Tracking Soilborne Diseases in Bean through Integrated Management

Project Number: GR01-030
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Project Justification –

Root rot organisms and soil-borne diseases are persistent problems that growers lack tools to control. There are few practical and economic means to reduce the severity of infection, which is conditioned in part by environmental stress and declines in soil quality. In climatically variable years, including under both high rainfall or drought conditions, Fusarium root rot often suppresses bean yields by 25%, and up to 80%. Current fungicide options are too expensive, and becoming highly regulated. Integrated management control options are required that are profitable and environmentally friendly.

Objectives

1. Determine components of integrated management for improved root rot resistance, including the use compost amendments and genotype to enhance root system vigor.
2. Disseminate information on integrated management of soil-borne disease.

Results and Accomplishments

1. **Determine components of integrated management for improved root rot resistance.**

Compost amendments have the potential to reduce disease through building soil quality, suppressing disease organisms and improving crop root vigor. Three years of field research confirmed benefits from compost, both in terms of soil improvement and root health. Root rot severity varied, and in some cases composted poultry manure had no significant effect but in other cases reduction in disease was observed in compost-amended soils.

We evaluated an integrated management approach by testing bean cultivars for *Fusarium* root rot tolerance in soils with and without compost amendments. The snap beans were grown at two locations: 1) Southwest Research and Extension Center (SWMREC) on a sandy soil, 2) Montcalm Research Farm on a sandy loam soil. There was a trend towards reduced root rot severity in compost-amended soil as compared to non-amended soil for some cultivars (Table 1). Composted poultry manure was associated with a 20 to 40% increase in shoot and pod weight, as well as root rot tolerance.

Similar results were observed in 2002 and 2003 field experiments. A moderate reduction in root rot occurred when soil was amended with 2.5 tons composted manure per acre before planting beans (Snapp et al., 2003). At the same time, fungicide seed treatments had inconsistent effects on reducing severity of root rot infection (Kirk et al., 2002).

Table 1. Effect of poultry compost amendments on Fusarium root rot severity of five bean cultivars at two field locations. Average of four replications with standard error in parentheses. Root rot score is on a scale of 1 to 7, where a score of 1 indicates no root rot and a score of 7 indicates roots are completely rotted.

	Montcalm Research Farm Root Rot Score		**SWMREC Root Rot Score**	
Cultivar	**- compost**	**+ compost**	**- compost**	**+ compost**
Hystyle	3.3 (0.24)	3.5 (0.25)	5.7 (0.3)	4.3 (0.38)
Bronco	4.8 (0.43)	3.5 (1.5)	4.1 (0.35)	3.5 (0.43)
Probe	----	----	4.1 (0.25)	4.3 (0.13)
FR266 (resistant check)	3.0 (0.3)	3.0 (0.21)	----	----
Montcalm (susceptible check)	4.8 (0.24)	5.0 (0.21)	5.9 (0.06)	4.6 (0.12)

Over the long-term we expect that plant breeding will be the most cost effective means of achieving integrated control of root rot and related soil-borne diseases. This is not an easy task as bean breeders have made limited progress in enhancing root rot resistance, despite decades of effort. In our research we focused on understanding the genetic source of resistance to root rot infections. A resistant (FR266) snap bean cultivar and a susceptible (Montcalm) dry bean cultivar were reciprocal grafted to determine if the shoot genotype, the root genotype, or the combination of root and shoot genotype is important in conferring *Fusarium* root rot resistance. Results were suggestive that the root genotype alone is responsible for root rot resistance. When the susceptible cultivar Montcalm served as the root genotype (either ungrafted, 'Montcalm' self graft, or 'Montclam' root grafted to 'FR266' shoot) there was a significant increase in root rot severity as compared to all controls (ungrafted 'FR266', 'FR266' self graft, or 'FR266' root grafted to 'Montcalm' shoot; Figure 1).

