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Response of french bean (*Phaseolus vulgaris*) varieties to plant density and nitrogen application

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ABSTRACT

A field experiment was conducted during the winter seasons of 1996–97 and 1997–98 at Baraut, Uttar Pradesh, to study the response of french bean (*Phaseolus vulgaris* L.) to plant density and N on sandy-loam soil analysing low in available N and medium in available P and K with pH 7.5. Varieties showed differential performance for growth and yield attributes. 'HUR 87' was the tallest with more seeds/pod, whereas 'VL 63' recorded the maximum branches/plant. Variety 'PDR 14' produced the maximum number of pods/plant and bolder seeds which finally led to higher seed and stover yields, and harvest index. Lowest plant density of 250 x 10^3 plants/ha recorded markedly higher values of growth and yield attributes, except plant height which was the maximum with the highest plant density of 500 x 10^3 plants/ha. Medium plant density (333x10^3 plants/ha) resulted in markedly higher yield than lower and higher plant densities. Higher plant density resulted in the highest stover yield. Lower and medium plant densities recorded higher harvest index over higher plant density. The growth and yield attributes and yields (grain and stover) increased with increasing rates of N up to 120 kg/ha. This level of N also recorded higher harvest index over no nitrogen.

Key words : French bean, Plant density, Nitrogen, Yield component, Yield, Economics

French bean (*Phaseolus vulgaris*) a non-traditional grain legume, has shown tremendous production potential during winter (*rabi*) season under north Indian condition (Ali and Kushwaha, 1987). During the last decade, suitable varieties for winter season (*rabi*) have been developed for the northern plains. These varieties show differential performance with the location and agronomic managememnt (Ali and Lal, 1991). Plant density plays an important role in maximizing the yield of crops. There is a meagre information on optimum plant population of these newly evolved french bean varieties. French bean possesses high yield potential, but unlike

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other leguminous crops it does not nodulate with the native rhizobia. Therefore the crop has to depend solely on soil N and applied source of N. Keeping above in view, the present study was undertaken to identify the best variety and its optimum plant density and N dose for realizing the maximum yield potential in North-west plain zone.

MATERIALS AND METHODS

A field experiment was conducted at Baraut during the winter season (*rabi)* of 1996–97 and 1997–98. The soil was sandy loam with pH 7.5, and contained 0.33% organic carbon, 231 kg/ha available N, 12.5 kg/ha available P and 259 kg/ha available K. The treatments comprising 3 varieties ('HUR 87', 'PDR 14' and 'VL 63') and 3 plant densities (500×10^3, 333×10^3 and 250×10^3 plants/ha) as main plots and 3 N levels (0, 60 and 120 kg/ha) as subplot were replicated thrice in split-plot design. Plant densities of 500×10^3, 333×10^3 and 250×10^3 plants/ha were maintained by adopting the spacing pattern of 20 cm × 10 cm, 30 cm × 10 cm and 40 cm × 10 cm respectively. The crop was sown in the last week of October during both the years. In addition to pre-soaking irrigation, 3 additional irrigations in each year were given to the crop. The nitrogen dose as per treatment was applied at sowing.

RESULTS AND DISCUSSION

Varietal performance

'HUR 87' produced taller plants than 'PDR 14' and 'VL 63' which indicated

Table 1. Yield and harvest index of french bean as influenced by variety, plant density and nitrogen fertilizer

Treatment	Seed yield (q/ha)		Stover yield (q/ha)		Harvest index (%)	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Variety						
'HUR 87'	6.48	4.71	11.83	11.33	35.54	29.64
'PDR 14'	11.14	9.60	15.65	15.62	41.28	38.65
'VL 63'	6.69	4.99	12.64	12.25	34.88	29.16
CD (P=0.05)	0.46	0.40	0.84	0.78	2.88	2.01
Plant density (× 10^3 plants/ha)						
500	7.60	6.00	16.03	15.51	31.69	26.92
333	8.63	6.90	12.81	12.47	39.04	34.61
250	8.07	6.40	11.29	11.23	40.97	35.92
CD (P=0.05)	0.46	0.40	0.84	0.78	2.28	2.01
Nitrogen (kg/ha)						
0	6.52	4.98	11.14	10.63	36.01	31.60
60	8.30	6.55	13.90	13.60	37.15	31.99
120	9.49	7.78	15.08	14.98	38.54	33.86
CD (P = 0.05)	0.48	0.39	0.79	0.76	2.16	2.08

Y_1, 1996–97; Y_2, 1997–98

Table 1. Growth and yield attributes of french bean as influenced by variety, plant density and nitrogen fertilizer

