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Effects of Sowing Dates, P Levels and Rhizobium Treatment on Seed Yield in French Bean cv. Contender in Hills

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ABSTRACT This investigation was conducted in French bean cv. 'Contender' sown at dates viz., 15 June, 15 July, 15 August and 15 September applied with four phosphorus levels viz., no P application, 30 kg P/ha, 60 kg P/ha and 90 kg P/ha and seed with and without treatment with *Rhizobium phaseoli* culture. The treatment with 15 August sowing, 90 kg P_2O_5/ha and seed treatment with Rhizobium culture was found most effective for highest values of nodulation, plant height, number of pods per-plant, grains per pod and seed yield per hectare.

Key words: French bean, Rhizobium culture, date of sowing, phosphorus

French bean (*Phaseolus vulgaris* L.) locally known as Pharas Bean belongs to the family Leguminosae. It is one of the important members of the bean group and used variously either as cooked vegetables of tender pods or as pulse of dried seeds known as 'rajmah'. It is considered to be a native of South and Central America. The importance of French bean is increasing day by day as the people of India are now more nutrition conscious. It can successfully be grown both in warm and cold climates. The hills of Uttarakhand, Himachal Pradesh, Jammu and Kashmir and North East permit its successful cultivation during summer and rainy seasons. A slight variation in the temperature may cause complete crop failure or low yield and productivity. It is, therefore, essential to adjust the sowing time in such a way that the soil and atmosphere may provide optimum temperature required for its growth and development.

Like other legumes, French bean also responses well to phosphorus application in terms of root nodule formation and in turn growth and yield of the crop [1]. The symbiotic association of rhizobium-legumes for nitrogen fixation is well known to biologists [2]. Looking the low seed yield and scope of improvement in yield by optimization of cultural operations, this experiment was designed and conducted.

MATERIALS AND METHODS

The experiment was conducted in French bean cv. *Contender* at the Horticultural Research Centre of H N B Garhwal University, Srinagar (Garhwal) situated in the Alaknanda valley (78° 47' 30" E longitude and 30° 13' 0" N latitude and at an elevation of 540 m above msl), a semi-arid, sub-tropical climate with dry summer and rigorous winters with occasional dense fog in the morning hours from mid December to mid February. The experiment were laid out in Split-Split Plot Design with three replications during *kharif* seasons of 2001-02, 2002-03 and 2003-2004. Treatment consisted of four sowing dates viz, D_1 (15 June), D_2 (15 July), D_3 (15 August) and D_4 (15 September), four phosphorus levels viz., P_0

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(no P application), P_1 (30 kg P/ha), P_2 (60 kg P/ha), P_3 (90 kg P/ha) and seed with and without treatment with culture i.e. C_0 (no seed treatment with Rhizobium culture) and C_1 (seed treatment with *Rhizobium phaseoli* culture) in all possible 32 combinations. The data recorded on days taken to flowering, number of nodules per plant, fresh weight of nodules per plant (g), dry weight of nodules per plant (g), plant height (cm), number of primary branches per plant, number of pods per plant, pod length (cm), number of grains per pod and seed yield per hectare (q) of three trials were pooled to get a mean value analyzed as per Cochran and Cox [3] for analysis of variance.

RESULTS AND DISCUSSION

The environmental factors have significantly influenced all the studied parameters under present investigation (Table 1).

Nodule formation was influenced by the date of sowing, D_3 (15 August) sowing exhibited the maximum nodule formation. The performance of French bean with respect to nodulation was influenced by the temperature, rainfall, humidity etc. prevailing during crop period. In earlier dates of sowing, the maximum and minimum temperatures were higher and relative humidity was lower. Knott [4] reported that the monthly temperature required for French bean is approximately around 26.6°C. This temperature closely coincides with the temperature prevailing in the month of August (D_3 sowing time) under this valley condition. Maximum plant height was recorded under D_3 (15 August) sowing treatment, followed by D_2 (15 July) sowing. With respect to the primary branches per plant, D_3 (15 August sowing) treatment ranked first and D_2 (15 July sowing) occupied second place. The maximum growth of French bean was recorded -under 15 August sowing. Above findings agree with the findings of Hoffman [5] with respect to growth in French bean crop. Sowing on 15 August (D_3) proved to be superior to all other sowing treatments by achieving the highest values of pod number, pod length and seed yield. On the other hand, D_1 (15 June) sowing showed the lowest values for these yield contributing characters.

