MID-YEAR REPORT

Optimizing fungicide spray volume for improved white mold management in soybeans

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Objectives of the research:

1. Identify the minimum fungicide spray volume needed to maximize white mold control and soybean yield and quality
2. Evaluate whether the impact of fungicide spray volume on white mold management differs across fungicides
3. Quantify the impact of soybean architecture (bushy versus upright) on the optimum fungicide spray volume for white mold management

Changes to the study objectives:

Objective #2 was changed to the following: Evaluate whether the impact of fungicide spray volume on white mold management differs for a single fungicide application versus two sequential applications.

This change was discussed during the grant defense in December 2021. Two fungicide applications are often needed in irrigated soybeans, and soybean canopy characteristics differ between the first and second applications: Soybeans are taller, and the canopy is denser at the second application. Because of the differences in canopy characteristics, there was concern that the impact of spray volume may differ for a single versus two sequential applications.

Completed work:

Soybeans were planted on June 2 and 3 in Carrington and on June 3 in Oakes. The relatively late planting date was due to the cold, wet spring. Because of concerns about delayed canopy closure associated with the relatively late planting date, soybeans were seeded to narrow (14-inch) rows. The experiments were established as a randomized complete block design with a split-plot arrangement, with the number of fungicide applications (one versus two) as the main factor and fungicide spray volume as the sub-factor. The study in Carrington was conducted with 9 replicates, and the study in Oakes was conducted with 6 replicates. White mold disease pressure is often highly variable over short distances, and a large number of experimental replicates was utilized to maximize the likelihood of each treatment being evaluated the same number of times in areas of high versus low disease pressure. Treatment plots were 25 feet long and 5 feet wide (consisting of four rows centered within the 5-foot width). To facilitate overspray of treatments and capture any fungicide drift, treatment plots were separated by 5-foot wide non-harvested filler plots on one side and 10-foot wide non-harvested filler plots on the other side. A tractor with a 5-foot wheelbase was used to apply fungicide treatments, and this tractor was driven in the center of the 10-foot wide filler plots. Parallel studies were established with each of four different soybean varieties in Carrington and three different varieties in Oakes. The number of varieties assessed in Oakes represents an increase from the two varieties proposed in the original grant. Testing was conducted on the following varieties in Carrington: Xitavo 'XO0602E' (0.6 maturity), Asgrow 'AG06X8' (0.6 maturity), Xitavo 'XO0731E' (0.7 maturity), and Asgrow 'AG09Xf0' (0.9 maturity). Testing was conducted on the following varieties in Oakes: Xitavo 'XO1041E', Asgrow 'AG11X8', and Xitavo 'XO1212E'. The Asgrow varieties were Extend-type soybeans, and the Xitavo varieties were Enlist-type soybeans. Fertility and weed management were conducted in accordance with best practices. In Carrington, fungicides were applied July 25 at the early R2 growth stage (79 to 91% of plants at the R2 growth stage, depending on the variety) and August 1 at early R3 growth stage. In Oakes, fungicides were applied July 21 at the full R2 growth stage (100% of plants at the R2 growth stage across all three soybean varieties) and on August 1 at the R3 growth stage. Fungicides were applied with a PTO-driven tractor-mounted sprayer equipped with a pulse-width modulation system (Capstan AG, Topeka, KS). Pulse width was modified as needed to maintain a constant driving speed, the same nozzles, and the same application pressure across spray volume treatments, with pulse width manually adjusted and set on the basis of the measured spray output. Nozzles and application pressures were selected to calibrate the droplet size relative to canopy closure, with medium droplets used when the canopy was nearing closure and coarse droplets utilized when the canopy was closed. TeeJet (Spraying Sytems Co.; Wheaton, IL) extended-range flat-fan nozzles were utilized due to their broad commercial usage and the familiarity of North Dakota producers with these nozzles. Fungicide application details are presented in **Table 1**. In Carrington, supplemental irrigation was applied via low-output rotating micro-sprinklers with a 20-foot spray radius established in a 20-foot offset grid pattern. Irrigation commenced at late vegetative growth and continued through the R5 growth stage, with irrigation delivered as needed to maintain the top half-inch of the soil moist (to facilitate production of apothecia and spores by the Sclerotinia pathogen) beginning at late vegetative growth and as needed to create conditions favor. In Oakes, supplemental overhead irrigation was applied via a linear irrigator as needed to optimize soybean agronomic performance. White mold was assessed on October 13-14 in Carrington and October 20-21 in Oakes when soybeans were at maturity. All plants in the third row (counted from the side of the plot closest to the tractor driving pass) of each four-row plot were individually assessed for white mold severity on a 0 to 5 scale representing the percentage of the plant impacted by Sclerotinia stem rot: 0 = 0%, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-99%, 5 = 100%. Soybeans were harvested October 13-14 in Carrington and October 21 in Oakes.

