Final Report for 2023-2023 Minnesota Soybean Research and Promotion Council Production Action Team

Project Title: **Soybean Stem and Root Diseases: Filling the Gaps for Management**

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- **Final Report for period May 1, 2022, to April 30, 2023**

The activity and outcomes for this project are summarized below. Please let me know if you have questions or would like additional information. Thank you.

Objectives for this project

1. Determine the efficacy of inputs and tactics to manage sudden death syndrome (SDS)
2. Evaluate tactics to manage brown stem rot (BSR) of soybean.
3. Increase survey efforts to determine distribution and prevalence of important soybean stem and root diseases/pathogens in Minnesota.

Progress Report by Objective

1. Determine efficacy of inputs and tactics to manage sudden death syndrome (SDS)

Background. Sudden death syndrome (SDS) is among the most important soybean diseases in Minnesota and upper Midwest. This disease is common across southern Minnesota and is also spreading into areas where it was previously uncommon. Thus, SDS is becoming a more widespread problem, including in more areas where high levels of resistance in locally adapted varieties is limited. Because SDS is an increasing risk, there has been a continuing need to improve understanding of disease management options. Soybean varieties are available with various levels of resistance to SDS and seed treatments are now available for management of SDS. Three seed treatments are widely marketed for management of SDS, but they can be expensive inputs that may or may not pay-off with increased yields. Thus, there is a need to determine the efficacy and relative benefits of these different management options for SDS in Minnesota.

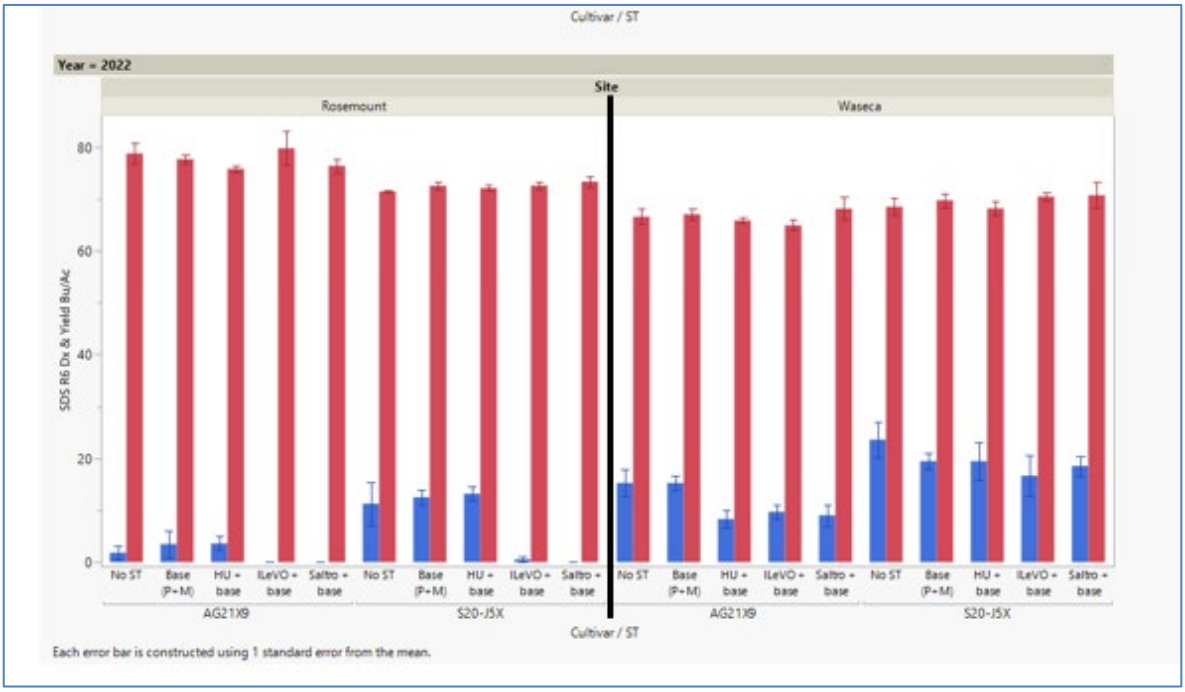
Goal. The goal of this project was to determine the value of three seed treatments (ILeVO®, Saltro®, and Heads-Up®) and resistant soybean varieties for managing SDS.