Phosphorus stimulates the activities of native microbes which enhance the nodule formation, root development and over all growth of French bean crops. Under the present study, phosphorus levels significantly increased the number of nodules per plant over control. Among all the phosphorus treatments, P_3 (90 kg P_2O_5/ha) produced the maximum number of nodules per plant as confirmed by Das *et al.* [6] in green gram and Kulkarni *et al.* [7] in chickpea. Different levels of phosphorus significantly increased the fresh and dry weight of nodules per plant over control. The fresh and dry weight of nodules have been found maximum under the influence of P_3 (90 kg P_2O_5/ha) treatment. It may be due to enhancing the activity of phosphorus on nitrogen fixing bacteria. Similar results were also reported by Das *et al.* [6] and Rana and Singh [8]. Plant height in French bean was significantly increased by different phosphorus levels over control. Among different phosphorus levels, P_3 (90 kg P_2O_5/ha) showed the maximum height and number of pods per plant as was confirmed by earlier works done by Rana and Singh [8] and Chandra *et al.* [9]. An increasing trend in number of grains per pod was observed in French bean with increasing levels of phosphorus, and the maximum being under P_3 (90 kg P_2O_5/ha) level. Similar trends have also been reported by Srinivas and Rao [10]. There was a significant increase in number, length of pods and seed yield due to increase in P level highest being with 90 kg/ha. The beneficial response of phosphorus towards yield was due to the increase in number and length of pods with every increase in phosphorus levels. Earlier studies also strengthened the present results of Rana and Singh [8], Roy and Parthasarathy [11]. Furthermore, P doses significantly increased 100 seed weight, the maximum found with P_3 (90 kg P_2O_5/ha). These results are in agreement with the findings of Tewari and Singh [12].

Rhizobium culture significantly increased fresh and dry weight of nodules per plant, grains per pod, number of pods per plant and seed yield probably because of higher nitrogen fixation in the plants and improvement in source and sink relation as well as nitrogen content of rhizosphere [9].

Table 1. Effect of sowing date, P levels and *Rhizobium* treatment on plant growth and seed yield of French bean in Hills of Uttarakhand

Treatments	Days to flowe-ring	No. of nodules per plant	Fresh weight of nodules/ plant(g)	Dry weight of nodules/ plant(g)	Plant height (cm)	No. of primary branches per plant	No. of pods/ plant	Pod length (cm)	100 seed weight (g)	No. of grains per pod	Seed yield per hectare (q)
$D_1P_0C_0$	51.88	0.59	1.88	0.79	22.92	1.52	8.01	10.42	25.62	3.50	1.53
$D_1P_0C_1$	50.95	1.84	2.65	1.23	23.67	2.08	8.02	10.67	26.86	3.51	2.01
$D_1P_1C_0$	49.93	1.83	3.67	1.90	25.04	2.77	8.64	10.74	28.85	3.85	2.83
$D_1P_1C_1$	49.32	2.72	4.12	2.63	25.85	2.92	9.33	11.17	30.38	4.03	3.59
$D_1P_2C_0$	48.83	2.49	5.83	3.39	25.98	3.32	10.14	11.58	30.30	4.47	4.40
$D_1P_2C_1$	48.12	3.90	7.15	3.79	27.22	3.72	10.83	12.52	31.70	4.95	5.62
$D_1P_3C_0$	47.20	4.74	9.87	4.32	27.92	3.99	11.63	13.62	32.42	5.45	7.32
$D_1P_3C_1$	46.55	5.59	14.42	5.46	28.74	4.53	12.57	14.55	33.89	5.62	10.06
$D_2P_0C_0$	49.77	0.79	2.02	0.84	23.32	1.62	8.67	10.54	27.53	3.55	1.74
$D_2P_0C_1$	48.90	2.05	2.65	1.27	24.73	2.11	8.88	10.66	27.58	3.60	2.16
$D_2P_1C_0$	47.58	2.57	4.39	1.93	26.91	2.87	10.00	11.01	29.24	4.05	2.87
$D_2P_1C_1$	46.99	4.32	6.41	2.67	29.12	3.35	10.64	11.51	30.76	4.45	3.58
$D_2P_2C_0$	46.35	4.61	7.48	3.40	29.14	3.63	11.25	11.86	32.16	4.76	4.74
$D_2P_2C_1$	45.71	6.27	9.28	4.10	30.65	3.94	11.68	12.81	32.89	4.98	5.88
$D_2P_3C_0$	44.65	6.86	10.97	5.45	31.09	4.67	13.49	14.28	36.84	5.55	8.48
$D_2P_3C_1$	44.14	8.33	16.23	7.31	32.63	5.02	15.75	15.60	39.78	6.01	12.44
$D_3P_0C_0$	48.08	1.38	2.28	0.93	24.52	1.85	8.82	10.59	27.29	3.55	1.84
$D_3P_0C_1$	46.38	3.53	3.24	1.67	26.68	2.19	9.04	10.89	29.15	3.54	2.58
$D_3P_1C_0$	43.80	4.55	5.27	2.41	28.17	2.84	9.73	11.39	30.77	4.11	3.78

