Dry Beans Do Respond To Inoculation

S.M. Phelps, and E. Hagele

Philom Bios Inc., 318-111 Research Drive, Saskatoon, SK S7N 3R2

Abstract

Rhizobial strains were evaluated in TagTeam peat and granular formulations for their effectiveness at increasing yields in dry beans. Five strains were formulated as TagTeam peat and tested with Nighthawk black beans in 1999. Yield increases ranged from 3% to 46% over controls. Two strains were superior and were reevaluated in 2000 in both granular and peat formulations of TagTeam. Two classes of beans were used and consisted of black bean (cv. Expresso) and pinto bean (cv. Camino). There was a strain response in the granule formulation, while both strains performed similarly in the peat. The formulation response was consistent in both bean classes. Overall the inoculant response was greater in the black bean (var. Express) than in the pinto bean (cv. Camino). In 2000, a second control was added that consisted of 40 lbs/acre additional nitrogen. This nitrogen control had the highest yield increases and demonstrated that even though there is a response to inoculation, fertilizer nitrogen is important for reaching top yields.

Introduction

Dry bean production has been growing in Western Canada due to the developments of newer varieties of beans that are shorter season and more tolerant to growing conditions in the prairies. Dry beans are known to be poor nodulators and have lower nitrogen fixation efficiency as compared to pea and lentil crops. Dry beans can only fix up to 50% of their required nitrogen as compared to 80 to 90% for field pea. With respect to nitrogen fertilizer use, dry bean have often been treated as a non-legume crop. With the increasing costs of nitrogen fertilizer in 2001,using inoculants may become more economical. However, there still remains the question of do dry beans respond consistently enough to inoculation, and do all beans respond similarily? The renewed interest in dry bean inoculation by producers and the development of new varieties that could expand the production areas further leads to greater opportunity for further research into finding better nodulating and better nitrogen fixating strains of rhizobia. The objective of this research is to identify a superior strain of rhizobia for all classes of dry beans, that works well in both peat and granule formulations of TagTeam.

Materials and Methods

Small plot field trials were set up at 7 locations in 1999 and 5 locations in 2000 to look at the efficacy of rhizobia strains on dry bean yields. Sites were chosen based on low nitrogen and phosphate levels (<35 lbs/acre), absence of dry beans grown in past 4 years, and no residual herbicide concerns.

In 1999, five rhizobia strains were evaluated in TagTeam peat formulation on black (cv. Nighthawk) dry beans. The top 2 strains from 1999 were reevaluated in 2000 as TagTeam peat and TagTeam granule formulations on both black (cv. Expresso) and pinto (cv. Camino) dry beans. There were no seed treatments used in 1999. In 2000, seeds were treated with Vitaflo 280.

The studies were arranged in a randomized complete block design with six replications in 1999 and four replications in 2000. Trials were direct seeded with a customized small plot air seeder. Monoammonium phosphate (11-51-0) was applied at rates according to soil test recommendations. In 2000, a nitrogen treatment was added that consisted of an uninoculated control plus 30 to 40 lbs an acre of additional nitrogen fertilizer.

Data collected included above ground dry matter and total grain yield in 1999 and only grain yield in 2000. The data was analyzed in SAS by GLM using contrasts to compare treatments. Data sets from sites that had coefficient of variance above 30% were not used in the calculations or statistical analysis of combined sites.

Results

Out of the 7 locations seeded, 5 were taken to harvest. The sites of Ellerslie, AB and Calmar, AB were lost due to poor establishment. The five remaining sites in Saskatchewan consisted of Cloan, Aberdeen, Borden, Elrose, and Milden. Results from 1999 are shown in Figure 1. Dry matter collected in July from all 5 locations show superiority of strains 114 and 121 over the other three strains. Dry matter results at harvest time show similar results with the exception of strain 124 which gave yields comparable to strain 114 and 121. The increased dry matter yields at harvest carried through to increased seed yields with strains 114, 121 and 124. Both strains, 112 and 127, show no increase in yields above the uninoculated control.

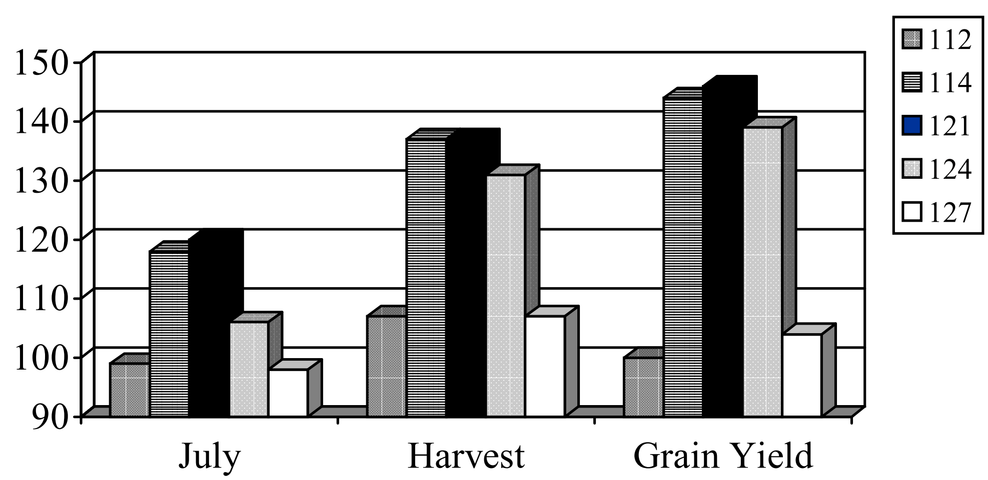

Figure 1. Dry matter and grain yield results from 1999 field trials in percent of control. LSD ($p<0.05$) are 10%, 8%, and 11% for July dry matter, harvest dry matter, and grain yield, respectively

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Individual locations were similar in their response to the 5 strains. Strain 114, 121, 124 were superior at all four sites where seed yield was collected. All 4 locations show different degrees of response to inoculation. Borden showed the least response while Milden showed the most response.

