Biological Control of Pythium Root Rot in Container Flower Production Using Microbial Inoculants

Project Leader: Neil Mattson, Department of Horticulture and Margery Daughtrey, Department of Plant Pathology and Plant-Microbe Biology

Abstract:
The effectiveness of microbial products, vermicompost and vermicompost extracts for Pythium root rot suppression in young transplants were compared in two studies under typical greenhouse production conditions, using first cucumber and then geranium (*Pelargonium*) seedlings. Protective drench and preincorporation treatments in a standard soilless mix substrate were included, and were challenged with Pythium inoculum. Data were analyzed and results were shared with growers at several extension meetings in NY during winter 2012-13. Results should aid growers who seek alternatives to chemical control methods or those who want to protect edible/organic crops.

Background and Justification:
The *Pythium* spp. water molds are among the most common root rot pathogens in greenhouse flower production. Commonly affected crops include geraniums (*Pelargonium)*, poinsettia, chrysanthemum and snapdragon. Several species of *Pythium* can infect roots, causing decay of the root system and ultimately leading to stunted plants or plant death; young seedlings may be killed outright. Economic damage is incurred due to loss of saleable plant material or due to labor and product costs of applying fungicide drenches to control *Pythium*. Producers of organic or edible crops cannot use conventional fungicides for Pythium root rot control. Further, resistance to specific fungicide products (Subdue and Subdue MAXX, containing metalaxyl and mefenoxam, respectively) has occurred in 40% of *Pythium* isolates (Garzon and Moorman 2010).

Biological control agents are alternatives to conventional fungicides. Commercially available biological control agents contain a specific strain of beneficial microbes (bacteria or fungi) that colonize the root-zone environment. Examples include RootShield or RootShield Plus, Bioworks, Inc., which contain *Trichoderma* spp.; and Actinovate, Natural Industries, Inc., which contains a *Streptomyces* species. The products are introduced to the root zone using granules or drenches. While these single-species biocontrol products can be effective, naturally occurring complex communities of microorganisms can also be effective at protecting plants from disease. Composts and liquid extracts of compost have been extensively studied in an attempt to understand exactly how microbial communities inhibit plant pathogens (Weltzien 1989; Bailey and Lazarovits 2003; Litterick et al. 2004).

Vermicompost, or worm processed compost, is effective for control in a variety of disease systems; however, considerable variability in efficacy exists (Jack 2010). Research conducted at Cornell University determined that vermicompost (Worm Power LLC) and non-aerated liquid vermicompost extract (NVE) effectively controlled Pythium infection in cucumber seedlings. Seed-colonizing microbes from vermicompost chemically modify cucumber seed exudates, thus interrupting the directional swimming of Pythium zoospores so that they fail to reach and infect their host (Jack and Nelson

2008). There is also preliminary evidence of a zoospore toxin produced by this microbial community (A. Jack, personal communication).

Vermicompost and vermicompost extracts (NVE) have not been tested for Pythium suppression in containerized production of greenhouse flowers. Similarly, while they have been tested in a model cucumber system, they have not been tested in commercial growing mixes in common greenhouse conditions. In this project we propose to test efficacy of single species biocontrol agents, vermicompost and NVE, for suppression of *Pythium aphanidermatum*. The first trial tested cucumber seeds during germination in a commercial mix as a follow-up to the work by Jack and Nelson. We then tested these biocontrol agents for *Pythium* suppression in geranium (*Pelargonium*), a popular flower crop that is quite susceptible to *Pythium*.

Many species of *Pythium* are generalists like *P. aphanidermatum,* which has over 50 commercially important crop species as hosts (Martin and Loper 1999) so finding a biological method of controlling this one pathogen has broad relevance for both flower and vegetable transplant production. This project specifically addresses the Ornamentals category priority of "Use of compost and microbially-based products for greenhouse disease suppression." In keeping with broader IPM priorities, the effective use of biological agents to suppress Pythium root rot would reduce producers' crop losses (shrinkage) and reduce the environmental risk as compared to application of conventional fungicides.

Objectives:

1. Conduct a greenhouse experiment to test several commercially available microbial inoculants and vermicompost to determine if they can reduce *Pythium* infection.
2. Project Evaluation to determine effectiveness of inoculants and prepare final report
3. Outreach with the greenhouse community to share results via online newsletters and at winter 2012-2103 greenhouse workshops.

