TOOLS FOR BETTER MANAGEMENT OF WHITE MOLD ON SOYBEAN

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Introduction

Sclerotinia sclerotiorum, the causal agent for white mold disease, is a devastating soybean fungal pathogen. In 2006, white mold ranked in the top 10 yield reducing diseases of soybean and was estimated to account for over 2 billion metric tonnes of yield loss world-wide (1). In the United States, soybean losses in 2009 reached an estimated 59 million bushels due to white mold, which cost producers ~$560 million (2, 3). Disease control is limited due to the lack of complete resistance in commercial cultivars and an incomplete understanding of resistance mechanisms (3). Further investigation of white mold resistance mechanisms in soybean and subsequent resistance evaluations of soybean germplasm would improve commercially available resistance.

Currently, chemical control is incomplete and even unnecessary in some cases, as white mold development requires a complex combination of conditions. In the field, *S. sclerotiorum* survives in the soil as a dormant structure until conditions permit sexual reproduction. Under conducive conditions, apothecia form to produce and release sexual ascospores, which must land on a nutrient source, i.e. soybean flowers, for infection to occur (3). Risk assessment tools are often used to more accurately predict the timing of effective fungicide applications based on weather conditions, pathogen presence, and host architecture. White mold forecasting models such as those for carrot and lettuce, however, do not exist for soybean systems (4,5). Studies have also shown that apothecial development is sensitive to a narrow range of ultraviolet wavelengths, thus, light quality will also be studied as a component in our forecasting model (6). Overall, the development of resistant germplasm and an optimized forecasting system will improve management strategies of white mold disease in soybean.

Research Objectives

1. Evaluate physiological resistance to white mold in soybean germplasm using aggressive *Sclerotinia sclerotiorum* isolates and release the best lines for breeding purposes.
2. Investigate the roles of light and other weather variables in the development of white mold in soybeans. Use this information to develop an improved advisory system for white mold in soybean cultivars.

Current Methods and Research Progress

The first step in evaluating soybean germplasm was to select an array of aggressive *S. sclerotiorum* isolates, from an existing collection, and for use in resistance screenings. During 2014 aggressiveness assays of 44 isolates from five locations in the North Central United States

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and Poland were evaluated on soybean. Isolate aggressiveness varied significantly across all hosts and locations; aggressive isolates from this initial experiment were selected for resistance evaluations.

To increase understanding of white mold resistance mechanisms, we are currently evaluating phenotypic resistance by investigating host colonization in resistant and susceptible soybean germplasm. The infection process of a fluorescent isolate of *S. sclerotiorum* will be monitored using epifluorescence and confocal microscopy. Difficulties in visualizing fungal hyphae in soybean tissues have prompted, 1) the transformation of a more aggressive isolate using the green fluorescent protein, and 2) the addition of a quantitative assay of fungal biomass in soybean tissues. This work will complement collaborative work analyzing genotypic resistance mechanisms to aid in developing assays for resistance screening.

Previously, resistant soybean germplasm was generated by crossing a highly resistant experimental line (W04-1002) with lines exhibiting good agronomic traits. After multiple screenings, 31 lines were selected for advanced white mold field screening in 2014. Lines were planted in a nursery with four check varieties. Disease ranged from almost 60 disease severity index (DSI) units in the susceptible breeding line 91-44 to zero DSI units for SSR81-23. All lines identified as physiologically resistant in greenhouse evaluations had less than 20 DSI units in the field trials. Yield loss is generally not expected until rating reaches 25 or more DSI units (Smith, *personal communication*). Yield ranged from 55.9 bu/a for AxN-1-55 to 26.6 bu/a for SSR81-123. Lodging was an important yield component in this trial. Lodging was significantly (α=0.05) correlated with yield. Breeding lines that lodged severely, yielded less than lines that had lower lodging scores (correlation coefficient = -0.47). Lines with the best physiological resistance to white mold (mostly the 9 x 1 population) tended to yield low-to-moderately in the 2014 trial. Further evaluation and selection will take place in 2015.

In 2014, we also monitored the growth and development of *S. sclerotiorum* and collected detailed data of the progression and severity of white mold disease in Wisconsin soybean fields. Publically available weather data are being accessed and a series of statistical models to predict disease development will be generated for testing in the 2015 field season. Additionally, we are studying light quality effects on apothecial development for integration into an optimized forecasting model. Novel prediction models will be validated at universities in Michigan, Iowa, Purdue, and Illinois through the North Central Soybean Research Program.

Conclusion

White mold-resistant soybean germplasm has been registered with the Wisconsin Alumni Research Foundation (WARF). WARF promotes innovative research by facilitating the commercialization of scientific technologies; therefore, soybean germplasm can be accessed by public and private breeders to develop locally and globally available commercial varieties. In addition, our findings pertaining to *Sclerotinia sclerotiorum* epidemiology will help generate a web-based system to conduct site-specific disease forecasting for fungicide application. This will help further increase the sustainability of soybean systems worldwide by reducing pesticide input.

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