Liquid inoculant for dry beans

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Introduction

Inoculation of dry bean seed ensures that a large and effective population of N_2-fixing rhizobia is available in the rhizosphere of a growing plant. Under optimum conditions, 60% of the plant's N requirement can be obtained from the root nodules following the conversion of atmospheric N_2 to NH_4^+. Liquid inoculants containing *Bradyrhizobium* for soybean and *Rhizobium* for field pea and lentil were available commercially in 1989 and 1991, respectively. These formulations provided farmers with a user friendly inoculant that was just as effective as the traditional peat-based inoculants for the delivery of rhizobia for nodule development, N_2 fixation and yield enhancement over the non-inoculated crops (Hynes et al. 1995). Over 2 million acres of dry bean were planted in Canada and the United States in 1997. Therefore this crop was an obvious choice to investigate development of a seed applied liquid formulation inoculant. Most bean seed is treated with the fungicide captan and antibiotic streptomycin and while they are effective against seed and soil-borne pathogens they inhibit nodulation and N_2 fixation by most *Rhizobium* (Rennie, 1986). The goal of this research was to:

1. Obtain a strain of *Rhizobium leguminosarun* bv *phaseoli* that could nodulate and fix N_2 on dry bean seed coated with captan and streptomycin.
2. Ensure that the strain in a liquid formulation was effective under field conditions.

Materials and Methods

Isolation and initial screening of *Rhizobium leguminosarum* bv *phaseoli* was conducted by Rennie (1986). A collection of elite strains were advanced into laboratory and greenhouse screening, initially in culture medium containing varying levels of captan and then onto dry bean seed coated with captan and streptomycin. Scale-up and commercial preparation of the liquid inoculant were carried out at Lipha Tech, Milwaukee, WI. From 1994 to 1996 the effect of inoculation on several varieties of dry bean in the presence and absence of N fertilizer (0 to 150 lb./a of NH_4NO_3) was examined at 16 field trials. Field trials were carried out in Michigan, North Dakota, Nebraska and Colorado. All experiments were of randomized complete block design.

Results and Discussion

The isolate that displayed the best growth in the presence of captan in the laboratory, was advanced into greenhouse experiments. The inoculant was applied to several varieties of dry bean coated and not coated with captan and streptomycin. Inoculated, coated and non-coated seed produced nodulated plants while non-inoculated plants did not have root nodules. Acetylene reduction measurements showed that there was no difference in the level of nitrogenase activity of root nodules from inoculated plants in the presence and absence of captan and streptomycin.

The residual N level in the soil at the field sites varied from 15 to 30 lb/a. At most sites nodule number per root decreased with addition of N (data not shown), demonstrating a well-known fact that N fertilizer inhibits nodulation of legumes including dry bean (Saito et al.

1984). In 1996 at Nebraska, trials were conducted to determine the proportion of N derived from N_2 fixation. When compared to a non-nod dry bean line (S. Park, Ag. Canada), Great Northern Beryl obtained 22 to 32% of its N from N_2 fixation. Inoculation improved the yield of dry bean in 7 of the 16 sites, significantly (p=0.05) at the Perham, Scottsbluff and Eckley sites. The yield from 6 of the 9 trials that did not benefit from inoculation similarly did not gain following addition of N fertilizer. This would indicate that soil residual N plus inputs through the growing season (mineralization) met the crops' requirements. Two of the remaining 3 trials may not have benefited from inoculation due to disease pressure by *Rhizoctonia* detected during evaluation of the roots at flowering. The yield benefit following inoculation ranged from 75 to 428 lb/a. Inoculated and non-inoculated dry bean yield from 5 of the 16 trials in the presence (35-50 lb/a) or absence of added N is reported in Table 1.

Table 1. The effect of RhizUp liquid inoculant on the yield of dry bean.

Treatment	Saginaw, MI[†]	Carrington, ND[‡]	Perham, ND[§]	Scottsbluff, NE[¶]	Eckley, CO[$]
			Yield (lb/a)		
Non-inoculated, 0 N	2392	2273	1371	1782	1223
RhizUp, 0 N	2504	2229	1771	2041	1554[b]
Non-inoculated + N	2381	2130	1401	2124	1724
RhizUp + N	2497	2529	2011[b]	2643[b]	1825

[†]Black Jack bean, 25lb/a N.; [‡] Othello pinto bean, 35 lb/a N.; [§] Montcalm kidney bean, 50lb/a N.; [¶]Great Northern Beryl, 35 lb/a N.; [$] Bill Z pinto bean, 35 lb/a N. N = NH_4NO_3. [b]Significant p= 0.05

Conclusions

1. A dry bean inoculant that tolerates the common seed coatings captan and streptomycin is available for commercial use.
2. Field trials were carried out examining the efficacy of RhizUp liquid dry bean inoculant in Michigan, North Dakota, Nebraska and Colorado.
3. In 2 of 3 trials in Michigan the inoculant increased the yield (not significant) by 101 and 75 lb/a; giving a financial return of $21 to $16/a at a cost of $2.00/a.
4. In 2 of 8 trials in Nebraska and Colorado the inoculant increased the yield (significant, p=0.05) by 428 and 261 lb/a; giving a financial return $90 to $55/a. Of the remaining 6 trials 4 did not respond to added N fertilizer.
5. In 3 of 5 trials in North Dakota the inoculant increased the yield (significant, p=0.05) by 355, 352, and 143 lb/a; giving a financial return of $74 to $31/a. The remaining two trials did not respond to added N fertilizer.

References

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