Mid-year report:

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

*Principal investigator: Michael Wunsch, NDSU Carrington Research Extension Center*
*Co-PI: Kelly Cooper, NDSU Robert Titus Research Farm, Oakes*

**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 to 8, 10 to 11, or 13 to 14 days).
3. Evaluate whether the low-cost, off-patent fungicide thiophanate-methyl (Topsin and generics) can consistently confer satisfactory white mold control in soybeans with an optimized interval between sequential fungicide applications.

**Completed work:**

Planting was conducted May 12 in Oakes and May 14 in Carrington. Experimental design was a randomized complete block with a split-plot arrangement (main factor = soybean variety, sub-factor = fungicide treatment) and eight replicates. The varieties Golden Harvest '0145X' (0.1 maturity), Golden Harvest '0543X' (0.5 maturity), and Peterson '14R09N' (0.9 maturity) were planted in rows 14 inches apart at 165,000 pure live seeds/ac. Plots consisted of four rows, 25 feet long at seeding and approximately 20 feet long at harvest. To facilitate overspray of fungicides, all treatment plots were separated by four-row unharvested plots.

Fungicides were applied in 15 gal/ac with a hand-held boom equipped with four AIXR110015 air-induction flat-fan nozzles spaced 19 inches apart (Spraying Systems Co.; Wheaton, IL). Application pressure was set relative to canopy closure to deliver fungicides with medium droplets when the soybean canopy was open and coarse droplets when the soybean canopy was at or near closure. The first application was made at the early to late R2 growth stage. Application details follow:

| | Carrington, ND (2020) | | | Oakes, ND (2020) | | |
|---|---|---|---|---|---|---|
| Soybean variety | GH '0145X' | GH '0543X' | PFS '14R09N' | GH '0145X' | GH '0543X' | PFS '14R09N' |
| 1st application | July 6 | July 8 | July 10 | July 1 | July 8 | July 8 |
| Growth stage | 24% R2, 75% R3 | 78% R2, 20% R3 | 11% R1, 89% R2 | 6% R1, 94% R2 | 65% R2, 35% R3 | 79% R2, 21% R3 |
| Canopy closure | 69% | 88% | 87% | 68% | 91% | 87% |
| Applic. pressure | 70 psi | 60 psi | 60 psi | 70 psi | 60 psi | 60 psi |
| Droplet size | medium | medium | medium | medium | medium | medium |
| 2nd application | July 13 | July 15 | July 17 | July 8 | July 15 | July 15 |
| Canopy closure | 95% | 97% | 96% | 84% | 95% | 94% |
| Applic. pressure | 40 psi | 40 psi | 40 psi | 60 psi | 40 psi | 40 psi |
| Droplet size | coarse | coarse | coarse | medium | coarse | coarse |
| 3rd application | July 16 | July 18 | July 20 | July 11 | July 18 | July 18 |
| Canopy closure | 94% | 99% | 98% | 93% | 94% | 94% |
| Applic. pressure | 40 psi | 40 psi | 40 psi | 50 psi | 40 psi | 40 psi |
| Droplet size | coarse | coarse | coarse | coarse | coarse | coarse |
| 4th application | July 20 | July 22 | July 24 | July 15 | July 22 | July 22 |
| Canopy closure | 98% | 99% | 99% | 93% | 99% | 99% |
| Applic. pressure | 40 psi | 40 psi | 40 psi | 40 psi | 40 psi | 40 psi |
| Droplet size | coarse | coarse | coarse | coarse | coarse | coarse |

Disease establishment: The research studies were planted on land with a prior history of Sclerotinia epidemics and received supplemental overhead irrigation. In Oakes, irrigation was

delivered with a linear irrigator; to facilitate disease pressure, a second pass with the irrigator delivering an extra 0.25 inches of water was made a day after the normal scheduled irrigation. In Carrington, irrigation was applied with micro-sprinklers established on a 20-foot offset grid, with 6.8 inches of water applied across 8 days from July 3 (R1 growth stage) to August 5 (R4/R5).

White mold was assessed Aug. 26-28 (0.1- and 0.5-maturity varieties; R7 growth stage) and Sept. 25 (0.9-maturity variety; R8) in Oakes and Oct. 8-15 (R8 growth stage) in Carrington. Each plant in the middle two rows of each plot was individually assessed for Sclerotinia stem rot severity using a 0 to 5 scale representing the percentage of the plant impacted by Sclerotinia stem rot, where 0 = 0% of the plant impacted by Sclerotinia, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-99%, 5 = 100%. Plant tissue was considered to be impacted by Sclerotinia stem rot if it exhibited symptoms of Sclerotinia and/or bore poorly filled or unfilled pods caused by one or more Sclerotinia lesions that girdled stem tissue below the pods.

