Effect of available soil N on growth, yield and N_2 fixation by common bean.

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Abstract

Two common bean cultivars were grown in a low nitrogen (N), stubble field with and without *Rhizobium* inoculation. Four rates of nitrogen fertilizer were applied. In addition, double enriched ammonium nitrate (10% atom excess) was used in microplots to estimate percentage nitrogen derived from the atmosphere (%Ndfa). Increased rates of N fertilizer resulted in increased plant height and yield and decreased %Ndfa. Inoculation of bean with granular *Rhizobium* inoculant enhanced N_2 fixation and improved seed yield.

Introduction

The common ascertain bean *(Phaseolus vulgaris* L) is the most widely grown pulse in the world and bean seed contains about 25% protein (Hemandez et al., 1993). Like most legumes, bean can fulfil its N requirement through mineral N assimilation and/or symbiotic N_2 fixation. The responses of bean to inoculation are often extremely variable and may be confounded by available soil N.

This study was conducted to ascertain the effect of available soil N on growth, yield and N_2 fixation of inoculated and uninoculated common bean.

Materials and Methods

A factorial arrangement of two cultivars (Othello pinto bean and US 1140 great northern bean), two inoculation levels (with and without *Rhizobium Zeguminosarum bv. phaseoli)* and four low nitrogen rates (0, 10, 20 and 30 kg/ha) were used in a randomized complete block design. The treatments were replicated four times and the experiment was grown at Sutherland Farm in 1995 and 1996. However, the 30 kg N rate was replaced by 50 kg N rate in 1996. Microplots (1 m2) were located within each plot, except for the unfertilized plots and were treated with $^{15}NH_4{}^{15}NO_3$ (10% atom excess) at the specified N rates. Data on growth and yield parameters were collected. Plant samples were analysed and the percentage of N derived from the atmosphere (%Ndfa) was calculated using the A-value approach (Hardarson et al., 1991) and ^{15}N-natural abundance method (Bremer and van Kessel, 1990).

Results and Discussion

Nitrogen rates had no effect on plant height at maturity in 1995, but plant height increased linearly with increasing N rates in 1996 (Table 1). Percent emergence, days to first flower, days to mature, 100-seed weight and number of pods per plant did not respond to different N levels in either year. The effect of increased N rates on seed yield was quadratic in 1995 due to low yield from 10 kg N/ha treatment (Table 2). However, the response to N was linear in 1996, due primarily to the high yield from the 50 kg N/ha treatment and linear in 1996.

In both years, %Ndfa and seed yield were significantly higher in inoculated plots than in the uninoculated plots, showing a good response to inoculation (Table 3). Increased N rates had no effect on %Ndfa in 1995, decreased %Ndfa linearly in 1996 (Table 4). The response of various traits to increased N rates in two years must be due to differences in these two environments plus the higher N rate used in **1996.**

Table 1: Bean plant height at maturity in the Sutherland plots.

N level (kg/ha)	Plant height (cm) 1995	1996
0	42.9	36.0a
10	46.1	38.5ab
20	45.7	39.5b
30	47.3	
50		41.0c

• values denoted by the same letter are not significantly different ($p < 0.05$)

Table 2: Bean seed yield in the Sutherland plots

N level (kg /ha)	Seed yield (kg/ha) 1995	1996
0	1829a	1522b
10	1515b	1644ab
20	1759a	1596b
30	1879a	
50		1733a

• values denoted by the same letter within a column are not significantly different ($p < 0.05$)

Table 3: Effect of granular inoculant on % Ndfa and seed yield of commom bean in the Sutherland plots

	%Ndfa		Seed yield (kg/ha)	
	1995	1996	1995	1996
Without inoculum	25.5b	23.2b	1590b	1473b
with inoculum	43.5a	39.8a	1900a	1775a

· values denoted by the same Ietter within a column are not significantly differeut ($p < 0.05$)

Table 4: Effect of N level on the %Ndfa by bean plants in the Sutherland plots

N level (kg/ha)	%Ndfa 1995	1996
0	NA*	36.0*
10	31.4	42.9a
20	37.6	33.5a
30	34.6	
50		13.7b

* not available

• values denoted by the same letter are not significantly different ($p < 0.05$)

Conclusions

Inoculation of bean with a granular formulation of *Rhizobium Leguminosarum bv. phaseoli* enhanced N_2 fixation and improved seed yield. In low nitrogen soils, the addition of low rates of N fertilizer may result in a linear *increase* in plant height and seed yield. Increasing rates of N fertilizer, even at low rates, may decrease %Ndfa, i.e., decrease N_2 fixation.

References

Bremer, E. and C. van Kessel. 1990. Appraisal of the nitrogen-15 natural abundance method for quantifying dinitrogen fixation. Soil Sci. Soc.Am.J. 54:404-4 11.

Hardarson, G., S. K. A. Danso, F. Zapata and K. Reichardt. 1991. Measurements of nitrogen fixation in fababean at different N fertilizer rates using the ^{15}N isotope dilution and 'A-value' methods. Plant and Soil. 131:161-168.

Hemandez, G., H. Vasquez, V. Toscano, M. Sanchez, T. Penante, A. Franchi-Alfaro and N. Mendez. 1993. Nodulation and growth of common bean *(Phaseolus vulgaris* L.) cultivars in hydroponic culture and in the field. Trop. Agric. 70:230-234.