*Executive Summary*

**Project Title:** Validation of Sclerotinia sclerotiorum Apothecial Prediction Models in North Dakota and Evaluation of Soybean Resistance to White Mold

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**Why the research is important to North Dakota soybean farmers:**

The research conducted here is highly important for North Dakota soybean farmers as it aimed to improve the management of white mold, which has proven to be a significantly challenging disease of soybeans. White mold development is highly dependent on environmental conditions, making it inconsistent and unpredictable. By improving the accuracy of predictive models like Sporecaster specifically for North Dakota's diverse growing regions, farmers can make better-informed decisions on fungicide applications, potentially saving costs by avoiding unnecessary treatments. Additionally, the research aims to identify germplasm lines that have distinct and diverse genetic resistance for the development of new soybean varieties, ultimately providing farmers with more effective tools for disease management. This dual approach of optimizing fungicide use and enhancing genetic resistance will help maintain and potentially increase soybean yields, thereby improving the overall profitability and sustainability of soybean farming in North Dakota.

**Research conducted:**

During the 2023 growing season, our team alongside NDSU county Extension agents conducted apothecial scouting and evaluations to assess white mold levels across North Dakota soybean fields. This was done by primarily targeting fields with a known history of white mold. During the flowering periods, our team scouted fields for apothecia, the white mold mushrooms. Between the R6-R7 growth stages, our team evaluated white mold development. Both of these scoutings were conducted by walking in a "W" pattern through each field and stopping at 20 random spots to measure disease incidence. This involves counting the number of diseased plants within a 1-meter section of row at each stop. The disease incidence ratings were averaged for each field to provide a field-level white mold incidence score. Using GPS coordinates, we retrieved weather data from IBM weather services to calculate daily risk probability levels for the entire growing season as determined by the Sporecaster models.

For screening PI lines of soybeans for resistance to white mold under greenhouse conditions, our team used a highly aggressive isolate of *Sclerotinia sclerotiorum* that had been previously identified and used for previous disease screenings. We then inoculated these soybean genotypes at the V4 growth stage using the cut-petiole technique. Alongside these breeding lines, we grew a panel of four soybean genotypes with known levels of resistance to white mold, serving as standard checks. These plants are exposed to controlled conditions in the greenhouse, where resistance is measured based on the development of lesions on the main stems at three independent time points that are then used to create the Area Under the Disease Progress Curves (AUDPC values). This screening process aims to identify PI

lines with varying degrees of resistance, which can then be used for future breeding efforts to develop soybeans with enhanced resistance to white mold. The ultimate goal is to continue evaluating these lines under field conditions across multiple environments with white mold pressure to validate their resistance in field screenings in future years.

**Findings of the Research:**

The findings of the research reveal significant advancements in managing white mold in soybeans. We scouted 16 fields across North Dakota for white mold development, focusing on the accuracy of the Sporecaster predictive models. Our analysis determined that an action threshold of 30% was most accurate for predicting when to make fungicide applications in non-irrigated fields, an adjustment from the default 40% threshold used in the Sporecaster app. This updated threshold improves the precision of disease management recommendations which will hopefully lead to greater control and profitability of farmers. Additionally, we screened 49 soybean PI lines from maturity groups 000-1, which will be valuable for future breeding efforts and for identifying new resistance mechanisms in lines adapted to the Northen Great Plains. These lines can also serve as new check lines for rating other germplasm. Our findings highlighted significant differences ($P < 0.01$) among the lines, with multiple lines exhibiting high resistance to white mold. Further, we identified highly susceptible lines (PI 458535 and PI 548601), which could be beneficial as susceptible checks and for genetic research into the disease resistance mechanisms in the future. These results offer valuable insights and tools for enhancing white mold resistance in soybeans, ultimately supporting more effective and economical disease management strategies for farmers.

