MID-YEAR REPORT

Optimizing fungicide application frequency and application interval relative to soybean maturity for improved white mold management in soybeans

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Objectives of the research:

1. Quantify the profitability of making a single versus two sequential fungicide applications targeting white mold in soybeans of early, mid or late 0-maturity.
2. Optimize the length of the interval between successive fungicide applications (7, 10, 12 or 14 days).
3. Evaluate whether the low-cost, off-patent fungicide thiophanate-methyl (Topsin and generics) applied at 40 fl oz/ac can confer satisfactory white mold control in soybeans applied as a single application or with an optimized application interval when applied in rotation with Endura.

Completed work:

Soybeans were planted on May 27 in Carrington and on June 2 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 8 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), with treatment plots established as pairs of 5-foot plots of different varieties. To facilitate overspray of treatments and capture any fungicide drift, pairs of treatment plots were separated by 5-foot wide non-harvested filler plots. Fungicides were applied with a 100-inch hand-held boom with six nozzles, each 20 inches apart (for a total spray width of 120 inches), and pressurized by compressed carbon dioxide. Applications were made by walking between each pair of 5-foot treatment plots. Fungicide spray volume was 15 gal/ac. Nozzles and application pressures were set such that the spray droplet size was calibrated relative to canopy characterstics. All applications were with TeeJet AIXR110015 flat-fan nozzles (Spraying Systems Company, Wheaton, IL) at 50 psi (coarse droplets); the soybean canopy was at or near closure at the first fungicide application and was closed in all subsequent applications. Parallel studies were established with each of four different soybean varieties at both study locations; this represented an increase from the three varieties per location proposed in the original grant proposal. 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: Asgrow 'AG09Xf0' (0.9 maturity), Asgrow 'AG11X8', Dairyland 'DSR1120' (1.1 maturity), and Peterson Farms '18X11N' (1.1 maturity)'. The Asgrow and Peterson Farms varieties were Extend-type soybeans, the Xitavo varieties were Enlist-type soybeans, and the Dairyland variety was a Roundup-Ready 2 type variety. Fertility and weed management were conducted in accordance with best practices. In Carrington, fungicides were applied July 21 at the full R2

growth stage (98-100% of plants at the R2 growth stage, depending on the variety), July 28, July 31, August 2, and August 4. In Oakes, fungicides were applied July 24 at the full R2 growth stage (100% of plants at R2), July 31, August 3, August 5, and August 7. 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 R4 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 14, 17, 18 and 19 in Carrington and October 21 in Oakes when soybeans were at maturity. All plants in the second row (counted from the south) 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 20 in Carrington and October 21-22 in Oakes.

Preliminary results:

In Carrington, white mold pressure was high, and strong statistical separation in soybean yields was observed across treatments (**Table 1**). Results parallel findings from the first two years of this project. In the 0.6-maturity, 0.7-maturity and 0.9-maturity varieties assessed in Carrington, soybean yields were maximized when sequential fungicide applications were made 7 days apart. Whether applied alone or as the first application in a two-fungicide sequence, no statistical separation was observed between the fungicides Topsin (40 fl oz/ac) or Endura (5.5 oz/ac), but, on average, Endura was generally associated with slightly higher yields than Topsin.

In Oakes, white mold pressure was low, and no statistical separation and very little numerical separation in soybean yields was observed across treatments (**Table 1**). Disease pressure differed sharply across the study: While there was virtually no white mold on the south end of the study, white mold pressure was moderate on the north end of the study.

Work to be completed:

Disease assessments were taken by evaluating individual plants and reading disease ratings into a voice recorder, and the audio recordings of the disease assessments have not yet been transcribed. Transcription of the audio recordings should be completed by the end of December 2022, and disease data will be analyzed immediately thereafter. If the disease data from Oakes show that the area with moderate disease pressure coincided with the blocking of the experimental replicates, the data will be re-analyzed to exclude those replicates in which there was no white mold disease pressure.

This project represented the final year of a 3-year research effort. A multi-year data summary and final conclusions will be prepared in January 2023, and 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. Results from this project and a previous project evaluating the returns to one versus two fungicide applications targeting white mold will be combined for an academic publication, with work on that manuscript anticipated in winter 2023-2024.

