AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
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TITLE: Elucidating the effect of root rot on phosphorus uptake by snap beans

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SUMMARY:

The overall objective of this project was to help snap bean farmers fine-tune their phosphorus (P) management program to maximize nutrient use efficiency without compromising bean yield and quality. In fields with a history of growing snap bean, root diseases (caused by the pathogens *Fusarium solani*, *Pythium* species, and *Rhizoctonia solani*) impair root function and cause root death, resulting in a poorly developed root system that limits access to nutrients and water. With a less extensive root system, diseased plants may be unable to access nutrients even though they are present in sufficient quantities to support maximum growth in healthy plants. Bean root rot is prevalent in the Willamette Valley. A survey of 13 fields in 2013 and 2014 showed moderate root rot severity even when the rotation interval out of beans was 4 to 7 years.

To explore the relationship between P uptake and root diseases, a preplant soil fumigation x P fertilizer trial was conducted at the OSU Vegetable Research Farm in Corvallis (Bray P1 soil test = 99 ppm, a very high value). The field was continuously cropped to beans over 3 years, resulting in high disease pressure in 2014. Gross pod yield was 62% greater in fumigated plots compared to non-fumigated plots (12.6 vs. 7.8 ton/acre). Despite the high disease pressure in the unfumigated treatment, pod yields did not respond to P fertilizer application. This study suggests that P fertilizer rates do not need to be adjusted for fields with high soil test P and a high root rot potential, and longer rotations out of beans could significantly increase pod yield due to a decrease in bean root rot disease severity.

OBJECTIVES:

Determine the relationships between bean root rot disease severity, P uptake, biomass, pod yield, and allocation of growth between pods and foliage.

PROCEDURES:

This trial was conducted at the OSU Vegetable Research Farm in Corvallis on a soil mapped as a Chehalis silty clay loam with a CEC = 27 meq/100g, pH= 6.3, Bray 1P = 99 ppm, and K= 217 ppm. At this site snap beans were continuously cropped for 3 years and the field had high bean root rot disease pressure. The experimental design was a split plot with the main plot as fumigation/no fumigation treatments and the subplots as P fertilizer treatments in a randomized complete block design. The plots were replicated 4 times and each subplot was 30’ in length.

On May 7, 2014 a commercial fumigation company applied the fumigant Tri-Clor EC (active ingredient chloropicrin, 94%) at a rate of 200 lb ai/acre (15.7 gal/A) in 11' strips through the field. A plastic film was applied immediately behind the fumigant applicator. The plastic was cut open 16 days after application (DAA) to allow any remaining Tri-Clor to dissipate. The plastic was removed and the soil rotovated with a Kuhn power harrow 20 DAA.

On May 30 (20 DAA) snap beans var. OSU 5630 were seeded in 4 rows per plot at a rate of 174,000/A followed by a pre-emergent herbicide application of Dual Magnum. After planting, P fertilizer treatments of 0, 15, 30, and 60 lb P_2O_5/A were applied by banding approximately 3" from the seed line and 2" deep using a hand-push fertilizer applicator. N fertilizer in the form of ammonium sulfate was banded with the P fertilizer at a rate of 40 lb N/acre. Three weeks after planting, an additional 40 lb N/acre of ammonium sulfate was side-dressed. Seven weeks after planting, Topsin and Rovral fungicides were applied to control white and gray mold.

Bean pods were harvested on August 1 (63 days after planting) from a 10 ft. section of one middle row in each plot. Plant stand, pod weight, and foliage weight were recorded. The beans were mechanically graded and then dried at 60C. The foliage was shredded in the field using a 5 hp shredder (MTD model 242-645-000), from which a subsample was collected and dried in an oven at 60C. The dried foliage and pods were then ground using a Willey grinder and sent to Brookside Laboratories, Inc for P tissue analysis.

SIGNIFICANT ACCOMPLISHMENTS:

Although we did not see a fertilizer response to P fertilization due to the high soil test P value (99 ppm Bray 1P), we addressed a significant issue affecting snap bean producers. Many growers have ignored bean root, or brush it off as not being important. Some believe that a certain level of bean root rot is desirable because it prevents excessive foliage. Our research has demonstrated that bean root rot can have a significant negative impact on yield and that healthy roots do not result in excessive foliage. We believe this data will help start a conversation about bean root rot. Some research highlights are given below:

- Soil test P (STP) at the experimental site was 99 ppm Bray 1P. At this high level, no yield response to P fertilizer was observed, whether or not plots were fumigated. For fields with high STP, root rot controls yield, not addition of P fertilizer.
- Bean root rot disease severity in the fumigated plots was significantly less than in the non-fumigated plots. Due to the selectivity of the fumigant for fungi, root nodulation by *Rhizobium* bacteria was unaffected.
- **Due to healthier roots, gross pod yield was 4.8 tons/acre greater (62% greater) in the fumigated plots (12.6 vs. 7.8 ton/acre).** See Figure 1 for an example of the differences between treatments.
- Although foliage yield was greater in the fumigated plots compared to the non-fumigated plots, **the ratio of gross pods to total fresh biomass was similar (62 vs. 58% for the non-fumigated and fumigated plots, respectively)**. Despite the increase in foliage, harvesting the plants with a commercial harvester would likely not have been an issue (i.e., the plants were similar in size to those found in many commercial fields).
- **This study suggests that longer rotations between bean crops would significantly increase pod yield due to a decrease in bean root rot disease severity.**

Figure 1. Non-fumigated plants (left) and fumigated plants (right) on July 20 (51 days after planting). The canopy in the non-fumigated plots never completely closed by harvest.

BENEFITS & IMPACT:

For fields with high soil test phosphorus (in this study 99 ppm), root rot determines a field's yield potential, not P fertilizer. Based on soil test data collected from 2012-15 on processed vegetable farms, the average soil test P level is 94 ppm (range 32 to 189; n=39). For many farms with high soil test P, P fertilizer additions could be significantly reduced or eliminated even when a high level of bean root rot is expected.

These results were presented in 2015 at the annual Oregon Processed Vegetable meeting and at other grower talks throughout the year. Results from this study will be incorporated into an updated snap bean nutrient management guide (estimated publication date Winter 2016), which will help farmers and their crop consultants better manage their P fertilizer applications.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM:

None

FUTURE FUNDING POSSIBILITIES:

This concludes our study and reevaluation of P use in snap beans.