North Central Soybean Research Program

Characterization of *Phytophthora sojae* and *Phytophthora sansomeana* populations in the North Central Region and an Assessment of Management Strategies

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Project Objectives

1) Recover *Phytophthora sojae* from fields within each state and characterize for pathotype and genetic diversity.

2) Evaluate the new sources of resistance to these regional populations.

3) Recover *Phytophthora sansomeana* from fields within each state and characterize for host range and genetic diversity.

4) Establish sensitivities (EC50) values for *P. sojae* and *P. sansomeana* isolates recovered from fields towards the new active ingredients ethaboxam, strobilurin, and oxathiapiprolin fungicides.

5) Compare new seed treatments on varieties with different resistance packages (Rps gene(s) and partial resistance) in field trials.

6) Evaluation of potential herbicide interactions with the development of seed rot and stand loss.

7) Develop outreach publications on the management of Phytophthora spp. that infect soybean in the North Central U.S. and Ontario regions.

Project Description

Phytophthora sojae is present in many soybean fields across the north-central region of the U.S. and Ontario, Canada and had been managed very successfully with the deployment of single resistance Rps genes (Rps1a, Rps1c, Rps1k, Rps3a, and Rps6) as well as partial resistance (field resistance or tolerance). However, there are an increasing number of reports where varieties are sold that have Rps genes that are no longer effective towards the regional population or lack sufficient levels of partial resistance. The consequence is stand loss from

damping-off or the development of stem rot throughout the season which results in lower yields and added weed pressure.

The most recent survey of *P. sojae* pathotypes (races) was completed during 2012/2013. In that study, 213 unique pathotypes were identified among 873 isolates collected from 202 fields in eleven states. Two key findings from this sampling indicate that the ability to recycle Rps genes is highly unlikely:

1) a greater number of regions have a higher proportion of isolates with virulence to key Rps genes, such that the resistance gene will no longer be effective
2) Phytophthota isolates across the region continue to increase in complexity.

In another study (2010-2013) funded by soybean checkoff dollars, the genotypic diversity among *P. sojae p*opulations was examined. With new markers, and in-depth sampling of populations recovered in the 2000s, regional populations of *P. sojae* in the Midwest were identified. Because P. sojae is a soil-borne organism, it was believed that *P. sojae* should be clonal (every individual is the same within a field and between neighboring fields) – but the findings from this study clearly indicated that the *P. sojae* populations in the Midwest are not clonal.

These findings indicate that a more thorough assessment of the *P. sojae* populations in the North Central region is needed. In addition, new Rps genes have been identified but their effectiveness is still highly questionable. Among the 15 Rps genes that were identified prior to 2001, only 5 were effective and incorporated into varieties.

A second Phytophthora, *P. sansomeana*, also appears to be contributing to seed and seedling damping-off of soybean at greater incidence than previously thought, both from surveys previously reported in Illinois (Malvick), Ohio (2003 and 2015 data), and region wide (Chilvers USDA-AFRI project data). This is intriguing as *P. sansomeana* has a larger host range (corn, douglas fir, soybean). As part of this proposed study, populations of *P. sansomeana* in each state will also be examined for host range, resistance in current soybean cultivars, and efficacy of seed treatment fungicides.

Reporting period accomplishments - October 2018

1. Recover *P. sojae* from fields within each state and characterize for pathotype and genetic diversity.

Soil collection and baiting of 25 to 50 locations is mostly complete for those states that were going to participate. In addition, we have 17 locations from Kentucky. With close to a total of 1450 isolates we have completed the isolation process and are moving into characterizing these isolates. The fall and winter will be spent working on this part of the project.

In Minnesota sampling is complete. Samples were collected from 66 locations in 57 counties. All *P. sojae* isolates (113) have been pathotyped. The Minnesota *P. sojae* isolates consisted of 19 pathotypes. Pythium spp. were present in 43 of the 66 Minnesota samples.

