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Short communication

Effect of sowing dates, phosphorus levels and seed treatment with *Rhizobium* culture on growth and yield of French bean cv. Contender under Garhwal Himalaya conditions

D.K. Rana*, S.S. Rawat, and S.P. Uniyal**
Department of Horticulture, HNB Garhwal University, Srinagar 246 174

French bean (*Phaseolus vulgaris* L.) locally known as *Pharas Bean* belongs to the family Fabaceae. It is one of the important members of the bean group and forms an important part in dietary of especially hill peasantry. It is considered to be a native of South and Central America. The crop is cultivated round the year in the country. It is highly sensitive to temperature variations. Slight variation in the temperature may cause complete crop failure or with 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. One of the major problems of acid soils of Uttarakhand hills is low availability of both native as well as applied phosphates. Like other legumes, French bean response well to phosphorus application through increased nitrogen fixation (Dwivedi and Dwivedi, 3). Phosphorous application has increased the yield of the crop linearly up to 60 kg P_2O_5 /ha. Therefore, availability of adequate phosphorus is very important for proper growth and development of roots and nodules and in turn yield of the crop. Seed treatment with suitable bacterial culture is a common practice in other legumes, viz., pea, soybean, moong. As the result of *Rhizobium* inoculation there is an increase in yield of the crop varied from 16-65, 6-64, 20-63 and 14-71 percent over uninoculated controls in the case of pigeon pea, chick pea, lentil and cowpea, respectively (Rao and Tilak, 5). Therefore, inoculation of seeds with *Rhizobium phaseoli* culture is also necessary for good nodulation. Hence a study was undertaken.

The experiment was conducted on French bean cv. *Contender* at the Horticultural Research Centre of H N B Garhwal University, Srinagar (Garhwal) situated in the Alaknanda valley (78^0 47' 30" E longitude and 30^0 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 trials of this 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 (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* 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), pod yield per plant (g) and pod yield per hectare (q) of three trials were pooled to get a mean value analyzed as per Cochran and Cox (2) for analysis of variance.

As the dates of sowing advanced from 15 June to 15 September, the soil and atmospheric temperatures showed the decreasing trends. Almost all the parameters studied showed a significance influence of different treatments (Table 1). Nodule formation was influenced by the date of sowing and in turn temperature, rainfall, humidity etc. prevailing during crop period. D_3 (15 August) sowing exhibited the maximum nodule formation, plant height. This result might be narrated as per Siddique and Goodwin (7) who reported pod set and retention were optimal at 24/19 and $27/22^0$C (day/night) which closely coincides with the temperature prevailing in the month of August in valley condition of Uttarakhand hills. Furthermore, sowing on 15 August proved to be superior for pod number, pod yield and pod length whereas, D_1 (15 June) sowing recorded 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. Phosphorus level at 90 kg P_2O_5/ha significantly

*Corresponding author's E-mail: drdkrana@gmail.com
**Deptt. Of Vegetable Science, GBPUA&T, Hill Campus, Ranichauri 249 199

Table 1. Effect of date sowing, P levels and *Rhizobium* treatment on plant growth and pod yield of french bean in hills of Uttarakhand.

