Final Report Project: 10-15-44-202289-7527

Proposal Title: **A new approach to managing white mold in MN soybean**

Institution/Organization: **Regents of the University of Minnesota**
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Project Synopsis:
White mold is an economically important disease of soybean caused by a soil-borne fungus called *Sclerotinia sclerotiorum*. Complicating management, the pathogen is capable of infecting many other crops of economic importance to Minnesota producers. Many of the production practices that have been adopted to maximize soybean yield potential tend to favor a dense canopy and therefore also favor white mold and significant yield losses in Minnesota. The periodic nature of white mold suggests that a fungicide applied only in those years in which disease is favored should be economical and highly effective. However, significant yield losses can occur even when fungicides are timed perfectly. This is likely due to inadequate canopy penetration and coverage of the plant by the fungicide. This proposal details what could be a game-changing way to improve fungicide coverage and drastically improve in-season white mold management.

Proposal Objective and Goal Statements:

1) A New Approach to Managing White Mold in MN Soybean. *(PI: A. Peltier, Cooperator: D. Malvick)*

- *a)* Conduct irrigated, inoculated field trials to compare coverage and efficacy of fungicides applied using a within-the-canopy, between-rows spraying system to typical over-the-top flat fan nozzles.
  - *i)* Assess fungicide coverage in the upper, middle and lower canopy plots treated using a within-the-canopy, between-rows spraying system to typical over-the-top flat fan nozzles.
  - *ii)* Assess disease incidence and severity and soybean yield and moisture for plots treated using a within-the-canopy, between-rows spraying system to typical over-the-top flat fan nozzles.

Sprayer configuration and 2020 fungicide application details.
During the 2019-2020 winter months Jeff Nielsen at the UMN College of Food, Ag and Natural Resource Sciences' Northwest Research & Outreach Center (NWROC) used steel tubing and plumbing parts to build inexpensive within-the-canopy, between-the-rows spray booms (**Figure 1**) to ride 1 foot above the soil-line between 22 and 30 inch soybean rows. Each within-the-canopy unit has three flat fan nozzles spraying medium-sized droplets, two oriented vertically spraying toward soybean rows and one oriented upward at a 45 degree angle to spray under the canopy in the direction opposite the

direction of travel (**Table 1**). The efficacy of fungicide applied using this spray boom was compared (keeping spray speed, volume and pressure constant) to the efficacy of fungicide applied using a typical, over-the-top spray boom. Note that while fungicides work best to protect plants when droplet size is small and more plant surfaces are covered, some fungicide labels suggest increasing droplet size for white mold management to ensure sufficient canopy penetration. This is why a different nozzle capable of producing very course droplets was used for the over-the-top treatment applications.

Figure 1. Configuration of the tractor-mounted hydraulic-powered plot sprayer used to apply fungicides in this experiment. Note that two different within-the-canopy booms were built to allow application down the center of both 22 (Crookston study site) and 30 inch (Staples study site)-spaced soybean rows. The within-the-canopy nozzle body (black circle/square) rode approximately 12 inches from the soil surface and the over-the-top nozzles (white circle/square) rode approximately 8 inches above the soybean canopy.

Table 1. Details regarding the nozzle type and details, spray volume, speed, pressure and droplet size of fungicides applied over the top of the canopy and within the canopy. See **Figure 1** for a picture of what both look like.

	Over-the-top	**Within-the-canopy**
Spray nozzle	TeeJet AI XR11002	TeeJet 110015
Nozzle details	Flat fans riding above the canopy	3 nozzles: 2 flat fans spray vertically toward rows & 1 sprays up at 45° angle under the canopy
Gallons/Acre	10	10
mph	5	5
Pressure	40 psi	40 psi
Droplet size	Very course	Medium

2020 research site details.

In May plots were planted to soybean at the Central Lakes College Ag and Energy Center outside of Staples, MN and the NWROC, outside of Crookston, MN using planting practices common in each area (**Table 2**). Inoculum of the fungus that causes white mold (*Sclerotinia sclerotiorum*) was produced on sterilized, moistened sorghum seed at the NWROC lab.

Table 2. Planting date, seeding rate, row spacing, variety and date of fungicide/inoculum application and harvest at the Central Lake College near Staples and the NWROC near Crookston.

