North Central Soybean Research Program

Improving our understanding of stem canker and how to manage it in soybean across the Midwest

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The overall goal of this research is to unravel the fungal species complex that cause stem canker and related diseases and identify soybean stressors that can influence stem canker in order to develop more effective and economical management strategies.

Project Objectives

1. Increase understanding and importance of diseases caused by *Diaporthe* species.
2. Determine the prevalence of *Diaporthe* species causing stem canker among the soybean producing states.
3. Determine which *Diaporthe* species cause the most damage on soybean.
4. Comparison of inoculation methods to study the aggressiveness of *Diaporthe* isolates by species.
5. Soybean seed treatments and in-furrow treatments for control of *Diaporthe* spp
6. Communicate research results with farmers, agribusinesses and other soybean stakeholders.

Research Accomplishments

As of the completion of this project stem canker, and more generally, Diaporthe-induced diseases are still substantial issues for soybean farmers in the North Central region. In objective 1 of this project we wanted to understand which species of Diaporthe were important in the soybean growing regions of the U.S. We have found several species associated with soybean disease. Out of 152 Diaporthe isolates associated with soybean 3 primary pathogens have been recovered from Iowa, Indiana, Kentucky, Michigan, and South Dakota. These are D. longicolla (67.1%), D. caulivora (24.3%), and D. aspalathi (8.6%).

The first two are generally associated with causing damage in the North Central states.

Inoculation procedures were also identified from our work. this will help improve breeding work, by better selection of resistant soybean germplasm. Our study determined that the stem-wound and toothpick methods for inoculation were reliable for all pathogens. However, isolate infection success did vary by method of inoculation, indicating that germplasm should be screened by multiple isolates. From this work we published a peer-reviewed journal article that was recently accepted: Ghimire, K., Petrovic, K., Kontz, B. J., Bradley, C. A., Chilvers, M. I., Mueller, D. S., Smith, D. L., Wise, K. A., and Mathew, F. M. 201X. *Inoculation method impacts symptom development associated with Diaporthe aspalathi, D. caulivora, and D. longicolla on soybean (Glycine max).* Plant Disease (PDIS-06-18-1078-RE; Accepted 9/19/2018).

Additional work is being conducted now to understand aggressiveness of isolates from these locations and also Wisconsin. This work will be published soon and enable researchers to identify a standard panel of isolates that breeders can use to ensure that germplasm is screened correctly. Inoculation procedures were also identified from our work. this will help improve breeding work, by better selection of resistant soybean germplasm.

For objective 2, we continue to develop improved presentations for plant pathologists in the North Central region. During the duration of this grant we have developed numerous outreach resources that are housed on the Crop Protection Network (CPN) Website (cropprotectionnetwork.org). These resources include the following:

1. Detailed webpage on stem canker of soybean (https://cropprotectionnetwork.org/encyclopedia/soybeans/stem-diseases/stem-canker/)
2. Color fact sheet on stem canker of soybean (https://cropprotectionnetwork.org/download/2564/)
3. A one-page information sheet on "zone lines" in soybean caused by Diaporthe organisms (https://cropprotectionnetwork.org/download/2606/)
4. Detailed webpage on pod and stem blight of soybean (https://cropprotectionnetwork.org/encyclopedia/soybeans/stem-diseases/pod-and-stem-blight-phomopsis-seed-decay/)
5. Color fact sheet on pod and stem blight and Phomposis seed decay of soybean (https://cropprotectionnetwork.org/download/2560/)

In addition to perennial resources pertaining to Diaporthe-induced timely publications are disseminated via university websites. An example of such an outreach publication is here: Byamukama, E., Strunk, C., and Mathew, F. 2018. *Early senescence or stem canker killing soybean plants?* iGrow – A service of SDSU Extension. Published Online - 9/11/2018 (http://igrow.org/agronomy/soybeans/early-senescence-or-stem-canker-killing-soybean-plants/).

Objective 3 continues to be on-going. Several experiments have been conducted trying to understand how other stressors such as SCN and aphid feeding might cause more significant issues for Diaporthe-induced diseases. While some evidence suggest that these other stressors can increase the severity of Diaporthe-induced diseases, results are inconclusive. Thus, work continues to understand the interactions among the biotic soybean stressors.

To address objective 4, research was conducted in South Dakota to investigate the effects that seed-treatments and in-furrow applications had on Diaporthe-induced diseases of soybean. As reported previously for 2017, no seed treatments were identified that had strong efficacy against Diaporthe.

In 2018, a field trial was set up in Felt Farm, Brookings, South Dakota to test the efficacy of seed treatments AND in-furrow fungicides against Diaporthe caulivora and D. longicolla. The trial was performed as a randomized complete block design with a total of 11 fungicide treatments (including seed treatments, in-furrow and combination of seed treatments and in-furrow) and a non-treated check under inoculated conditions. Disease pressure was established by spreading sunflower plants pre-inoculated with a South Dakota isolate of D. caulivora. At R6 growth stage, the plants were examined for disease. The disease rating was based on 1 to 4 scale ; 1= healthy plant; 2= plants with lesion restricted to one node (minor lesion); 3= plants with lesion in more than one node (major lesion) and 4= dead plants. The rating scale was converted into a disease severity index (DSI). No significant differences in DSI were observed among the treatments indicating that the seed treatments, in-furrow and combination of seed treatments and in-furrow, are not effective. The trial will be shortly harvested for yield.

In studies conducted in Wisconsin in 2016 and also South Dakota in 2018, no foliar fungicide treatments have been identified that are effective against Diaporthe-induced diseases. In fact, in the trial from South Dakota in 2018, common soybean fungicides like Headline, Priaxor, and Folicur were applied at the R1 and R3 growth stages. No differences among any of these products or timings were identified. Further work in Iowa has investigated the microbiome of the soybean plant when treated with QoI fungicide. Headline is an example of a fungicide in the QoI class. In these trials, a QoI fungicide applied at pod set stage (R3) increased Diaporthe in stems and foliage of healthy soybean plants at full pod (R5) by an average of 40% in 6 cultivars tested. Seed produced from plants with an R3 QoI fungicide had 3 to 12 times higher Diaporthe infection than non-sprayed plants, depending on maturity group. In soybean, Diaporthe spp. are a part of an endophytic community consisting of at least 15 fungal species, some that cause disease and others that don't. Some of these QoI fungicides may lead to increased colonization of soybean parts including seed. In fact, four species of Diaporthe collected from healthy soybeans plants caused seedling disease on inoculated seed.

Due to the lack of seed treatment, in-furrow, and foliar fungicide products available that provide control for Diaporthe-induced diseases, objective 5 has been reasonably easy to accomplish. The chemical products tested in this research do not seem to offer a positive return on investment (ROI), when Diaporthe-induced diseases are the main goal of control. This means that resistant varieties of soybean will continue to be the primary basis of management for diseases like stem canker or pod and stem blight. Therefore, the foundational work conducted in this study, to identify Diaporthe species that cause the primary disease problems in soybean, was critical to guide breeding programs. In addition, the work published to identify a useful inoculation technique will help improve breeding efforts. Future research will focus on identifying new germplasm with high levels of resistance against the primary Diaporthe species identified in this study.