Treatment	Days to flowering	No. of nodules per plant	Fresh wt. of nodules /plant (g)	Dry wt. of nodules /plant (g)	Plant height (cm)	No. of primary branches /plant	No. of pods / plant	Pod length (cm)	Pod yield /plant (g)	Pod yield per ha (q)
$D_1P_0C_0$	51.88	0.59	1.88	0.79	22.92	1.52	8.01	10.42	130.09	92.23
$D_1P_0C_1$	50.95	1.84	2.65	1.23	23.67	2.08	8.02	10.67	131.48	96.46
$D_1P_1C_0$	49.93	1.83	3.67	1.90	25.04	2.77	8.64	10.74	137.15	103.69
$D_1P_1C_1$	49.32	2.72	4.12	2.63	25.85	2.92	9.33	11.17	141.52	112.44
$D_1P_2C_0$	48.83	2.49	5.83	3.39	25.98	3.32	10.14	11.58	144.89	116.41
$D_1P_2C_1$	48.12	3.90	7.15	3.79	27.22	3.72	10.83	12.52	148.50	120.71
$D_1P_3C_0$	47.20	4.74	9.87	4.32	27.92	3.99	11.63	13.62	152.67	124.27
$D_1P_3C_1$	46.55	5.59	14.42	5.46	28.74	4.53	12.57	14.55	160.56	131.40
$D_2P_0C_0$	49.77	0.79	2.02	0.84	23.32	1.62	8.67	10.54	132.72	95.21
$D_2P_0C_1$	48.90	2.05	2.65	1.27	24.73	2.11	8.88	10.66	133.76	98.51
$D_2P_1C_0$	47.58	2.57	4.39	1.93	26.91	2.87	10.00	11.01	136.56	108.49
$D_2P_1C_1$	46.99	4.32	6.41	2.67	29.12	3.35	10.64	11.51	141.41	118.07
$D_2P_2C_0$	46.35	4.61	7.48	3.40	29.14	3.63	11.25	11.86	146.37	123.29
$D_2P_2C_1$	45.71	6.27	9.28	4.10	30.65	3.94	11.68	12.81	150.54	129.99
$D_2P_3C_0$	44.65	6.86	10.97	5.45	31.09	4.67	13.49	14.28	156.79	136.84
$D_2P_3C_1$	44.14	8.33	16.23	7.31	32.63	5.02	15.75	15.60	169.57	145.96
$D_3P_0C_0$	48.08	1.38	2.28	0.93	24.52	1.85	8.82	10.59	132.63	94.83
$D_3P_0C_1$	46.38	3.53	3.24	1.67	26.68	2.19	9.04	10.89	134.33	99.55
$D_3P_1C_0$	43.80	4.55	5.27	2.41	28.17	2.84	9.73	11.39	140.63	106.00
$D_3P_1C_1$	42.78	6.41	7.30	3.05	29.75	3.35	10.41	12.32	144.96	117.18
$D_3P_2C_0$	41.91	6.91	9.25	3.92	30.81	4.04	11.35	12.98	149.01	129.88
$D_3P_2C_1$	41.37	9.21	11.73	5.28	33.27	4.39	13.15	13.79	154.44	136.46
$D_3P_3C_0$	41.36	9.94	14.36	6.77	33.73	4.95	15.14	15.26	164.12	144.33
$D_3P_3C_1$	39.69	10.45	21.11	9.27	34.98	5.72	17.69	16.81	188.19	168.96
$D_4P_0C_0$	51.80	0.95	1.95	0.85	24.63	1.77	8.14	10.69	129.42	92.16
$D_4P_0C_1$	51.19	2.61	3.11	1.42	24.25	1.88	8.08	11.44	131.07	97.70
$D_4P_1C_0$	49.96	3.33	4.47	1.93	26.17	2.62	9.08	11.06	135.46	103.69
$D_4P_1C_1$	49.19	4.86	5.55	2.61	27.16	3.10	9.78	11.51	138.55	109.58
$D_4P_2C_0$	48.30	4.94	7.23	3.47	27.64	3.65	10.57	12.08	143.89	114.51
$D_4P_2C_1$	47.67	6.57	9.01	4.02	29.68	3.97	11.45	12.89	148.77	117.49
$D_4P_3C_0$	46.23	6.51	11.18	4.54	29.38	4.36	12.57	13.61	152.95	123.75
$D_4P_3C_1$	45.05	7.97	13.70	5.59	30.55	4.81	14.10	14.47	160.66	130.13
CD (5%)	0.82	0.49	0.51	0.26	1.24	0.46	0.25	0.55	1.52	3.12

increased the plant growth parameters like number of nodules per plant, fresh and dry weight of nodules per plant, plant height and number of branches per plant. Similar results were also reported by Chandra *et al.* (1), and Rana and Singh (4) in various legumes. The treatment P_3 (90 kg P_2O_5/ha) was also promising for number of pods per plant, length of pods and pod yield per plant and per hectare. Earlier workers like Chandra *et al.* (1), Rana and Singh (4), and Roy and Parthasarathy (6) also found higher values of yield and yield contributing characters with at higher phosphorus levels in French bean.

Rhizobium culture had significant effect on number of nodules and plant fresh and dry weight. Earlier, Chandra *et al*. (1), and Wange *et al*. (8) also found increasing effects of culture treatment on nodule formation in French bean. Rhizobium treatment (C_1) increased the number of pods per plant, pod yield significantly over control (C_0). The findings of Chandra *et al.* (1) in French bean also confirm the present results obtained as an influence of rhizobium culture. It is evident from the results of the present study that among the various treatment combinations, D_3 P_3 C_1(15 August sowing, 90 kg P_2O_5/ha and Rhizobium treatment) was found most effective to obtain the highest values for all the growth and yield contributing characters such as nodulation, plant height, number of pod per plant and pod yield. These interaction results have largely been

supported by earlier findings of Wange *et al.* (8) in French bean.

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