Treatment	Plant height (cm)		Branches/ plant		Dry matter (g/plant)		Pods/ plant		Seeds/ pod		100-seed weight (g)	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Variety												
'HUR 87'	27.24	26.45	5.40	6.14	10.57	9.64	4.40	3.77	3.71	3.70	25.98	24.50
'PDR 14'	25.85	24.82	6.48	6.62	11.86	11.72	5.14	4.62	3.62	3.33	33.64	31.69
'VL 63'	22.22	21.70	7.81	7.74	11.29	10.65	4.81	4.33	3.48	2.85	27.68	26.29
CD (P=0.05)	1.11	1.24	0.39	0.54	0.69	0.62	0.26	0.25	0.22	0.21	1.60	1.62
Plant density (plants/ha)												
500,000	26.81	26.11	5.77	6.37	9.33	9.09	3.44	3.00	3.25	3.00	27.78	26.58
333,000	24.62	24.63	6.66	6.85	11.21	10.55	5.11	4.51	3.68	3.29	28.61	27.29
250,000	23.88	22.23	7.25	7.29	13.18	12.36	5.81	5.22	3.88	3.59	30.91	28.61
CD (P = 0.05)	1.11	1.24	0.39	0.54	0.69	0.62	0.26	0.25	0.22	0.21	1.60	1.62
Nitrogen (kg/ha)												
0	22.69	21.69	5.29	5.74	8.45	7.83	2.88	2.74	3.07	2.70	24.86	22.77
60	25.48	24.83	6.88	7.00	11.88	11.28	5.44	4.62	3.74	3.40	30.22	28.68
120	27.13	26.45	7.51	7.77	13.38	12.90	6.03	5.37	4.00	3.77	23.23	31.03
CD (P = 0.05)	1.35	1.25	0.25	0.29	0.58	0.56	0.25	0.26	0.21	0.20	1.56	1.59

Y_1, 1996–97; Y_2, 1997–98

their expression of genetic character under iso-nutritional and moisture conditions. 'VL 63' produced more branches/plant and 'PDR 14' had higher dry matter/plant which was reflected in higher stover yield (Tables 1 and 2). 'HUR 87' recorded more seeds than 'VL 63' and 'PDR 14'. 'PDR 14' produced more number of pods/plant and bolder seeds/pod than the other 2 varieties. The higher values of these yield attributes consequently resulted in higher seed yield/ha. These results are in conformity with those of Ali (1989). The greater apportioning of photosynthates in seed of 'PDR 14' resulted in higher harvest index.

Plant density

The greater intra-specific competition for the resource utilization at higher plant density (500×10^3 plants/ha) reduced the number of branches and dry-matter accumulation/plant (Table 1). Plant height, however, increased with the increase in plant density because of competition of light (Das *et al.*,1996). Yield components, viz. pods/plant, seeds/pod, and 100-seed weight, recorded the highest values at lower plant density (250×10^3 plants/ha). However, this improvement in the yield attributes was not reflected in seed yield/ha, since lower (250×10^3 plants/ha) and medium (333×10^3 plants/ha) plant densities outyielded the higher plant density (500×10^3 plants/ha) (Table 2). This could be possible due to greater competition for growth resources at higher plant density, and inefficient utilization of growth resources at the lower plant density of 250×10^3 plants/ha. In the present experiment, the plant density of 333×10^3 plants/ha appeared optimum.

Nitrogen

Growth attributes, viz. plant height, branches/plant and dry matter/plant, increased with an increase in dose of N up to 120 kg/ha (Table 1). The higher values of these growth attributes with 120 kg N/ha resulted in better growth and development of plants, consequently leading to more pods/plant, seeds/pod and 100-seed weight. Since yield is dependent on yield attributes, the improvement in these with N application resulted in higher seed yield Singh *et al.* (1996). The improvement in growth attributes with 120 kg N/ha indicating more efficient translocation of metabolites into seed, suggested that improvement in seed yield could be achieved entirely by increasing the harvest index without any increase in stover or biological yield.

Economics

Response of french bean to applied nitrogen up to 120 kg/ha was linear in nature, indicating still higher N need by the crop. Variety 'PDR 14' fetched the highest net return of Rs 6,886/ha because of higher productivity than 'VL 63' and 'HUR 87'. The net returns were also the highest with 333×10^3 plants/ha (30 cm × 10 cm) and 120 kg N/ha. This shows that french bean is more responsive towards in inputs use. The relationship of seed yield and the applied N was studied with the help of regression analysis, and the following regression equations were derived.

1996–97

$Y = 6.62 + 0.026X$

1997–98
Y=5.05+0.023X
Pooled
Y=5.82 + 0.024X

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