2. Evaluate the new sources of resistance to these regional populations.
Seed was increased again in 2018 as the quality due to weather conditions and total amount was low for some lines from 2017. We did spray with fungicides in the hopes of improving quality but we have had ~5" of rain in the last 2 weeks. An agreement to share this germplasm is in place and has been signed by some states. However, we are unable to obtain the new material for Rps11 from Purdue. We may have access to the plant introduction for this one. Minnesota has obtained seed with potentially novel R-genes RpsUN1 and RpsUN2. These sources of resistance will be tested for resistance to pathotypes found in Minnesota.

3. **Recover *P. sansomeana* from fields within each state and characterize for host range, genetic diversity.**
Almost 100 isolates of P. sansomeana have been collected in total throughout the region and they will be characterized this fall and winter. Host range studies, sources of resistance, and efficacy of seed treatments are all in progress. In Minnesota all isolates that appeared to *be P. sansomeana* on basis of cultural and morphological characteristics were genotyped. None of the isolates were *P. sansomeana*. *P. sansomeana* was not found In fields sampled in this survey.

4. Establish sensitivities (EC_{50}) values for *P. sojae* and *P. sansomeana* isolates recovered from fields towards the new active ingredients ethaboxam, strobilurin, and oxathiapiprolin fungicides.

- EC_{50} values for oxathiapiprolin were completed from isolates collected in Ohio during 2015-2016
- Two manuscripts are in development for long term studies of ethaboxam and oxathiopiprolin in Ohio
- One set of isolates is complete, published from Minnesota – Radmer et al., 2017, Plant Disease 101:62-72.
- MI has initiated fungicide sensitivity for their isolates to ethaboxam, mefenoxam, azoxystrobin, pyraclostrobin and oxathiapiprolin

5. Comparison of new seed treatments on varieties with different resistance packages (*Rps* gene(s)/partial resistance) in field trials.
Santiago Mideros Mora evaluated a number of lines from Brian Diers program to include in this study. Both Rps gene and partial resistance were characterized to evaluate which set of varieties would work best.

Data to be collected of the seed treatment will be stand and canopy closure. We did identify a need in establishing these field protocols as well as situations where inoculations maybe necessary.

A field trial was planted at Boone (IA) that compared varieties with different resistance to *P. sojae* and seed treatments. The site was inoculated with *P sojae*. 2 row plots. Early stand counts across all plots ranged from 80 to 85%. Seedlings were sampled from the plot and evaluated for Phytophthora root rot symptoms. The incidence of root rot among plots ranged

from 20 to 25% with severities ranging from 15 to 30%. Data have yet to be analyzed for treatment effects on root rot. Two hailstorms one week apart occurred at approximately V2-V3 and severely damaged plants in the plots. No PSR developed during the growing season. The trial will likely be harvested in early October.

ial herbicide interactions with the development seed rot and stand

ing diseases can vary greatly from season-to-season but prolonged il conditions associated with cooler soil temperatures seems to favor ons have also been reported to enhance herbicide injury caused by PPO ulfentrazone, saflufenacil; Group 14), commonly adopted pre-emergent son weed control in soybeans. To this date, only few studies delineating ed pre-emergent herbicides on soybeans have been carried out.Field two locations near Mead and Lincoln (East Central Nebraska) in 2017. In 2018, four locations near Tekamah, Arizona (Northeast Nebraska), Mead and Bruno (East Central Nebraska) are being currently evaluated.

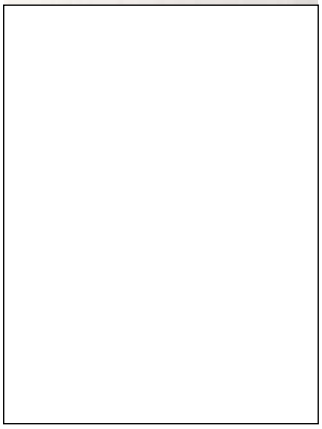

Figure 1. Right picture showing post-emergence damping-off caused by *Phytophthora sojae*. Figure on the left showing cotyledonar symptoms of PPO pre-emergent herbicide injury to emerging soybean seedling. Both abnormalities are favorable by cool and wet soil conditions.