AUV-315	120.66	2.88	38.33	42.33	7.93	26.33	7.88	2.66	50.66	91.33	13.47	1.15	5.89	61.40	4.88	23.83	17.58	361.96
AUV-317	129.21	3.99	38.33	48.33	10.89	38.66	7.88	2.55	55.33	96.00	10.89	0.90	3.56	53.97	6.21	14.50	25.12	190.74
PMA01-237	167.63	4.77	41.33	48.33	5.54	22.66	5.66	2.55	56.33	83.33	9.70	0.80	2.89	31.22	5.44	16.23	23.64	90.17
RSMP-842	140.50	4.33	41.33	44.33	5.89	50.00	5.11	2.44	53.00	92.33	10.09	0.87	2.88	82.55	6.66	13.00	31.37	237.24
Kentucky Wonder	183.47	2.66	50.33	52.33	11.77	38.00	5.99	3.44	57.33	84.00	15.62	0.77	7.06	40.22	7.99	19.06	23.18	286.98
PLB10-01	121.74	3.66	37.33	38.33	5.43	35.21	5.66	1.88	54.33	95.00	12.17	1.18	5.92	55.77	4.55	47.40	17.60	294.87
Ayoka	159.78	3.66	42.00	44.33	11.64	38.88	6.77	3.55	52.33	85.66	12.92	0.56	4.03	58.18	6.88	16.16	27.15	226.14
Range	110.99-201.32	2.11-4.77	32.00-60.33	34.33-62.66	1.92-15.49	14.66 65.99	3.10-10.10	1.33-3.77	45.33-76.33	80.66-115.33	7.76-15.62	0.51-1.33	1.95-7.97	12.90-104.03	2.99-7.97	7.10-47.40	15.68-34.74	65.13-361.96
Mean	149.82	3.40	40.29	43.68	6.53	33.88	5.32	2.56	54.88	96.57	11.15	1.06	4.53	42.92	4.79	22.96	25.03	190.32
C.V.	4.38	12.54	3.11	4.05	13.56	7.80	14.37	12.30	3.89	2.55	6.28	5.97	5.25	9.10	10.95	5.09	4.44	9.60
S.E. ±	3.79	0.24	0.72	1.02	0.51	1.52	0.44	0.18	1.23	1.42	0.40	0.03	0.13	2.25	0.30	0.67	0.64	10.55
C.D. 5%	10.65	0.69	2.03	2.87	1.43	4.29	1.24	0.51	3.47	4.00	1.13	0.10	0.38	6.34	0.85	1.90	1.82	29.68
C.D. 1%	14.12	0.92	2.69	3.81	1.90	5.68	1.64	0.67	4.60	5.30	1.50	0.13	0.51	8.40	1.12	2.51	2.42	39.33s

Table 3: Estimates of variability, heritability and genetic advance as per cent of mean for eighteen traits in forty four genotypes of French bean

Character	Range		Variance		PCV	GCV	h^2	Genetic	GA as %
	Minimum	Maximun	Phenotypic	Genotypic	(%)	(%)	(%)	advance	of mean
Plant height (cm)	110.99	201.32	599.51	556.41	16.34	15.74	92.81	46.81	31.24
No. of primary branches per plant	2.11	4.77	0.68	0.50	24.34	20.85	73.42	1.25	36.81
Days to first flowering	32.00	60.33	38.33	36.75	15.36	15.04	95.89	12.23	30.35
Days to 50 per cent flowering	34.33	62.66	42.60	39.47	14.94	14.38	92.64	12.45	28.51
Length of inflorescence (cm)	1.92	15.49	11.95	11.17	52.94	51.17	93.44	6.65	101.89
No. of inflorescence per plant	14.66	65.99	141.00	134.00	35.04	34.16	95.04	23.24	68.60
No. of flowers per inflorescence	3.10	10.10	3.24	2.66	33.85	30.64	81.96	3.04	57.15
No. of pods per inflorescence	1.33	3.77	0.54	0.44	28.71	25.94	81.64	1.24	48.30
Days to first pod harvest	45.33	76.33	48.96	44.39	12.74	12.13	90.65	13.06	23.80
Days to last pod harvest	80.66	115.33	81.36	75.28	9.33	8.98	92.53	17.19	17.80
Pod length (cm)	7.76	15.62	4.08	3.59	18.12	17.00	87.98	3.66	32.85
Pod width (cm)	0.56	1.33	0.03	0.02	16.91	15.82	87.53	0.32	30.50
Pod weight (g)	1.95	7.97	1.99	1.93	31.15	30.71	97.16	2.82	62.36
No.of pods per plant	12.90	104.03	344.28	329.00	43.22	42.25	95.56	36.52	85.09
No.of seeds per pod	2.99	7.99	1.39	1.11	24.62	22.05	80.22	1.95	40.69
100 seed weight (g)	7.1	47.4	85.01	83.64	40.15	39.82	98.39	18.68	81.37
Protein content (%)	15.68	34.74	24.25	22.99	19.67	19.15	94.78	9.61	38.41
Marketable pod yield per plant (g)	65.13	361.96	6639.19	6304.72	42.81	41.71	94.96	159.39	83.74

advance gives most effective criteria for selection (Johnson *et al*., 1955). Heritability along with genetic advance would be helpful in assessing the nature of gene action. In the present study, high heritability estimates coupled with high expected genetic advance as percentage were observed for all the traits indicating the additive gene effects. Further, these traits could be considered as reliable selection indices. This is in conformation with the findings of Rai *et al*. (2009) and Upadhayay and Mehta (2010). High heritability coupled with moderate GA as per cent mean values were observed for the character days to last pod harvest. This indicates the influence of non additive gene action and considerable influence of environment on the expression of this trait.

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