Table 1. Driving speed, nozzles, application pressure, spray droplet size, and spray pulse width utilized for fungicide treatment imposition; Carrington and Oakes, ND (2022).

Location	**Oakes**	**Oakes**	**Carrington**	**Carrington**
Date	July 21	August 1	July 25	August 3
Fungicide	Endura, 5.5 oz/ac	Endura, 5.5 oz/ac	Endura, 5.5 oz/ac	Endura, 5.5 oz/ac
Driving speed	10.0 mph	9.5 mph	11.2 mph	10.5 mph
Nozzles	XR11006	XR11008	XR11008	XR11008
Pressure	35 psi	30 psi	30 psi	30 psi
Droplet size	medium	coarse	coarse	coarse
Spray pulse width				
5.0 gal/ac	25%	21%	27%	25%
7.5 gal/ac	40%	33%	42%	38%
10.0 gal/ac	57%	46%	58%	51%
12.5 gal/ac	76%	59%	76%	66%
15.0 gal/ac	97%	75%	96%	84%

Preliminary results:

Increasing fungicide spray volume from 5.0 to 15.0 gal/ac had very little impact on white mold management across the seven soybean varieties tested. Response to fungicide spray volume was similar across upright varieties with delayed canopy closure, bushy varieties with early canopy closure, tall varieties and short varieties (**Figures 1, 3**). When a single fungicide application was made, no impact on white mold severity or soybean yield was observed as fungicide spray volume increased from 5.0 to 15.0 gal/ac (**Figures 1, 2**). When two sequential fungicide applications were made 9 or 11 days apart, a weak trend of slightly improved disease control and increased yield was observed as spray volume increased from 5.0 to 15.0 gal/ac (**Figures 3, 4**), but statistical separation across spray volume treatments was only observed for the disease reduction conferred by 5.0 vs. 12.5 gal/ac (**Figure 4**).

Figure 1. Soybean canopy closure and height at the first fungicide application and white mold and yield response to **a single fungicide application** (Endura, 5.5 oz/ac) applied in 5.0 to 15.0 gal/ac spray volume. Within-column means followed by different letters are significantly different ($P < 0.05$; Tukey multiple comparison procedure).

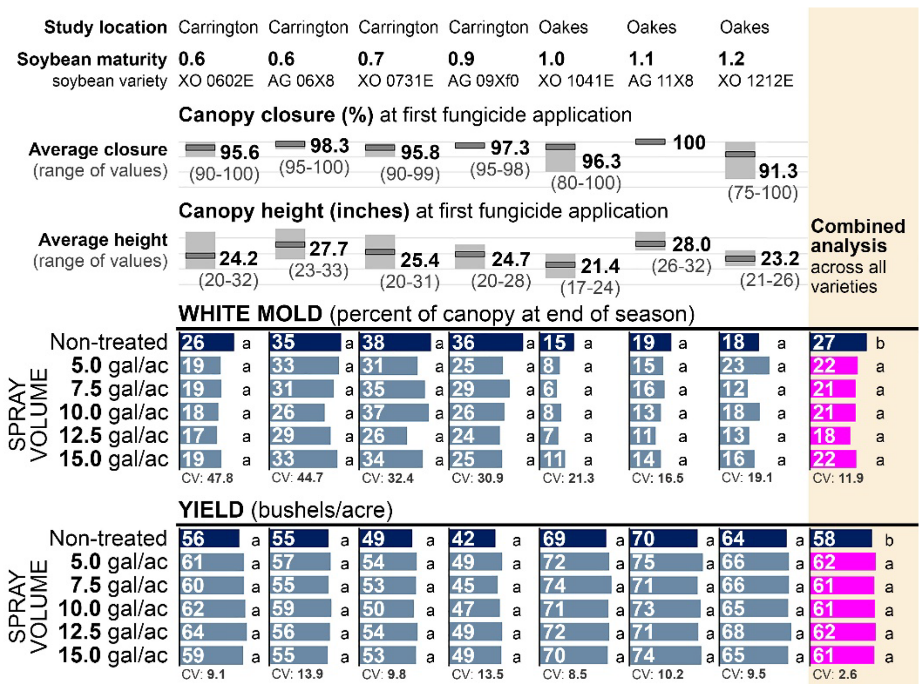
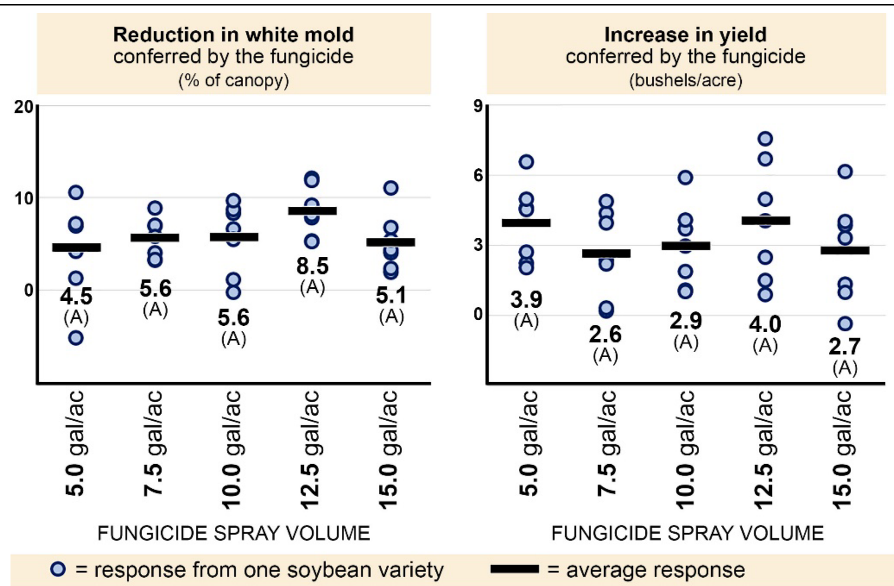