Experimental Approach. Replicated field studies were conducted at two locations (Rosemount and Waseca, MN) in 2022. The treatments included all combinations of three seed treatments and two soybean varieties with different levels of SDS resistance. In total, five treatments (including controls and base seed treatment alone) were included on each of the two soybean varieties. Seed was treated on the St Paul campus using a rotating drum tabletop lab seed treater. The plots (10 ft wide by 25 ft long) were inoculated with the SDS

pathogen (*Fusarium virguliforme*) and irrigated to enhance development of SDS. All plots were evaluated for the severity and incidence of SDS at two growth stages, and Dx score for SDS was calculated based on the incidence and severity of SDS. Soybean yield was measured with a plot combine at maturity in October.

Progress and results: The field studies were conducted and completed at the two field locations in 2022 to determine the effects of the three seed treatments (noted above) combined with two soybean varieties on development of SDS and soybean yield. Soybeans were planted in May at Rosemount and Waseca, MN. The studies were conducted as planned, and the plants grew well throughout the season.

The summer was exceptionally dry and warm at both field locations in 2022. Low levels of SDS developed at each trial location despite the inoculation and irrigation that was applied to the plots. Slightly higher levels of SDS developed at Rosemount than Waseca, but the Dx score for SDS at both locations was low compared to previous years. In Rosemount, SDS levels were low with an average foliar incidence of 2% in the untreated susceptible plots. In Waseca, SDS levels were more moderate with an average foliar incidence of 15% in the untreated susceptible plots. The seed treatments reduced SDS development but had minimal effects on yield at either location in 2022. This was likely due to the low incidence and the slow and late development of SDS. The results for the different seed treatments and soybean varieties on SDS Dx score and soybean yield are shown below for the studies at Rosemount and Waseca.



Results from field studies conducted in Rosemount and Waseca, MN in 2022 to determine the value of five selected seed treatments and two soybean varieties for managing SDS. *Note that red bars represent yield and blue bars represent SDS incidence and severity (Dx score).*

Objective 2. Evaluate tactics to manage brown stem rot (BSR)

Brown stem rot (BSR) is likely among the top five most important diseases in Minnesota and was common again in fields in central and southern MN in 2022. Crop rotations can suppress BSR and can reduce populations of the pathogen in the soil. Without knowing the pathogen population in the soil, however, it is only a guess as to how effective the rotations are and when BSR-susceptible varieties can be planted with minimal risk. Because BSR is a continuing threat to soybean production in Minnesota, more information is needed to understand risk factors and disease management options.

Goal A. Evaluate soybean breeding lines and varieties for resistance to BSR. Advanced breeding lines from the U of MN soybean-breeding program and selected commercial soybean varieties were evaluated for resistance to BSR. This was done in cooperation with Dr. Aaron Lorenz and his soybean breeding program. The work was conducted in a greenhouse under controlled conditions. Plants were inoculated at the VC/V1 growth stage in replicated studies with two types (A and B) of the BSR pathogen (*Cadophora gregata*). BSR stem and leaf severity was measured at the R6 growth stage. In addition, because BSR resistance is difficult and time-consuming to evaluate, we also worked to evaluate different resistance testing methods with the goal of developing a method that is consistent and has higher throughput for breeding and research needs.

Goal B. This goal is to determine the effects of crop rotation and BSR pathogen populations in soil on risk and management of BSR. Soil samples from long-term crop rotation plots in Waseca were collected and tested to determine the effect of rotation on populations of the BSR pathogen in the soil. A quantitative PCR (qPCR) method was used to estimate pathogen populations (inoculum potential) in soil.