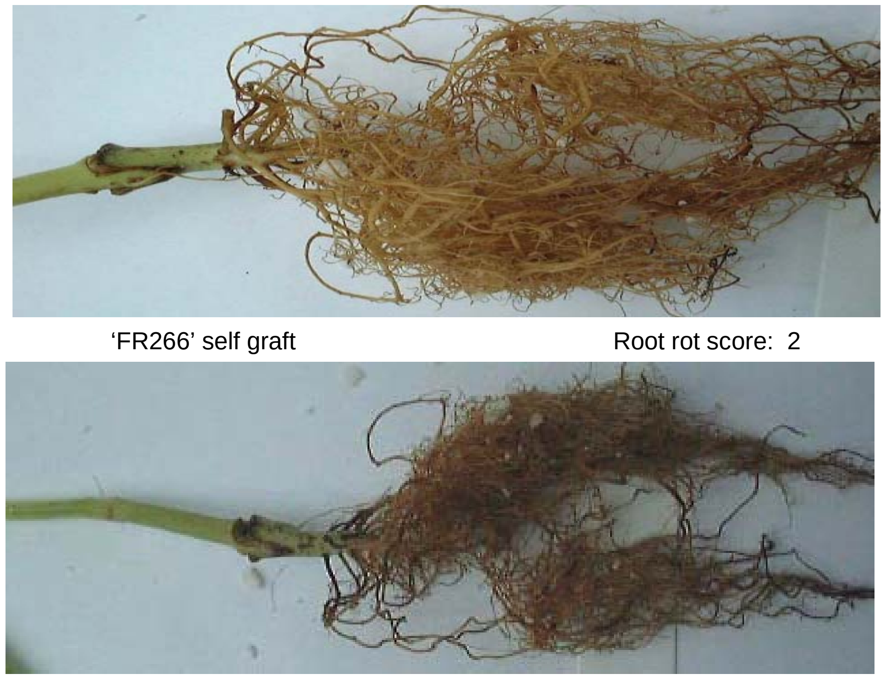

Figure 1. Root rot severity of grafted beans: ‘FR266’ as the root genotype as compared to ‘Montcalm’ as the root genotype.

Objective 2.
Disseminate information.
A major thrust of our outreach has been developing and disseminating a new extension bulletin on root rot tolerance strategies for integrated management of bean crops in Michigan (Roman et al., 2003). A series of grower talks based on this extension bulletin was conducted as part of extension project of PhD student Roman- Avilés, who has just graduated in Crops and Soils and the Plant Breeding and Genetics program. This student was supervised by Jim Kelly, and committee members Willie Kirk, Sieg Snapp and Ken Poff. The multidisciplinary approach of her research is illustrated by this collaboration across horticulture, plant pathology, soil science and plant breeding. Growers have benefited from the information she generated and disseminated with the assistance of MSUE agents Jim Breinling and Dave Glenn about the root rot resistant characteristics of dry bean and snap bean cultivars grown in Michigan.

Impact
The integrated approach used here of investigating root rot suppression of snap beans has been the foundation for the rapid adoption observed in the use of poultry manure to suppress disease and increase yields. Manure use has increased from nil to over 1800 acres of potatoes; about 20% of these acres are grown in rotation with snap bean and the double benefits of manure to potatoes and snap bean are a factor in the rapid adoption observed. Adoption is occurring due to grower-perceived profitability increases of $100 to 300/acre, and there are environmental benefits as well from reduced fungicide use and careful manure management.

Long-term benefits from this research project include improved understanding of root rot resistance mechanisms in common bean, including dry bean and snap bean cultivars. The localization of genes involved that was achieved will make it possible to conduct the next steps in developing improved bean cultivars that have a broad base of resistance to Fusarium root rot organisms.

Outputs

1. **New Extension Bulletin:** Roman- Avilés, B. S.S. **Snapp**, J.D. Kelly and W. Kirk. 2003. Fusarium root rot in common bean. Michigan State University Extension Bulletin E2876 (New)
2. **Refereed journal published**: Snapp, S.S. W. Kirk, B. Roman and J.D. Kelly. 2003. Root traits play a role in integrated management of *Fusarium* root rot in snap beans. *HortScience*38:187-191.
3. **Four Michigan extension talks** given that addressed root rot control, root vigor and the use of manure and integrated management in snap bean and snap bean/potato rotations.
4. **Fungicide technical report:** W.W. Kirk, S. Snapp, R.L Schafer and D. Berry. 2002. Evaluation of soil treatments for snap bean root rot control in 2002.
5. Partial support for a PhD dissertation just completed by Belinda Roman- Avilés, Plant Breeding and Genetics, Crop and Soil Science Dept. MSU and initial research support for the first year of PhD student Karen Cichy, Plant Breeding and Genetics, Crop and Soil Science Dept. MSU

Summary

New tools to improve integrated management of the persistent problem of root rot in dry and snap bean have been developed. These include the use of composted poultry manure at moderate rates, which farmers have shown interest in and have started to adopt. Improving root and soil health are two key aspects of integrated disease management, but over the long-term what is needed is improved cultivars with superior root rot resistance. Thus the most significant findings of our project were insights into the genetic control and development of resistance in bean cultivars.

Funding Partnerships

Non-MSU funding partnerships: The USDA Sustainable Agriculture Grant to MSU has contributed significantly to this collaborative effort by supporting graduate student training and research costs, through a grant of $57,000 for our proposal 'Healthy roots for sustainable agriculture: Quantifying the effect of cover crops and composts on root traits, disease and nematodes' PI S. Snapp; Collaborators G. Bird and W. Kirk.