North Central Soybean Research Program

Seedling Diseases: Biology, Management and Education

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Progress report for 2017

Soilborne seedling and root diseases of soybean significantly reduce yields in the North Central region of the United States. Seedling diseases rank among the top four pathogen threats to soybean, because their insidious nature makes them difficult to diagnose and control. It is nearly impossible to predict when they will take a heavy toll, until it happens. The challenges and failures of managing soilborne diseases and pathogens of soybean and other crops are based in part on limitations in knowledge and methods.

This project addresses critical limitations in identifying and managing seedling diseases. Producers and industry will see benefits in the form of rapid diagnostics and management recommendations. This benefit will also help industry in their assessments in pesticides and germplasm development.

Project Objectives

1. Development and deployment of a panel of QPCR probes to identify and quantify fungal seedling pathogens of soybean
2. Curate the collection of fungal pathogens collected during the first phase of this project
3. Improve understanding of the biology of *Rhizoctonia solani* as a seedling pathogen of soybean

4. Improve understanding of the biology of *Fusarium* sp. as a seedling pathogen of soybean
5. Improve understanding of the biology of *Pythium* as a seedling pathogen of soybean
6. Evaluate the effect of multiple pathogen interactions on seedling disease
7. Impact of seed treatments on the interaction of seedling pathogens
8. Communicate research results with farmers and stakeholders

Reporting Period Accomplishments

Objective 1: *Develop and deploy of a panel of QPCR probes to identify and quantify fungal seedling pathogens of soybean*

Phytophthora genus-specific markers that will have applicability across species and hosts have been developed and are currently being validated. In addition, preliminary *Pythium* genus specific markers have been designed and are undergoing additional testing. A manuscript describing the use of a qPCR assay for quantification of *F. virguliforme* and identification of risk factors for SDS development within a field was submitted to *Phytopathology.* The manuscript was accepted pending revisions.

Objective 2: *Curate the collection of fungal pathogens collected during the first phase of this project*

We have finished cataloguing 3000 fungal isolates that are now stored and maintained at SIU. A searchable site is still under construction and will be publically available soon.

Objective 3: *Improve understanding of the biology of Rhizoctonia solani as a seedling pathogen of soybean*

The collection of Rhizoctonia root and stem rot isolates now includes *Rhizoctonia zeae* (23), *R. solani* AG-4 (20), *R. solani* AG-3 (2), *R. solani* AG-2 (1), *R. solani* AG 1-IB (4), and AG-B (2). Our work is further characterizing the level of pathogenicity of these isolates and has identified a surprising number of *Rhizoctonia zeae* that are pathogenic to soybean.

Fungicide sensitivity assays are currently underway for Rhizoctonia isolates using the plate dilution method. Screening will be done for four fungicides with different modes of action: propiconazole (DMI), fludioxonil (Phenylpyrrole), thiabendazole (TBZ), and penflufen or sedaxane (SDHI). Results from this work will use isolates previously collected in the North Central states and new isolates collected from Nebraska, to

provide a comprehensive overview of sensitivity across the region.

Replicated field and greenhouse studies were conducted to determine if early maturity group soybean germplasm vary in response to *Rhizoctonia solani* and to identify those with different levels of susceptibility. Cultivars and lines responded with significant differences in plant height and stand count in the greenhouse and with significant differences in stand count and yield in the field for inoculated vs. noninoculated treatments. These initial studies suggest that many soybean cultivars can respond differently to Rhizoctonia root and stem rot, which could relate to yield in the field under conditions favorable for this disease. Additional studies are being completed in the field and are underway in the greenhouse to validate these results under varying conditions.

Objective 4: *Improve understanding of the biology of Fusarium sp. as a seedling pathogen of soybean*

Soybean genotype seeds belonging to maturity groups 0 and I were screened for resistance against four Fusarium species recovered from commercial soybean fields in South Dakota. The plant introductions (PIs) with origins from 15 countries, and a susceptible soybean cultivar Asgrow 1835 was used as the check.
Disease severity was measured as lesion length on plant tap root caused by the Fusarium isolates and was evaluated at 14 days after inoculation.

All the Fusarium isolates caused both pre and post-emergence damping off on most of the PIs. Soybean genotypes in which the fungal pathogens caused less than 35% mortality were subjected to further analysis.

We found distinct differences in the abililty of Fusarium isolates to cause root lesions on the PIs, particularly in maturity group 0. One genotype (PI 437343) developed less root lesion in all four Fusarium screenings. This genotype may be used to develop soybean breeding line and commercial cultivar with resistance to the four species of Fusarium.

- Of 54 MG-0 genotypes screened against *F. graminearum,* 15 genotypes developed a shorter lesion length (less root rot) compared to the check.
- Of 106 MG-1 genotypes screened against *F. graminearum,* no genotypes had less root rot.
- Of 104 MG-0 genotypes screened against *F. proliferatum*, 85 genotypes developed less root rot.
- Of 123 MG-1 genotypes screened against F. *proliferatum,* 43 genotypes developed less root rot.
- Of 115 MG-1 genotypes screened against *F. sporotrichioides,* we found

86 genotypes that survived at greater than 35% mortality, but all PIs developed root rot as severe as the check.

- Of 73 MG-1 genotypes screened against *F. subglutinans*, we found 48 which survived at greater than 35% mortality, and 21 genotypes which developed less root rot.

Part of understanding the biology of *Fusarium* spp. as seedling pathogens of soybean is the detection of pathogens in seed and seedlings that have the potential to cause disease. So far, *F. proliferatum* was the most abundantly amplified *Fusarium* sp. from soybean seed in Kansas.

Isolates of *F. proliferatum* were collected from soybean seeds and seedlings in Kansas and tested against increasing concentrations of fludioxonil. In our tests, isolates with EC50 > 100 ug/ml a.i. were considered resistant to fludioxonil. Approximately 25% of F. proliferatum isolates were found to be resistant to fludioxonil with EC50s between 115-447 ug/ml a.i. Additionally, we have tested isolates of *F. oxysporum* and *F. fujikuroi* against fludioxonil. Unlike *F. proliferatum*, only 6.7% of *F. fujikuroi* isolates showed resistance to fludioxonil.

Germplasm screening using the rolled towel test has been used to evaluate entries for resistance to *F. proliferatum* in the Kansas Soybean Variety Trial. For example, two varieties that appear to have moderate resistance to F. proliferatum are LG C3333RX and Midland 9373R2.

Objective 5: *Improve understanding of the biology of Pythium as a seedling pathogen of soybean*

A manuscript entitled "*Seed treatment reduces damping off caused by Pythium sylvaticum on soybeans subjected to periods of cold stress*" was submitted to the Canadian Journal of Plant Pathology. A second manuscript titled "*The effect of cold stress on damping-off of soybean, seed exudation and sporangia germination of Pythium sylvaticum*" was submitted for peer-review.

A high-throughput fungicide sensitivity assay has been developed. Manuscripts describing guidelines for accurate fungicide sensitivity estimation and the high-throughput fungicide sensitivity assay were submitted for publication.
See: Significant influence of EC50 estimation by model choice and EC50 type - *Plant Disease, December 2017*

Objective 6: *Evaluate the effect of multiple pathogen interactions on seedling disease*

A manuscript discussing the interaction of two *Pythium* species with two *Fusarium* species on damping off of soybeans is being prepared.

Objective 8: *Communicate research results with farmers and stakeholders*
See: Research leads to a better understanding of Rhizoctonia solani on soybean - *SRII Research Highlight, November 2017*