Figure 2. Reduction in white mold and increase in yield conferred by **a single fungicide application** (Endura, 5.5 oz/ac) applied in 5.0 to 15.0 gal/ac spray volume. Means followed by the same letters are not significantly different ($P < 0.05$; Tukey multiple comparison procedure).



The split-plot experimental design allowed for a statistical assessment of whether the response to fungicide spray volume was consistent or whether it changed when a single fungicide application was made versus two sequential fungicide applications. No statistically significant differences (at a 95% level of confidence) in the impact of increased spray volume on yield were observed across one versus two fungicide applications. Statistically significant differences ($P < 0.05$) in the impact of increased spray volume on white mold control were observed for two of seven varieties. In both varieties, increased fungicide spray volume had a greater impact on disease control when fungicides were applied twice (versus a single application).

Work to be completed: Plot-level seed quality and soybean market grade assessments are in progress and will be completed by January 2023. A user-friendly summary of results will be posted to the NDSU Carrington webpage by March 2023. Major results will be disseminated to stakeholders at winter crop meetings and summer plot tours from January to September 2023.

Figure 3. Soybean canopy closure and height at the first fungicide application and white mold and yield response to **two applications** of Endura (5.5 oz/ac) made 9 days (Carrington) or 11 days (Oakes) apart applied in 5.0 to 15.0 gal/ac spray volume. Within-column means followed by different letters are significantly different ($P < 0.05$; Tukey multiple comp. procedure).

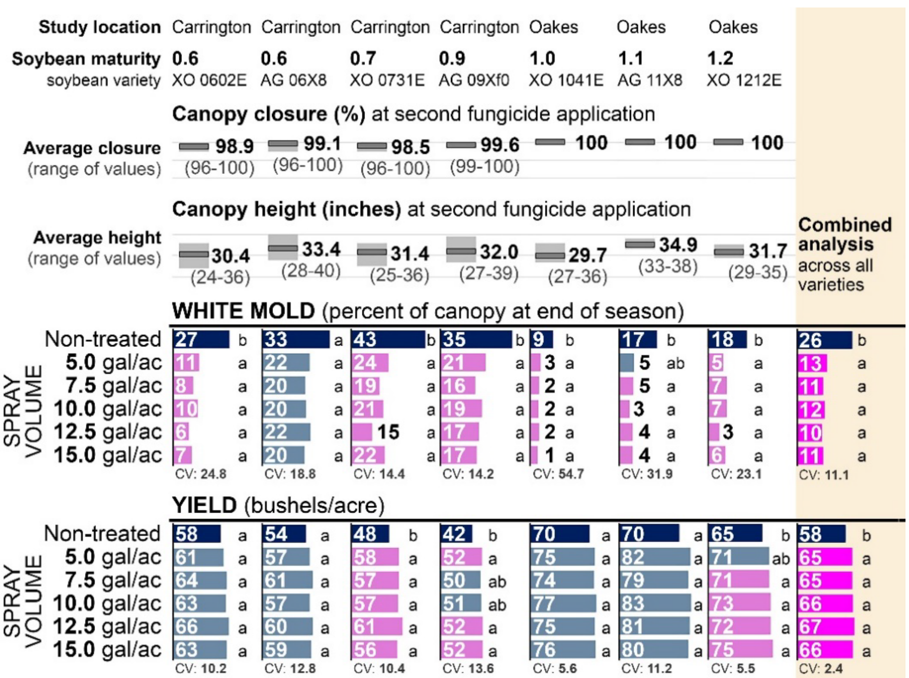


Figure 4. Reduction in white mold and increase in yield conferred by **two fungicides applications** (Endura, 5.5 oz/ac) applied in 5.0 to 15.0 gal/ac spray volume. Means followed by different letters are significantly different ($P < 0.05$; Tukey multiple comp. procedure).