Location	Staples	NWROC
Planting date	May 15	May 21
Seeding rate (Seeds/A)	140,000	167,718
Row spacing (inch)	30	22
Variety	RS084NR2	AG03X7
Fungicide/Inoculum application	July 13	July 17
Harvest	October 5	September 22

When plants reached the beginning (R1) to full flowering (R2) growth stages in mid-July, 8 oz/A of Endura and a non-ionic surfactant were applied at a rate of 10 gallons per acre using flat fan nozzles either over the top of or within the soybean canopy. One liter of air-dried sorghum that had been colonized by *Sclerotinia sclerotiorum,* the fungus that causes white mold, was spread on research plots of three of the four treatments (positive control, over the top and within the canopy fungicide treatments) as soon as fungicide treatments had dried.

For the first month after fungicide treatments were applied and inoculum added to plots, rainwater was supplemented with irrigation water to try and create a more favorable environment for white mold to develop. Unfortunately, the high temperatures that prevailed after treatment applications ensured that, despite adding fungal inoculum and irrigating, conditions were not conducive for disease development. Consequently, it was not a surprise that there were no differences observed among treatments for soybean yield (66.7 bu/A average, $P = 0.2869$) and moisture (12.0% average, $P = 0.2307$) at the Staples site and yield (29.8 bu/A average, $P = 0.9644$) and moisture (8.8% average, $P = 0.1882$) at the Crookston site.

Fungicide coverage and deposition.

To estimate percentage spray coverage using the two application methods, water sensitive paper was placed within the soybean row at six and twelve inches above the soil line before fungicide was applied using the two different methods. A digital scanner was used to input images to be analyzed by a free computer program developed by USDA-ARS, called Deposit Scan. Deposit Scan can be used to estimate deposition and spray coverage.

The within-the-canopy application resulted in significantly better fungicide coverage within the soybean row 6 inches above the soil line than the over-the-top application in Crookston, but not in Staples (**Table 3, Figure 2**). This same trend was observed 12 inches above the soil line (**Table 4**), with significantly more coverage when applying fungicides within-the-canopy at Crookston and numerically better coverage in Staples compared to over-the-top. We speculate that at the CLC in Staples, the thick canopy may have interfered with fungicide penetration at the 6-inch height regardless of application method. More similar research in 2021 is to be funded by MSRPC.

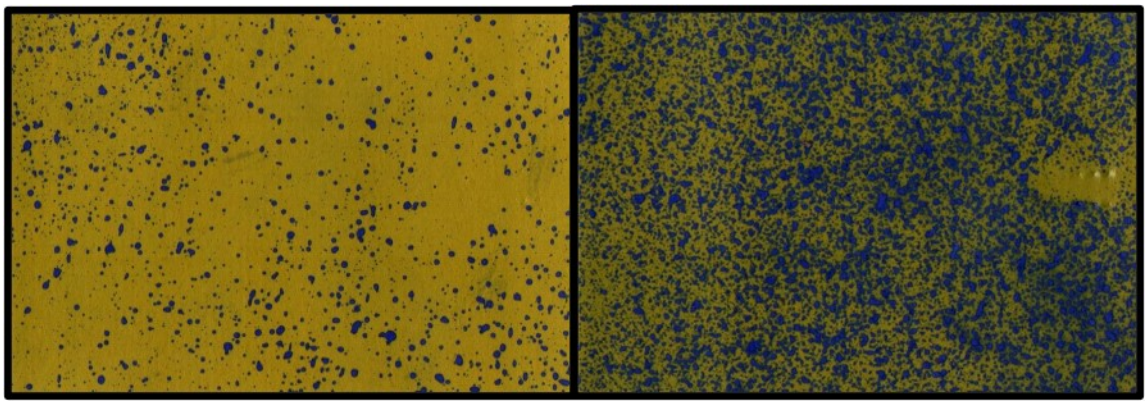

Figure 2. Water sensitive paper that had been placed 6 inches above the soil line in the soybean row before fungicide was applied using either the traditional over-the-top method (left) or the experimental within-the-canopy method (right).

Table 3. Coverage (%) and deposition (µL/cm^2) of fungicides applied over-the-top or within-the-canopy captured by water-sensitive paper placed within the R1 soybean canopy at 6 inches above the soil line in 22 inch rows at the NWROC in Crookston and in 30 inch soybean rows at the CLC in Staples. Treatments means within a column followed by different letters are significantly different from one another.