**Benefits and Recommendations to the North Dakota Soybean Farmers and Industry:**

This research provides significant benefits for North Dakota farmers by enhancing their ability to manage white mold in soybean crops effectively. By utilizing the Sporecaster tool with an adjusted action threshold of 30% for non-irrigated fields, farmers can make more accurate decisions regarding fungicide applications, reducing unnecessary treatments and associated costs. This adjustment from the default 40% threshold increases the precision of disease management recommendations, ensuring that fungicide applications are made only when there is a genuine risk of white mold development. Additionally, the identification and screening of 49 soybean PI lines from Maturity Groups 000-1 provide valuable resources for breeding efforts, leading to the development of new soybean varieties with enhanced resistance to white mold. This combination of improved predictive tools and resistant soybean varieties will help farmers maintain higher yields, reduce input costs, and increase overall profitability, supporting the sustainability of soybean farming in North Dakota.

**Acknowledgements:**

We would like to thank all the county Extension agents who assisted in identifying fields with a history of white mold present. We would also like to acknowledge the farmers who allowed us to scout their fields throughout the season. Finally, we would like to thank the North Dakota Soybean Council for their support in this research.

**Figure Captions:**

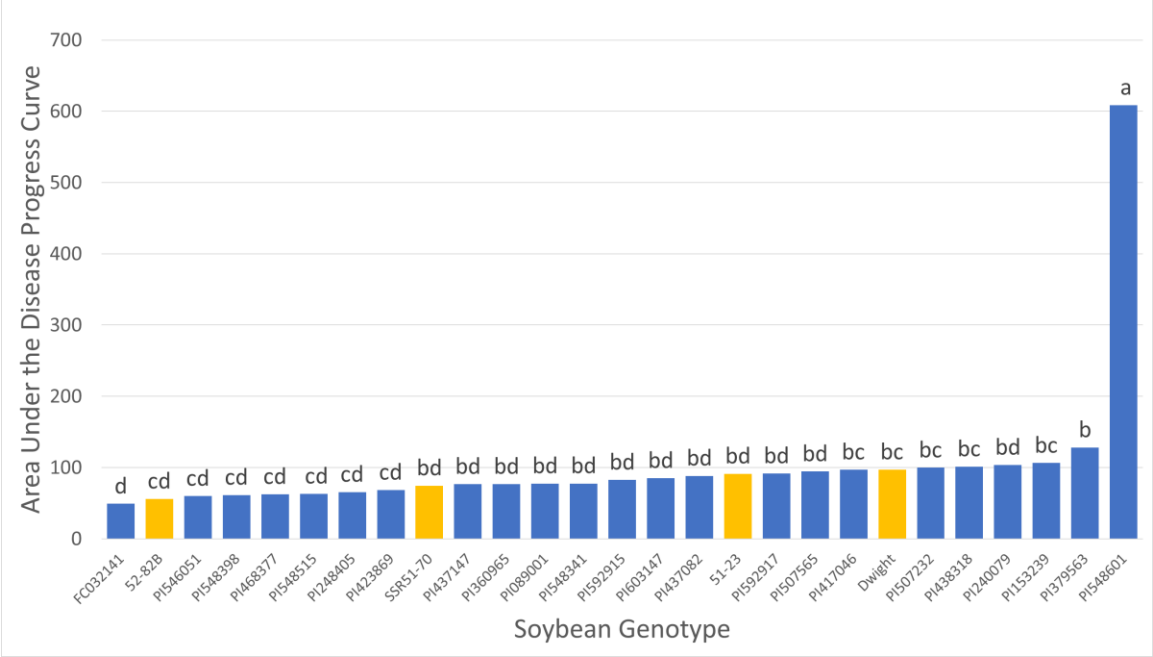


**Figure 1.** Evaluation of early maturity soybean germplasm lines for resistance to *Sclerotinia sclerotiorum* under greenhouse conditions. The gold bars represent four soybean check lines with known levels of resistance (52-82B – Resistant, SSR51-70 and 51-23 – Moderately Resistant/Susceptible, and Dwight – Susceptible). Soybean lines that share letters do not differ as determined by Fisher's LSD (a = 0.05).

