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# Enhancing Yield and Biological Nitrogen Fixation of Common Beans

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**Abstract**
Two studies were conducted at the ISU Horticulture Station to evaluate potential limitations on yield and atmospheric nitrogen fixation by common bean (Phaseolus vulgaris L.). This legume is a food staple for small landholder farm families worldwide. But it has a limited capacity for nitrogen fixation and often yields only a fraction of its genetic potential. In these studies, we examined the dependence of pod filling on current assimilate supply, as well as the potential to improve nitrogen fixation using an inoculant shown to enhance biological nitrogen fixation under stressful conditions.

**Keywords**
RFR A1131, Agronomy

**Disciplines**
Agriculture | Agronomy and Crop Sciences

# Enhancing Yield and Biological Nitrogen Fixation of Common Beans

**RFR-A1131**

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## Introduction

Two studies were conducted at the ISU Horticulture Station to evaluate potential limitations on yield and atmospheric nitrogen fixation by common bean (*Phaseolus vulgaris* L.). This legume is a food staple for small landholder farm families worldwide. But it has a limited capacity for nitrogen fixation and often yields only a fraction of its genetic potential. In these studies, we examined the dependence of pod filling on current assimilate supply, as well as the potential to improve nitrogen fixation using an inoculant shown to enhance biological nitrogen fixation under stressful conditions.

## Materials and Methods

*Altered assimilate supply.* Three common bean varieties K131, Nabe2, and Nabe6 were used in this trial. These are advanced lines released by the Uganda National Bean Breeding Program. The experiment was arranged in a randomized complete block design with three replicates. Each plot was 20m × 10m. Weed competition was controlled by regular hand weeding and applying corn stalk mulch over the soil prior to flowering. A shade treatment was applied at the start of seed filling to decrease assimilate supply to developing pods (Figure 1). This treatment reduced the incident light intensity below the netting by 50 percent, on average. Entire plants were harvested at physiological maturity (mature pod color) from a 1.3m$^2$ area to estimate seed yield and related production parameters. Data collected included total plant biomass, total pod weight, total seed weight, 100 seed weight, pod Harvest Index = (pod weight/seed weight) × 100. Yield (kg/ha) and pod Harvest Index are presented in this report. Further analysis includes total stem, pod, and leaf Nitrogen and Iron and Zinc content in the seeds.

*Response to inoculant.* The objective of this study was to test impact of the BioStacked® inoculant on nodulation and nitrogen accumulation by a set of recombinant inbred lines (RILs) generated from a cross between varieties Puebla × Eagle. These parents and their progeny lines were selected because of their wide variation in capacity for nitrogen fixation. Lines were planted in paired rows with spacing of 0.60m between rows and 0.05m between plants. Non-inoculated and inoculated treatments were randomized at planting. Whole plants were excavated after flowering. Roots, leaves, petioles, and stem tissues were isolated and dried at 60°C for biomass, ureide content, and total N determination. Plant biomass data are presented in this report.

## Results and Discussion

*Altered assimilate supply.* Preliminary results show that the yields reached the potential yield averages of the individual varieties, with K131 performing better than the other two varieties (Table 1). The yields are 3 to 4 times the average yields in Uganda. Shade treatment depressed the yields of all three varieties. Whether this reduction in yield will lead to a change in seed composition is yet to be determined. The pod Harvest Index results show that Nabe2 allocated less assimilates to the pod wall, followed by Nabe6 and K131, respectively. Shading had little impact on partitioning within the pod.

*Response to BioStacked® inoculant.* Plants were harvested soon after flowering to evaluate inoculant × genotype effects on plant growth and nitrogen assimilation. Preliminary data shown in Figure 3 indicate little impact of inoculation on shoot or root biomass. An exception was the inoculated plants of line P42, which apparently developed a much larger root system compared with non-inoculated plants. Nodulation scores are currently being analyzed. Stem, petiole, and leaf samples collected from these plants are being processed for total nitrogen and ureide content.

## Acknowledgements

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**Table 1. Bean yield and pod harvest index (PHI) of common beans from Uganda.**

| Variety | Yield (kg/ha) | | Pod harvest index[1] | |
|---|---|---|---|---|
| | Control | Shaded[2] | Control | Shaded[2] |
| K131 | 2,545 | 2,093 | 73.4 | 73.7 |
| Nabe2 | 2,225 | 1,846 | 80.2 | 78.9 |
| Nabe6 | 2,439 | 2,089 | 75.6 | 76.6 |

[1]PHI is (bean wt./pod wt) × 100.
[2]Shade cloth that decreased incident light approximately 50 percent was placed over the plants during early pod fill to harvest maturity.

**Figure 1. Field plots of common beans shaded during pod filling.**

**Figure 2. Unique genetic lines of common beans varying in capacity for nitrogen fixation.**

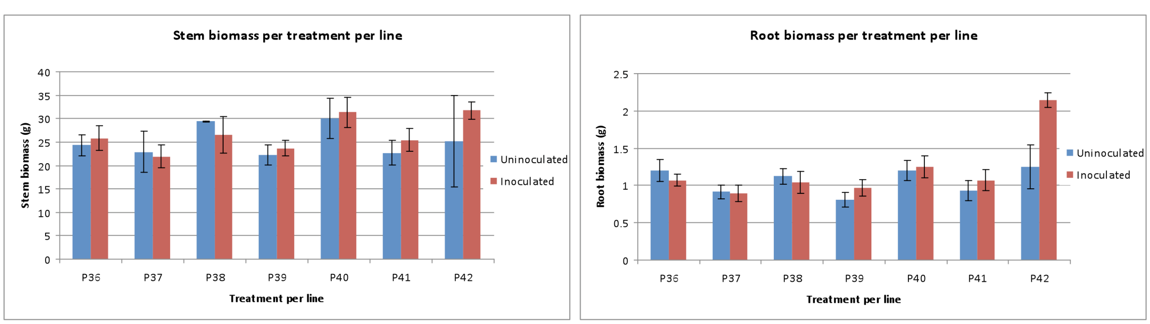


**Figure 3. Shoot (left) and root (right) biomass of recombinant inbred lines of common beans. Right bars indicate seeds treated with BioStacked® inoculant. Data are the mean ± SE of 2 to 10 plants.**