	NWROC, Crookston			CLC, Staples	
	Coverage	Deposition		Coverage	Deposition
Nozzle configuration	%	microL/cm^2		%	microL/cm^2
Over-the-top	14.3 a	1.6 a		20.9 a	3.1 a
Within-the-canopy	55.1 b	31.8 b		20.4 a	2.5 a
P=	0.0357	0.0282		0.9776	0.6825

Table 4. Coverage (%) and deposition (µL/cm^2) of fungicides applied over-the-top or within-the-canopy captured by water-sensitive paper placed within the R1 soybean canopy at 12 inches above the soil line in 22 inch rows at the NWROC in Crookston and in 30 inch soybean rows at the CLC in Staples. Treatments means within a column followed by different letters are significantly different from one another.

	NWROC, Crookston			CLC, Staples	
	Coverage	Deposition		Coverage	Deposition
Nozzle configuration	%	microL/cm^2		%	microL/cm^2
Over-the-top	27.8 a	2.3 a		11.3 a	0.7 a
Within-the-canopy	51.9 b	26.5 a		27.6 a	2.6 a
P=	0.0813	0.4070		0.1996	0.2352

Compared to the traditional over-the-top fungicide application method, there was significantly more fungicide deposited by the within-the-canopy fungicide application method 6 inches above the soil line (**Table 3**). When compared to the traditional over-the-top fungicide application method, there was numerically more fungicide deposition at 12 inches above the soil line in the within-the-canopy plots at both the Staples and Crookston locations (**Tables 3 & 4**).

Outreach.

The PI presented this research project to farmers through the NW MN soybean plot tour events co-presented by UMN Extension, NW MN County Soybean & Corn Growers Associations and MSRPC (**Table 5**).

Table 5. County and nearest city, program dates, speakers and topics of summer soybean plot tour programs.

County (nearest city)	Date	Speakers/Topics*
Marshall (Warren)	July 22	1, 2, 3, 4, 5, 6
Norman (Shelly)	August 24	1,4,5,6
Pennington (St. Hilaire)	August 25	1,2,3,4,5
Polk (Fosston)	August 25	1,3,4,5

*Speakers: 1) David Key, research director MSRPC, Topics MN Soybean is addressing that are currently making MN soybean production more difficult, 2) Garth Krueger, statistician and farmer, Using variety trial data to make seed selections for your farm, 3) Bill Craig, county soybean variety trial coordinator, Our emcee, 4) Angie Peltier, UMN Extension educator, MSRPC-sponsored projects in 2020, 5) Debalin Sarangi, UMN Extension weeds specialist, Managing Palmer amaranth and waterhemp in NW MN, 6) Aaron Lorenz, UMN soybean breeder, MN soybean breeding projects.

The project's PI traveled to the Central Lakes College Ag and Energy Center to participate as a speaker at their annual field day program on the morning of August 21. Ten people spent more than an hour at the white mold stop learning more about white mold management, this project and other soybean diseases.

In lieu of holding the typical Crops & Soils Day in mid-July, researchers at the NWROC decided to reduce the risk of the field day becoming a COVID-19 super-spreader event by instead creating short videos to highlight their research projects. This project is highlighted in a video housed on the NWROC's YouTube page and is currently highlighted on the NWROC homepage (https://youtu.be/qXx5Wk4brPI).

An article summarizing the 2020 results of this project was posted in the "Cropping Issues in NW MN" digital newsletter online (https://blog-nwcrops.extension.umn.edu/2020/11/a-new-way-of-managing-white-mold-in.html) which is distributed to 729 people through email. This article, in this venue alone, was read by 1,084 people.

Details about this project and results from 2020 were summarized in the “On-farm Cropping Trials Northwest & West Central Minnesota and 2020 Minnesota Wheat Research Review”. This printed booklet is typically distributed to NW MN and E ND farmers at the Prairie Grains Conference held each December in Grand Forks, ND. Due to COVID-19, this year’s printed booklet was mailed to 810 wheat farmers (who also grow soybean) in the region and archived online at the MN Wheat website (https://mnwheat.org/council/wheat-research-reports/).

Lastly, on January 19, the project PI was invited to speak to farmer-members of the Northland Community & Technical College’s Farm Business Management program at a monthly breakfast meeting and so decided to speak about the results of this project to 12 people via Zoom.