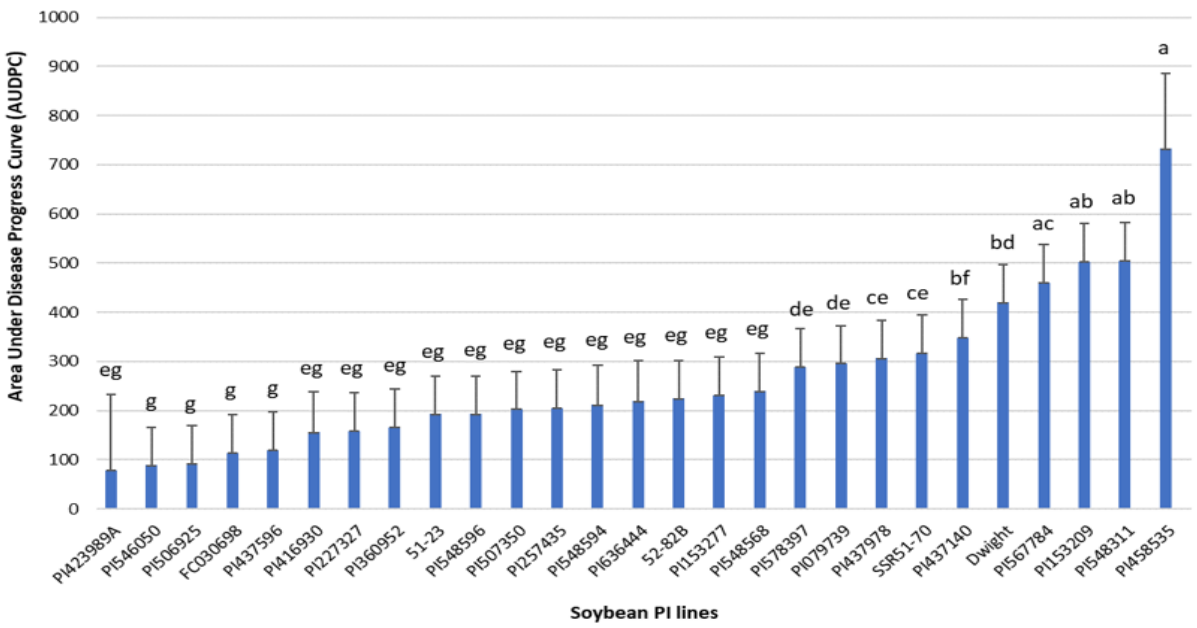


**Figure 2.** Evaluation of early maturity soybean germplasm lines for resistance to *Sclerotinia sclerotiorum* under greenhouse conditions. Four soybean check lines with known levels of resistance levels are used as controls (52-82B – Resistant, SSR51-70 and 51-23 – Moderately Resistant/Susceptible, and Dwight – Susceptible). Soybean lines that share letters do not differ as determined by Fisher's LSD (a = 0.05).

| | | | | | Risk ≥Threshold (R1-R4) | | | Success or Failure at 5% DI | | | Success or Failure at 10% DI | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FieldID | Max_Proba | DI | DI5 | DI10 | 20 | 30 | 40 | 20 | 30 | 40 | 20 | 30 | 40 |
| F-1 | 32.966268 | 55.6 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| F-2 | 36.249276 | 91.3 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| F-3 | 44.2714 | 34.3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| F-4 | 42.17335 | 63.2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| F-5 | 12.17358 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| F-6 | 16.7613 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| F-7 | 19.15643 | 0.1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| F-8 | 12.8678 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| F-9 | 12.8678 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| F-10 | 10.399 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| F-11 | 30.1387 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| F-12 | 17.5669 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| F-13 | 26.99836 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| F-14 | 25.5844 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| F-15 | 9.449037 | 49.8 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F-16 | 12.49385 | 56.4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Accuracy** | | | | | | | | **68.75%** | **81.25%** | **75%** | **68.75%** | **81.25%** | **75%** |

**Table 1.** Validation table of Sporecaster models on the development of white mold disease incidence (DI%). Max Probability lists the maximum risk probability as derived from the predictive models during the flowering period (R1-R4) for each location. DI lists the percentage of plants that exhibited white mold at the time of scouting at the R6 growth stage. DI5 and DI10 indicate if the DI was either greater than 5% or 10%, where if DI > 5% then DI5 would equal 1, and DI < 5% then DI5 would be 0. Further, a binary variable was used to determine if the max probability was greater than different thresholds of 20%, 30%, or 40% during the flowering period. Finally, success/failure was determined if the DI and the risk thresholds were in agreement then a 1 was given, and if DI and risk thresholds were not in agreement, then a 0 was given. Finally, the percentage of each DI and threshold was calculated to determine the success accuracy across all locations.