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Effect of nitrogen and micronutrients on growth, yield and nutrient uptake by Frenchbean

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ABSTRACT

Effect of nitrogen and micronutrient levels on Frenchbean cv HUR 137 was studied in a field experiment during winter seasons of 1999-2000 and 2000-01 at Agricultural Research Farm, Banaras Hindu University, Varanasi. Plant height, dry weight, nodule number and dry weight, pod length, pod number and weight, seeds per pod, 100 - seed weight, grain and straw yields, nutrient uptake and protein harvest increased significantly up to the highest level of 180 kg N ha^{-1} application recording a grain yield of 2651 kg ha^{-1}. Application of 6 kg Zn ha^{-1} followed by 1 kg Mo ha^{-1} recorded maximum values for the above stated attributes culminating to the maximum grain yield of 2515 kg ha^{-1}. Nitrogen level of 180 kg ha^{-1} gave the highest net return (Rs. 43,744 ha^{-1}) and a benefit: cost ratio of 2.37. As regards micronutrients, application of 6 kg Zn ha^{-1} over and above normal N, P, K, S showed the maximum net return of Rs. 42, 309 ha^{-1} with a benefit: cost ratio of 2.54.

Key Words: French bean, Growth, Micronutrients, Nitrogen, Nutrient uptake, *Phaseolus vulgaris*

The recent introduction of French bean (*Phaseolus vulgaris* L.) as winter pulse crop in the plains of India is attributed to the development of photo-insensitive varieties. This is being viewed as a cash crop against the high input cereal crops, under good management conditions. Unlike other leguminous crops, it does not nodulate effectively with native rhizobia in the plains and, hence, it requires more nitrogen fertilizer. The response of French bean to macronutrients has been investigated in the past but scanty attention has been given to micronutrients use which could contribute substantially to achieve higher productivity. Therefore, the present investigation was carried out to study the response of French bean to nitrogen in relation to micronutrients under Varanasi conditions.

MATERIALS AND METHODS

The field experiment was conducted during winter (*rabi*) seasons of 1999-2000 and 2000-01 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The soil of experimental field was Gangetic alluvial (Ustochrept) having sandy clay loam texture with pH 7.5. It was moderate in fertility status being low in organic carbon (0.40 %) and available nitrogen (184.27 kg ha^{-1}), and medium in available phosphorus (18.34 kg ha^{-1}) and potassium (208.36 kg ha^{-1}). Available zinc (0.56 ppm), molybdenum (0.19 ppm) and boron (0.38 ppm) contents were below the critical limit range. The experiment was laid out in a randomized block design with three replications and the treatments comprised of 4 N levels (0, 60, 120, 180 kg N ha^{-1}) and 7 micronutrient levels (0, 3 kg Zn, 6 kg Zn, 0.5 kg Mo, 1.0 kg Mo, 0.5 kg B, and 1.0 kg B ha^{-1}). Urea, single super phosphate, muriate of potash, zinc sulphate, sodium molybdate and borox were used as sources of fertilizers. Half of the quantity of nitrogen and full amount of zinc, molybdenum and boron were applied basal (soil application) as per treatment at the time of sowing. The remaining quantity of nitrogen was top dressed after first irrigation as per treatment at 30-35 DAS. A uniform basal dose of 60 kg P_2O_5 ha^{-1}, 30 kg K_2O ha^{-1} and 40 kg S ha^{-1} was applied to all the plots. The "Raj 2" carrier based *Rhizobium* culture @ 200 g per 10 kg seed was used for uniform inoculation of seeds. Crop variety "HUR 137" was sown on 30th and 24th October during the first and second years using 150 kg seed per ha in rows 30 cm apart and plant to plant spacing of 10 cm within row was maintained by thinning at 15 DAS. The crop was harvested on 1st March and 23rd February in first and second years of experimentation.

RESULTS AND DISCUSSION

Plant height and dry weight increased significantly with N levels upto 180 kg N ha^{-1}. Application of 6 kg Zn ha^{-1} out-yielded the rest of the micronutrient applications (Table 1a). A short vegetative growth period with a faster growth rate responded more to intermittent (split) mode of N (3) and other nutrients. Number of root nodules and nodule dry weight per plant recorded at 50 DAS decreased with increasing N levels beyond 60 kg N ha^{-1}, as the activity of nitrogen fixing bacteria decreased at higher nitrogen levels (1). Application of 1 kg Mo ha^{-1} followed by 6 kg Zn ha^{-1} and 0.5 kg Mo ha^{-1} recorded higher number of root nodules. However, the nodule dry weight per plant at 1 kg Mo ha^{-1} was significantly inferior to the highest one under 6 kg Zn ha^{-1} followed by 0.5 kg B ha^{-1}, as status of nodulation and activity may not necessarily be determined by nodule number alone.