Procedures:

Objectives 1 and 2: A variety of products and preparations were tested for their ability to reduce the impact of Pythium root rot initially during the germination stage of seed cucumber and then on seed geranium 'Pinto Classic White'. Treatments included a nontreated control, and several incorporated biocontrols: a *Streptomyces* (Actino-Iron), a *T. harzianum* (RootShield G), and a *T. harzianum* + *T. virens* combo (RootShield Plus G), 10% vermicompost (by volume as incorporated into the substrate), and a 100 mL/pot vermicompost extract drench. The vermicompost extract drench was prepared using a non-aerated 1:40 (W/W) solution at transplant, repeated in 48 hrs. The cucumbers were seeded three to a pot into 6-inch pots just after the bioantagonists were incorporated into the potting mix. The geraniums were transplanted into Lambert LM 111 mix in 4-inch pots with the bioantagonists incorporated using the recommended label rate and as described above for the vermicompost materials. Two days after transplanting, agar plugs of Pythium inoculum were added at rates of 0, 1, 2, or 3 agar plugs per pot. The inoculum was a potato-dextrose agar plug (4mm diam.) of a 2-week old culture of *Pythium* (for cucumber this was with *Pythium aphanidermatum* and for geraniums with

Pythium irregulare), set 1 cm away from the stem in a shallow depression. There were 6 replications of one plant for each treatment combination arranged in a randomized complete block design. Plants were irrigated daily using 20-10-20 water soluble fertilizer at a rate of 200 ppm N. Plant growth and mortality was scored 5 weeks later, plants were collected at the soil line for dry weight analysis, and the data were subjected to statistical analysis. **Objective 3:** Results of the study were described to growers attending bedding plant schools and floriculture conferences in Capital District, Hudson Valley and Long Island regions.

Results and Discussion and Impact:

The cucumber plants did not respond to the *Pythium aphanidermatum* inoculum, suggesting that either the strain used was not virulent to them or that the 6-inch container size (which has better drainage and root-zone aeration than 4-inch pots) was not conducive to disease infection. Unfortunately we could not draw any conclusions about the biological control agents with the cucumber system. However, we were able to successfully infect geranium transplants with *Pythium irregulare* and found some interesting results. When geraniums were assessed 5 weeks after inoculation, the inoculated control plants showed 10% mortality and some stunting while noninoculated controls showed no symptoms. Geraniums given RootShield and ActinoIron treatments exhibited less mortality (about 5%) and less stunting than inoculated controls, whereas geraniums in RootShield Plus and vermicompost incorporation treatments showed 40-50% mortality. We hypothesize that storage issues related to the RootShield Plus and vermicompost explain why they performed poorly versus controls, highlighting a relevant consideration when utilizing biological materials.

Interestingly, all 24 of the plants given the vermicompost extract treatments were vigorous at the end of the trial, with no mortality. Dry weights were reduced in comparison to controls by all treatments except the vermicompost extract. Further trials will be conducted to determine whether the miscellany of microorganisms in the vermicompost extract can provide this level of biocontrol consistently. In addition it may be that substrate incorporated solids provide poorer coverage of the root-zone with the biological agents than with drench applied materials (such as the vermicompost extract). Drenches may have had an advantage over incorporation treatments in this trial because the inoculum was added at the surface of the growing mix. This would be useful to test in the future as RootShield, RootShield Plus and Actino Iron (Actinovate) are available in wettable powder formulations. Our study was reported to growers at bedding plant schools around the state in winter 2012-2013 (reaching about 260 attendees); surveys in 2014 will enable us to find out whether the greenhouse industry has experimented with vermicompost extract as a result of our research reports (Mattson has already fielded questions from a few interested growers). Prior to our recommending the use of vermicompost extract for root health improvement, we hope to conduct additional studies in 2013-2014 to evaluate whether compost extract treatments would be of practical use to a geranium grower. Further work is essential to determine whether positive results are repeatable, and whether effective treatments are economical for growers. Potentially the results of this research could reduce the pesticide use of the several hundred commercial geranium growers in New York State, by providing guidelines for using an organic, natural biological control for Pythium management. Benefits to additional crops might be found as well.

This project was also helpful as it provided preliminary data used by Mattson and Worm Power LLC to apply for a USDA Small Businesses Innovative Research grant for $100,000 in funds to pursue biological control of Pythium in hydroponic spinach

production. As of this our proposal is still under review and we will find out early in 2014 if it is selected for funding.

Project locations:

The research project was conducted at the Kenneth Post Lab greenhouses at Cornell University. The *Pythium* cultures were prepared in the lab of M. Daughtrey at the Long Island Horticultural Research and Extension Center. Because of the widespread effects of Pythium root rot in many ornamental and vegetable crops grown in greenhouses, this work is potentially applicable to all greenhouse growers in New York State.

Project findings are applicable to greenhouse bedding plant producers nationwide.

Samples of resources developed:

See images accompanying this report.

Figure 1. Geranium "Pinto Classic White" at experiment evaluation. The top picture shows plants not treated with a biological control and inoculated with Pythium and the bottom picture shows plants inoculated with Pythium and treated with vermicompost extract.

N. Mattson holding the vermicompost extract commercially prepared at Worm Power LLC.