The studies were harvested on October 8-9 in Oakes and October 15-16 in Carrington.

**Preliminary results:**

Sclerotinia disease pressure was low across all soybean varieties evaluated in Oakes and across two of three soybean varieties evaluated in Carrington (**Table 1**). The fungicide Endura (5.5 oz/ac) conferred statistically significant reductions in white mold most consistently when applied twice, but, under the low disease pressure observed in these studies, a single application of Endura performed similarly to two applications. The fungicide Topsin (20 fl oz/ac) conferred a statistically significant reduction in white mold in Carrington when followed by the application of Endura 7 days later but did not confer statistically significant reductions in white mold when applied alone. Applied once or applied twice sequentially, Topsin did not confer statistically significant reductions in white mold in any of the application intervals tested, any of the soybean varieties, or either of the study locations. When fungicides were applied twice sequentially, disease pressure was insufficient to differentiate the impact of fungicide application interval on white mold control at either study location. Disease pressure was insufficient to differentiate the impact of any of the fungicide treatments on soybean yield and profitability in Oakes.

**Work to be completed:**

Yield data still need to be collected and analyzed from the study conducted in Carrington. Anticipated completion: December 2020.

The profitability of making one versus two fungicide applications targeting white mold (objective 1) will be calculated as soon as the collection of yield data is finalized. Anticipated completion: December 2020.

Results need to be placed into a user-friendly format and disseminated to growers. Anticipated completion: December 2020.

**Table 1.** Impact of fungicide application frequency and application interval on white mold management and soybean yield; Carrington and Oakes, ND (2020).