Yield attributes *viz.*, pod length, pods/plant, grains/pod and 100-seed weight increased significantly with increasing N levels upto 180 kg N ha^{-1} (Table 1a). This may be due to direct role of nitrogen to seed growth and indirectly to help accommodate osmotic imbalances present during final stage of seed filling. Among the micronutrients, higher level of Zn (6 kg ha^{-1}) and molybdenum (1 kg ha^{-1}) proved significantly superior for all the attributes except 100-seed weight and were

Table 1 (a). Effects of nitrogen and micronutrients on growth, yield attributes, yield and economics of Frenchbean (pooled data of 2 years)

Treatment	Plant height (cm)	Dry weight/ plant (g)	Number of root nodules/ plant	Root nodules dry weight/ plant (g)	Pod length (cm)	Number of pods/plant	Number of grains/ pod	100-seed weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net return (Rs ha^{-1})	Benefit : cost ratio
Nitrogen (kg ha^{-1})												
0	48.13	26.18	26.15	0.74	12.65	5.45	3.60	48.74	1823	1947	26183	1.58
60	54.80	31.35	28.32	1.39	13.40	8.52	4.24	53.68	2056	2378	31088	1.81
120	58.25	35.69	26.74	0.98	13.86	10.40	4.43	55.17	2333	2670	36939	2.08
180	60.32	40.17	24.23	0.71	14.99	11.67	4.76	58.21	2651	2964	43744	2.37
CD (P = 0.05)	2.01	1.10	1.42	0.08	0.43	0.33	0.12	1.12	131	169		
Micronutrient (kg ha^{-1})												
0	51.40	26.27	27.29	1.24	12.81	6.66	3.71	51.13	1901	2136	28378	1.75
3 Zn	54.31	30.80	23.82	0.50	13.44	8.25	4.16	53.79	2143	2452	33836	2.06
6 Zn	60.01	40.61	32.88	1.49	15.47	12.02	4.78	55.94	2515	2802	42309	2.54
0.5 Mo	55.47	34.24	24.05	0.89	13.59	8.72	4.28	54.20	2209	2522	33657	1.85
1.0 Mo	59.29	37.56	40.22	1.37	14.14	10.43	4.46	55.15	2478	2706	37946	1.88
0.5 B	56.05	34.14	19.21	0.71	13.68	9.04	4.36	54.60	2269	2543	36495	2.15
1.0 B	51.45	26.82	17.06	0.51	12.93	7.94	4.05	53.05	1977	2268	28647	1.61
CD (P=0.05)	2.67	1.32	1.88	0.11	0.57	0.43	0.15	1.48	174	224		

Table 1 (b). Interaction effects of nitrogen x micronutrients on grain yield of Frenchbean during 1999-2000

Nitrogen (kg ha^{-1})	Micronutrient (kg ha^{-1})						
	0	3 Zn	6 Zn	0.5 Mo	1.0 Mo	0.5 B	1.0 B
0	1715	1748	1963	1674	1942	1885	1671
60	1937	1954	2171	1949	2283	2064	1779
120	1941	2271	2528	2250	2477	2335	1975
180	1957	2535	2976	2778	2925	2442	2359
C.D (P = 0.05)				296			

also at par with 0.5 kg B ha^{-1} (2). Lower level of B (0.5 kg ha^{-1}) appeared significantly superior to its higher level (1.0 kg ha^{-1}) being attributed to toxic effect on plants due to accumulation of excess B under Zn deficiency situations (4).

Nitrogen application significantly increased grain and straw yields over its preceding dose upto the highest level of 180 kg N ha^{-1} (Table 1a), as all the yield attributes showed a significantly similar response. Among the micro-nutrients, application of 6 kg Zn ha^{-1} was at par to 1 kg Mo and superior to 0.5 kg B ha^{-1}. Soil Zn (0.56 ppm) below the critical limit responded to maximize the grain yield with 6 kg Zn ha^{-1} application (5). Interaction effects of nitrogen x micronutrient on grain yield was found significant during 1999-2000 (Table 1 b). Higher rates of nitrogen along with higher rates of zinc (6 kg Zn ha^{-1}) and molybdenum (1 kg Mo ha^{-1}) produced significantly higher grain yield except in case of boron where lower rate (0.5 kg B ha^{-1}) gave higher grain yield. Application of 180 kg N ha^{-1} along with 6 kg Zn ha^{-1} and 1.0 kg Mo ha^{-1} gave the highest grain yield of 2976 kg ha^{-1} and 2925 kg ha^{-1}, respectively. The magnitude of yield maximization over no application with 6 kg Zn (33.3 %) was less than 180 kg N ha^{-1} (95.42%). This may be critically attributed to a greater influence of N than Zn on 100-seed weight as was also evident from at par 100-seed weight values with zinc, molybdenum and boron. Similar trend was also observed in straw yield.

