Soilborne Pathogens

This project has advanced our understanding of soilborne plant pathogens and identified effective treatments and practices that prevent and/or control the diseases they cause, thus improving crop yield and quality and reducing grower costs.

Who cares and why?

Soilborne pathogens are tiny organisms like bacteria, viruses, or fungi that infect plant roots, stems, and leaves, leading to reduced plant growth, increased costs to the growers, and potential damage to the environment. Cotton seedling diseases caused by soilborne pathogens can kill or weaken seeds and seedlings, delay crop growth, or require costly replanting. Though U.S. cotton seed is universally treated with fungicides prior to sale, growers must decide whether to use additional fungicides to ward off disease. Growers need to know which treatments are most effective for their specific problems and growing conditions in order to prevent needless expenses, ineffective treatments, and crop losses. Soilborne pathogens are also problematic for bedding plants and vegetable transplants, both of which are key commodities in the Southeast. Although production of these plants typically takes place in greenhouses where environmental conditions can be controlled and sanitation is practiced, many greenhouses inadvertently provide conditions favorable for pathogen survival. Even one diseased plant can result in the loss of the entire flat of plants. In 2009, soilborne pathogens were responsible for an estimated 10% of losses in vegetable crops. Though these soilborne pathogens and others are common throughout the southeastern U.S., we know little about their genetics, making it difficult to develop control methods. Because fungicide use is not consistently effective, economical, ecologically desirable (due to environmental and worker exposure concerns), or commercially desirable (production of pesticide-free or organic crops can increase crop value by 30%), biological control and plant growth promoting agents should be considered key management components. Research is needed to make sure that these control methods are safe, effective, and economical for greenhouse, field, and landscaping use. In turn, this research will help reduce our reliance on chemical fungicides and increase the sustainability of U.S. agriculture.

Bedding plants and vegetable transplants (top, photo by Owen Lin) are especially susceptible to soilborne pathogens, which can kill plants and result in serious economic losses for growers and customer dissatisfaction. *Rhizoctonia solani* is a destructive plant fungus that attacks a variety of host plants and can cause many different types of damage, including seed decay, foliage diseases, and root rot (early symptoms shown on bean seedlings above, photo by Howard Schwartz/CSU, Bugwood.org).

What has the project done so far?

This project has created opportunities for multistate, multidisciplinary collaboration. The S-1028 team has conducted many trials and field tests. More specifically, project scientists have examined biological control agents for use as seed treatments, in-furrow treatments, or as potting soil mix-ins for plants like broccoli, tomatoes, impatiens, cotton, and soybeans. The group has also examined the effect of cultural practices (such as crop rotation and tillage) on soilborne pathogens and plant growth. Members have also examined the genetic diversity of soil pathogens. S-1028 scientists have shared their findings at annual meetings and in various publications and outreach materials, including a peer-reviewed video about soil fungi (available through the American Society of Microbiology's MicrobeLibrary, *http://www.microbelibrary.org/library/fungi/3178-soil-fungi*) and an educational website about important soil organisms (*http://www.agron.iastate.edu/~loynachan/mov/*).

Impact Statements

Advanced knowledge of soilborne pathogen diversity, helping scientists pinpoint ways to increase plants' resistance or tolerance to specific pathogens and support longer-term disease prevention.

Helped growers make science-based fungicide choices by developing a database of fungicide recommendations for wheat, corn, and soybeans.

Helped growers increase plant quality and yield, reduce fungicide use, and cut costs by identifying new alternatives to fungicides, including biological agents that control pests, farming practices that reduce disease symptoms, seed treatments that can be safely combined for greater control, fertilizer that reduces seedling disease, and microorganisms that boost plants' resistance to pathogens or promote plant growth. For example, the group identified a formulation of beneficial fungi, Tenet™ WP, which significantly suppresses root and collar rot, enhancing vegetable crop quality, yield, and profits for both conventional and organic vegetable producers.

Changed farmer practices by showing them how certain plants can protect crops when they are incorporated into soils or used as off-season field cover. For example, using hairy vetch as a winter cover crop suppressed disease (by releasing pathogen-deterring ammonia into the soil) in a South Carolina watermelon field and increased that year's watermelon acreage three-fold.

Researchers tested mustard (*Brassica* species) as a cover crop because the plants produce a large amount of biomass in a short time, thus providing benefits like increased soil organic matter, erosion control, and weed control. Most *Brassica* species also release chemicals that may be toxic to soilborne pathogens and may help suppress diseases. Field trials have shown that *Brassica* cover crops have potential to change soil microbial populations and reduce damage from soilborne pathogens in strawberry, bell pepper, and cotton fields. Photo by Michael Stephens, USDA-NRCS South Dakota.

What research is needed?

Although scientists have been investigating soil microbial communities for several decades, knowledge of how these tiny organisms affect crop yield, disease severity, and ecosystem function is still incomplete. However, with the advent of next-generation sequencing technology, scientists are now able to look at the genomes of all organisms present in a soil (metagenomics) as well as all the genes they are expressing (metatranscriptomics). These technologies will shed light on the basic mechanisms by which control strategies such as crop rotation, cover crops, plant variety mixture, biocontrol organisms, and organic soil additives impact both pathogenic and beneficial soil organisms contributing to disease suppression. Researchers also need to continue thoroughly testing control options to make sure that recommended strategies are effective in a variety of settings and when plants are infected by more than one pathogen.

Want to know more?

Administrative Advisor:
Harald Scherm
scherm@uga.edu

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Compiled and designed by Sara Delheimer