Table 1 contd ....

Table 1. (*Contd* .....)

Treatments	Days to flowe-ring	No. of nodules per plant	Fresh weight of nodules/ plant(g)	Dry weight of nodules/ plant(g)	Plant height (cm)	No. of primary branches per plant	No. of pods/ plant	Pod length (cm)	100 seed weight (g)	No. of grains per pod	Seed yield per hectare (q)
$D_3P_1C_1$	42.78	6.41	7.30	3.05	29.75	3.35	10.41	12.32	32.61	4.25	4.80
$D_3P_2C_0$	41.91	6.91	9.25	3.92	30.81	4.04	11.35	12.98	34.56	4.74	6.38
$D_3P_2C_1$	41.37	9.21	11.73	5.28	33.27	4.39	13.15	13.79	40.57	4.95	8.32
$D_3P_3C_0$	41.36	9.94	14.36	6.77	33.73	4.95	15.14	15.26	39.99	5.87	10.69
$D_3P_3C_1$	39.69	10.45	21.11	9.27	34.98	5.72	17.69	16.81	44.74	6.65	16.41
$D_4P_0C_0$	51.80	0.95	1.95	0.85	24.63	1.77	8.14	10.69	25.57	3.53	1.63
$D_4P_0C_1$	51.19	2.61	3.11	1.42	24.25	1.88	8.08	11.44	26.58	3.54	2.07
$D_4P_1C_0$	49.96	3.33	4.47	1.93	26.17	2.62	9.08	11.06	28.92	4.05	2.90
$D_4P_1C_1$	49.19	4.86	5.55	2.61	27.16	3.10	9.78	11.51	29.69	4.36	3.77
$D_4P_2C_0$	48.30	4.94	7.23	3.47	27.64	3.65	10.57	12.08	30.88	5.36	5.23
$D_4P_2C_1$	47.67	6.57	9.01	4.02	29.68	3.97	11.45	12.89	31.02	5.15	6.73
$D_4P_3C_0$	46.23	6.51	11.18	4.54	29.38	4.36	12.57	13.61	32.89	5.37	8.04
$D_4P_3C_1$	45.05	7.97	13.70	5.59	30.55	4.81	14.10	14.47	35.03	5.75	10.66
SE (m±)	0.28	0.17	0.18	0.09	0.43	0.16	0.09	0.19	0.45	0.14	0.1
CD (5%)	0.82	0.49	0.51	0.26	1.24	0.46	0.25	0.55	1.31	0.39	0.29

Table 2. Monthly average of meteorological data during the period of investigation

Month	Temperature (°C)		Relative humidity (%)
	Max.	Min.	
June	35	25	60
July	33	23	80
August	28	22	80
September	29	21	69
October	28	19	58
November	27	16	57
December	22	09	65

The treatments combinations D_3 P_3 C_1 (15 August sowing, 90 kg P_2O_5/ha and with rhizobium culture) was found most effective to obtain the highest values for all the growth and yield contributing characters such as nodulation, plant height, number of pods, grains per pod and seed yield similar to Pynenborg *et al.* [13].

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