N, K, Zn, Mo, and B uptake increased significantly with increasing levels of nitrogen from 0 to 180 kg N ha^{-1} (Table 2) and the highest uptake of these major and micronutrients was found with the application of 180 kg N ha^{-1}. This was mainly

Table 2. Effect of nitrogen and micronutrients on nutrients uptake (grain + straw) and protein harvest of French bean (Pooled data of 2 years)

Treatment	Nutrients uptake (kg ha^{-1})						Protein harvest (kg ha^{-1})
	N	P	K	Zn	Mo	B	
Nitrogen (kg ha^{-1})							
0	74.14	12.75	14.54	0.865	0.0056	0.041	0.0153
60	87.01	16.16	18.28	0.104	0.0068	0.048	0.0191
120	101.66	18.88	25.47	0.128	0.0078	0.055	0.0216
180	118.43	21.67	34.43	0.151	0.0090	0.062	0.0243
CD (P=0.05)	5.11	0.91	1.12	0.0055	0.0003	0.002	0.013
Micronutrients (kg ha^{-1})							
0	79.76	13.88	15.49	0.092	0.0047	0.041	498.54
3 Zn	92.51	16.52	23.56	0.121	0.0072	0.048	578.19
6 Zn	109.86	18.48	29.24	0.148	0.0084	0.058	686.42
0.5 Mo	96.26	17.62	22.85	0.112	0.0077	0.052	602.43
1.0 Mo	106.94	18.65	25.69	0.131	0.0091	0.057	668.38
0.5 B	97.07	19.18	23.71	0.118	0.0075	0.053	606.71
1.0 B	84.67	17.30	21.74	0.098	0.0065	0.048	529.24
CD (P=0.05)	6.48	1.21	1.48	0.0075	0.0004	0.003	38.98

due to increasing biomass production under higher N levels. Amongst micronutrients, Zn application increased the N, P, K, Zn and B uptake at higher level (6 kg Zn ha^{-1}), as was also seen for 1 kg Mo ha $^{-1}$ application. Boron application responded more at the lower level of 0.5 kg B ha^{-1} application (Table 2)

Protein harvest increased significantly (Table 2) with increasing levels of nitrogen and the highest values were found with the application of 180 kg N ha^{-1}. Micronutrients application also increased the protein harvest and the maximum values were recorded with 6 kg Zn ha^{-1} followed by 1 kg Mo ha^{-1} and 0.5 kg B ha^{-1} as compared to no micronutrient application.

Increasing N levels increased the net return and benefit : cost ratio and the highest net return (Rs 43,744 ha^{-1}) and benefit : cost ratio (2.37) were obtained with the application of 180 kg N ha^{-1}.Similarly, net return and benefit : cost ratio over no micronutrient application increased with micronutrient applications (Table 1a) and the highest net return (Rs 42,309) and a benefit : cost ratio of 2.54 was obtained with the 6 kg Zn ha^{-1} application followed by 1.0 kg Mo ha^{-1} (Rs 37,946)

LIETRATURE CITED

1. Andrade, M.J.B.De, Alvarenga, P.E., Carvalho, J.B. de., Silva, R.de amd Nares, R.de.1998. Effect of nitrogen, rhizobia and molybdenum on growth, root nodulation and nutrient contents in beans. *Revisa Cares* 45(257): 65-79.

2. Kushwaha, B.L. 1999. Studies on response of Frenchbean to zinc, boron and molybdenum application. *Indian Journal of Pulses Research* 12 (1): 44-48.

3. Piha, M.I. and Munns, D.N. 1987. Nitrogen fixation potential of bean (*Phaseolus vulgaris* L.) compared with other grain legumes under controlled condition. *Plant & Soil* 98(2): 169-182.

4. Ross, O.N., Gray, S.B. and Jeffery, G.P. 1997. Boron toxicity. *Plant & Soil* 193: 181-198.

5. Umamaheswari, P. and Singh, C.P. 2002. Influence of irrigation levels and micronutrients (Fe and Zn) on yield and yield attributes of *rajmash* (*Phaseolus vulgaris* L.). *Legume Research* 25 (2):121-123.