Progress and results:
For Goal A, the primary work on evaluating soybean varieties and breeding lines for resistance to both genotypes of the BSR pathogen was conducted in greenhouses on campus in St Paul. The studies were initiated in December and completed in February. The data reveal various levels of susceptibility/resistance among the soybean entries evaluated to types A and B of the BSR pathogen. Studies were also conducted to determine if we can detect and measure BSR resistance sooner using a new method. The initial results from this work suggest that resistance to BSR can be measured sooner when evaluation is done based on pathogen colonization (pathogen DNA quantity) in the stems than with symptom development, which could increase throughput for BSR resistance screening. Additional studies are needed to determine the feasibility of this new method.

For Goal B. Multiple soil samples from fields with different crop rotation histories have been tested with a PCR assay to determine the quantity of the BSR pathogen in the soil. Initial results suggest a relationship between soil populations of the BSR pathogen and crop rotation history of a field, but the results are not as clear as we would like and more analysis of the data is needed and will be conducted.

Objective 3. Increase survey efforts to determine distribution and prevalence of important soybean stem and root diseases/pathogens in Minnesota.

Increasing and even maintaining soybean yields in the presence of new and evolving pathogens and diseases requires continued improvement in soybean varieties, fungicides, and crop management practices. New pathogens and new disease management practices require more information to manage and use them most effectively. For example, the seed treatments for SDS are expensive and may only be beneficial where SDS occurs, and thus knowing when and where SDS has spread can improve our abilities to use these products most effectively and economically. Thus, there is a need for increased disease/pathogen survey activity to detect and understand how risks from key soybean diseases are changing and where they occur. Stem pathogen surveys have not been done in over 10 years, and new survey efforts and needed to provide a more current 'picture' of prevalence and distribution of types A and B of BSR, pod and stem blight, stem canker, and charcoal rot.

Surveys for soybean stem and root diseases are needed to better understand their current distribution and risk to Minnesota soybean growers. The results will guide disease management priorities. The survey was conducted in August and September to determine the prevalence of key diseases in selected areas in central and southern MN. Samples were collected from problematic and 'healthy' looking commercial fields and research sites. Then plants will be diagnosed in a laboratory to identify symptoms and the presence of key pathogens using pathogen isolation methods and specific DNA diagnostic tests. The new molecular tools based on DNA analysis improved our abilities to test samples in the laboratory for the presence of these diseases.

Progress and results: Soybean stem and root diseases become problematic in multiple fields and areas in the late summer and early fall. A limited survey for soybean stem and root diseases was done in August and September to evaluate and develop methods and to better understand their current distribution and risk to Minnesota soybean growers. Samples were collected from eight problematic and 'healthy' looking commercial fields and at Research and Outreach Centers. The number of samples was low this year in part due to low participation by cooperators and drought conditions. However, this is enabling us to evaluate and perfect our pathogen detection methods and gain interesting results based on preliminary data. Then plants were diagnosed in a laboratory to identify symptoms and the presence of key pathogens using pathogen isolation methods and specific DNA diagnostic tests. The molecular tools based on DNA analysis improved our abilities to test samples in the laboratory for the presence of these diseases. The pathogens/diseases that we tested for (BSR types A and B, pod and stem blight, stem canker, and charcoal rot) were detected in the samples at frequencies of 25-100%, suggesting widespread distribution and common infection by these pathogens in the region sampled.

Information Dissemination of data/information from this research over this project period.

- A field day was conducted in early September in Rosemount, MN to demonstrate and discuss results from this project.
- I brought a group of plant pathology graduate students to view the soybean SDS field study in Rosemount, MN in August to demonstrate and discuss results from this project, and to improve their knowledge of soybeans and soybean diseases.
- Results were presented and discussed with a large group (>100 farmers) at an annual crops meeting in Trimont, MN in November.
- Results from the SDS research were presented to a group of regional and national researchers and agronomists with Bayer Crop Science as well as a group of Extension Educators in November in Shakopee, MN.
- Results were presented and discussed at Research Update Meetings at Waseca, Lamberton, Wilmar, and Morris in January 2023.
- Results from SDS research were presented at the Best of the Best conferences in soybean and wheat research in Grand Forks, ND and Moorhead, MN in February
- Results were presented and discussed at a meeting of Independent Crop Consultants in Bloomington, MN in February.
- Results were shared and discussed at AgExpo in Mankato in January
- Results were shared and discussed at Winter Crops Day in Waseca in January