Although there were 3 strains that were statistically similar in terms of seed yield, strains 114 and 121 produced slightly higher yields and were retested in 2000. The four locations harvested in 2000 include two irrigated fields at Birsay and Broderick and two dryland fields at Rosthern and Elstow. Results from Birsay show no response to nitrogen fertilizer or to inoculation. Further investigation revealed that after the initial soil sampling for site selection the stubble was burned. The soil sample results from seeding time show a very high level of nitrogen which could explain the unreseponsiveness of the site.

The site of Elstow was the first location to be seeded and it was seeded on May 25. Elstow was highly responsive to nitrogen fertilizer as yields were increased up to 243% of the control in pinto beans and 135% of the control in black beans. There was nodulation of the bean plants with inoculant but yields showed no response (Table 1).

Table 1. Harvest yield results from small plot field trials in 2000.

Treatments	**Birsay**		**Elstow**		**Rosthern**		**Brod**	
Black Bean	Kg/ha	% of control	Kg/ha	% of control	Kg/ha	% of control	Kg/ha	% of control
Control	2063	100%	522	100%	521	100%	398	100%
Control + N	2080	101%	703	135%	988	190%	798	200%
114 peat	2222	108%	451	86%	667	128%	886	222%
121 peat	2207	107%	448	86%	704	135%	824	207%
114 granule	2090	101%	451	86%	649	125%	642	161%
121 granule	2151	104%	544	104%	695	133%	875	220%
LSD (p<0.05)	245.34	12%	117.89	23%	280.95	54%	227.2	57%
Pinto Bean								
Control	1777	100%	248	100%			719	100%
Control + N	1854	104%	603	243%			939	131%
114 peat	1944	109%	254	102%			755	105%
121 peat	1912	108%	268	108%			740	103%
114 granule	1808	102%	200	81%			502	70%
121 granule	1816	102%	250	101%			966	134%
LSD (p<0.05)	124.51	7%	55.3	22%			266.8	37%

An early frost at Rosthern had an affect on the maturity of the plants. The pinto beans were not included in results as they were too variable. Due to variability in the black beans the only significant response was to nitrogen fertilizer. There appeared to be an inoculant response as well, but the numbers were not significant.

The site at Broderick was the most responsive to inoculation. The inoculated black bean yields were as high as 222% of the control. The yield response to inoculation was similar to that obtained with nitrogen fertilizer which was 200% of the control. The strains performed similarly in the peat formulation, but in the granular formulation strain 114 was inferior. With the pinto beans, there was no significant inoculation or nitrogen fertilizer response.

The two black bean sites of Rosthern and Broderick were the only locations to show some response to both nitrogen fertilizer and to inoculation. Analysis of the combined locations shows a signficant nitrogen fertilizer and inoculant response to all strains and formulations (Figure 2). Although the nitrogen fertilizer treatment has a higher yield response, there is statistically no difference to the peat inoculants and to strain 121 granular formulation. Strain 114 granular formulation was inferior to the nitrogen fertilizer treatment.

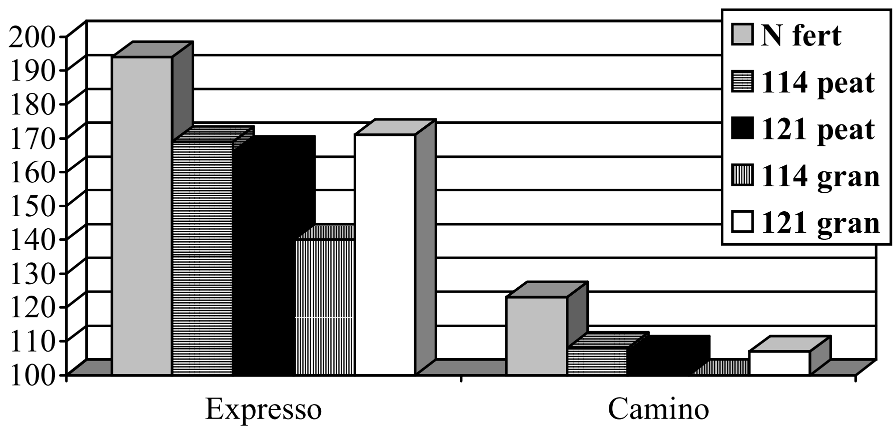

Figure 2. Combined results from black bean (var. Expresso) and pinto bean (var. Camino) trials. Sites of Rosthern and Boderick combined for Expresso and all three sites for Camino. LSD ($p<0.05$) is 38% for blacks and 7% for pinto.

Combined site analysis of all three pinto bean trials shows a significant response to nitrogen fertilizer but not to inoculation (Figure 2). The nitrogen fertilizer treatment outyielded all strains in all formulations. Within the inoculant treatments strain 114 granular formulation was again inferior.

Conclusions

Dry beans do respond to inoculation, but the response is specific to each bean type and may be to each variety within the bean types. The two black bean varieties, Nighthawk and Expresso, responded more to inoculation than the pinto variety Camino. There is a definite strain response as three out of the five strains tested in 1999 gave increased yields compared to the control. There is also a strain by formulation interaction as strain 114 performed similarly to 121 in peat but was inferior in the granule formulation. For strain 121, there was no difference between the response to granular versus the response to peat TagTeam formulation. Finally, beans do respond more consistently to nitrogen fertilizer and in some locations the beans responded more to the nitrogen fertilizer than to inoculation.