Table 1. Impact of fungicide application frequency (one versus two applications), the interval between sequential fungicide applications (7, 10, 12 or 14 days), and the fungicide applied (Topsin at 40 fl oz/ac versus Endura at 5.5 oz/ac) on soybean yield under high white mold pressure; Carrington, ND (2022).

study location	Carrington	Carrington	Carrington	Carrington
soybean maturity	0.6	0.6	0.7	0.9
variety	AG06X8	XO 0602E	XO 0731E	AG09Xf0
	SOYBEAN YIELD (bushels/acre)			
Non-treated control	**25** d	**29** d	**21** c	**25** d
Topsin, 40 fl oz/ac (R2 growth stage)	**34** c	**40** bc	**32** ab	**34** c
Topsin, 40 fl oz/ac (R2) + Endura, 5.5 oz/ac (7 days later)	**43** ab	**44** abc	**40** a	**42** ab
Topsin, 40 fl oz/ac (R2) + Endura, 5.5 oz/ac (10 days later)	**40** abc	**45** ab	**38** ab	**38** abc
Topsin, 40 fl oz/ac (R2) + Endura, 5.5 oz/ac (12 days later)	**41** abc	**48** a	**38** ab	**40** abc
Topsin, 40 fl oz/ac (R2) + Endura, 5.5 oz/ac (14 days later)	**38** bc	**43** abc	**35** ab	**36** bc
Endura, 5.5 oz/ac (R2 growth stage)	**37** bc	**37** c	**31** b	**40** abc
Endura, 5.5 oz/ac (R2) + Endura, 5.5 oz/ac (7 days later)	**47** a	**47** ab	**38** ab	**45** a
Endura, 5.5 oz/ac (R2) + Endura, 5.5 oz/ac (10 days later)	**39** abc	**46** ab	**37** ab	**42** ab
Endura, 5.5 oz/ac (R2) + Endura, 5.5 oz/ac (12 days later)	**42** ab	**44** ab	**37** ab	**41** ab
Endura, 5.5 oz/ac (R2) + Endura, 5.5 oz/ac (14 days later)	**40** abc	**41** abc	**34** ab	**39** abc
F:	11.28	12.26	10.77	14.05
P>F:	< 0.0001	< 0.0001	< 0.0001	< 0.0001
CV:	12.1	10.6	13.3	10.6

Table 2. Impact of fungicide application frequency, the interval between sequential fungicide applications, and the fungicide applied on soybean yield under low to moderate white mold pressure; Oakes, ND (2022).

study location	Oakes	Oakes	Oakes	Oakes
soybean maturity	0.9	1.1	1.1	1.1
variety	AG09Xf0	AG11X8	DSR1120	18X11N
	SOYBEAN YIELD (bushels/acre)			
Non-treated control	**71** a	**74** a	**67** a	**68** a
Topsin, 40 fl oz/ac (R2 growth stage)	**70** a	**76** a	**67** a	**68** a
Topsin, 40 fl oz/ac (R2) + Endura, 5.5 oz/ac (7 days later)	**72** a	**80** a	**67** a	**68** a
Topsin, 40 fl oz/ac (R2) + Endura, 5.5 oz/ac (10 days later)	**70** a	**77** a	**67** a	**67** a
Topsin, 40 fl oz/ac (R2) + Endura, 5.5 oz/ac (12 days later)	**69** a	**80** a	**68** a	**67** a
Topsin, 40 fl oz/ac (R2) + Endura, 5.5 oz/ac (14 days later)	**72** a	**75** a	**67** a	**72** a
Endura, 5.5 oz/ac (R2 growth stage)	**72** a	**76** a	**71** a	**71** a
Endura, 5.5 oz/ac (R2) + Endura, 5.5 oz/ac (7 days later)	**73** a	**77** a	**68** a	**68** a
Endura, 5.5 oz/ac (R2) + Endura, 5.5 oz/ac (10 days later)	**71** a	**77** a	**67** a	**70** a
Endura, 5.5 oz/ac (R2) + Endura, 5.5 oz/ac (12 days later)	**71** a	**77** a	**66** a	**70** a
Endura, 5.5 oz/ac (R2) + Endura, 5.5 oz/ac (14 days later)	**70** a	**78** a	**68** a	**68** a
F:	0.46	1.50	1.27	1.10
P>F:	0.9115	0.1571	0.2650	0.3725
CV:	6.9	5.5	5.1	6.6