| | **Sclerotinia incidence** (percent of plants) | | | | **Sclerotinia incidence** (percent of plants) | | | |
|---|---|---|---|---|---|---|---|---|
| | **OAKES, ND** (2020) | | | | **CARRINGTON, ND** (2020) | | | |
| | Combined analysis | **GH0145X** | **GH0543X** | **14R09N** | Combined analysis | **GH0145X** | **GH0543X** | **14R09N** |
| | GH0145X, GH0543X: Aug. 26-28 (R7 growth stage) | | | | October 8-15 (R8 growth stage) | | | |
| | 14R09N: Sept. 25 (R8 growth stage) | | | | | | | |
| **Non-treated control** | **2** d*‡‡ | **0.4** a*‡‡ | **4** c*‡ | **2** cde*‡‡ | **9** | **0.5** a*‡‡ | **2** a*‡ | **18** bcd* |
| **Topsin** 20 fl oz/ac **(R2 growth stage)** | **3** d | **0.7** a | **4** c | **4** e | **8** | **0.5** a | **2** a | **25** d |
| **Topsin** 20 fl oz/ac **(R2 + 7 days)** | **2** d | **0.9** a | **3** bc | **3** de | **5** | **0.2** a | **3** a | **22** cd |
| **Topsin** 20 fl oz/ac **(R2 + 10 days)** | **2** d | **0.5** a | **2** bc | **3** de | **7** | **0.0** a | **2** a | **11** ab |
| **Topsin** 20 fl oz/ac **(R2 + 14 days)** | **2** abc | **0.4** a | **2** abc | **3** b-e | **5** | **0.5** a | **2** a | **18** bcd |
| **Endura** 5.5 oz/ac **(R2 growth stage)** | **1** bcd | **0.2** a | **2** bc | **2** a-e | **3** | **0.1** a | **1** a | **12** abc |
| **Endura** 5.5 oz/ac **(R2 + 7 days)** | **0** ab | **0.1** a | **1** ab | **0** a | **2** | **0.0** a | **1** a | **9** ab |
| **Endura** 5.5 oz/ac **(R2 + 10 days)** | **0** a | **0.0** a | **0** a | **1** abc | **2** | **0.0** a | **1** a | **6** a |
| **Endura** 5.5 oz/ac **(R2 + 14 days)** | **0** a | **0.0** a | **1** a | **1** ab | **6** | **0.0** a | **1** a | **7** a |
| **Topsin** 20 fl oz/ac **(R2 growth stage) + Endura** 5.5 oz/ac **(7 days later)** | **1** abc | **0.2** a | **1** ab | **1** a-d | **7** | **0.2** a | **3** a | **14** abc |
| *F*: | 13.57 | 2.07 | 6.81 | 6.76 | significant | 2.13 | 2.31 | 8.58 |
| *P>F*: | <.0001 | 0.0461 | <.0001 | <.0001 | interaction, | 0.0404 | 0.0260 | <0.0001 |
| CV: | 57.4 | 147.2 | 55.1 | 45.6 | variety x trt | 185.6 | 67.2 | 43.5 |
| | **Sclerotinia severity index** (percent of canopy) | | | | **Sclerotinia severity index** (percent of canopy) | | | |
| | **OAKES, ND** (2020) | | | | **CARRINGTON, ND** (2020) | | | |
| | Combined analysis | **GH0145X** | **GH0543X** | **14R09N** | Combined analysis | **GH0145X** | **GH0543X** | **14R09N** |
| | GH0145X, GH0543X: Aug. 26-28 (R7 growth stage) | | | | October 8-15 (R8 growth stage) | | | |
| | 14R09N: Sept. 25 (R8 growth stage) | | | | | | | |
| **Non-treated control** | **1.1** d*‡‡ | **0.2** a*‡‡ | **2.3** d*‡‡ | **0.7** cde*‡‡ | **4** de*‡‡ | **0.5** a*‡‡ | **2** a*‡‡ | **11** b-e* |
| **Topsin** 20 fl oz/ac **(R2 growth stage)** | **1.3** d | **0.4** a | **1.9** d | **1.5** e | **6** d | **0.5** a | **2** a | **17** e |
| **Topsin** 20 fl oz/ac **(R2 + 7 days)** | **0.9** d | **0.6** a | **1.1** bcd | **1.2** de | **5** cd | **0.1** a | **2** a | **13** de |
| **Topsin** 20 fl oz/ac **(R2 + 10 days)** | **0.9** d | **0.4** a | **1.2** cd | **1.0** de | **3** abc | **0.0** a | **2** a | **7** a-d |
| **Topsin** 20 fl oz/ac **(R2 + 14 days)** | **0.7** cd | **0.3** a | **0.9** a-d | **0.9** b-e | **5** cd | **0.4** a | **2** a | **12** cde |
| **Endura** 5.5 oz/ac **(R2 growth stage)** | **0.5** bcd | **0.2** a | **0.9** bcd | **0.5** a-e | **3** abc | **0.1** a | **1** a | **7** a-d |
| **Endura** 5.5 oz/ac **(R2 + 7 days)** | **0.1** ab | **0.1** a | **0.3** abc | **0.1** a | **2** ab | **0.0** a | **1** a | **5** abc |
| **Endura** 5.5 oz/ac **(R2 + 10 days)** | **0.1** a | **0.0** a | **0.1** a | **0.1** abc | **1** a | **0.0** a | **0** a | **3** a |
| **Endura** 5.5 oz/ac **(R2 + 14 days)** | **0.1** a | **0.0** a | **0.2** ab | **0.1** ab | **1** ab | **0.0** a | **0** a | **3** ab |
| **Topsin** 20 fl oz/ac **(R2 growth stage) + Endura** 5.5 oz/ac **(7 days later)** | **0.2** abc | **0.1** a | **0.2** abc | **0.2** a-d | **3** bc | **0.1** a | **2** a | **8** a-d |
| *F*: | 13.09 | 1.86 | 7.24 | 7.04 | 10.83 | 2.21 | 2.22 | 7.97 |
| *P>F*: | <.0001 | 0.074 | <.0001 | <.0001 | <.0001 | 0.0333 | 0.0320 | <0.0001 |
| CV: | 63.8 | 154.2 | 45.9 | 48.8 | 39.0 | 190.6 | 55.6 | 53.0 |
| | **Yield** (bushels/acre) | | | | **Yield** (bushels/acre) | | | |
| | **OAKES, ND** (2020) | | | | **CARRINGTON, ND** (2020) | | | |
| | Combined analysis | **GH0145X** | **GH0543X** | **14R09N** | Combined analysis | **GH0145X** | **GH0543X** | **14R09N** |
| | yields reported at 13% moisture | | | | yields reported at 13% moisture | | | |
| **Non-treated control** | **75** a* | **72** a* | **77** a* | **76** a* | | | | |
| **Topsin** 20 fl oz/ac **(R2 growth stage)** | **76** a | **72** a | **79** a | **76** a | | | | |
| **Topsin** 20 fl oz/ac **(R2 + 7 days)** | **76** a | **74** a | **79** a | **76** a | | | | |
| **Topsin** 20 fl oz/ac **(R2 + 10 days)** | **76** a | **72** a | **79** a | **76** a | | | | |
| **Topsin** 20 fl oz/ac **(R2 + 14 days)** | **77** a | **74** a | **80** a | **77** a | | | | |
| **Endura** 5.5 oz/ac **(R2 growth stage)** | **77** a | **75** a | **77** a | **79** a | Yield data will be forthcoming | | | |
| **Endura** 5.5 oz/ac **(R2 + 7 days)** | **76** a | **73** a | **77** a | **79** a | | | | |
| **Endura** 5.5 oz/ac **(R2 + 10 days)** | **76** a | **73** a | **78** a | **78** a | | | | |
| **Endura** 5.5 oz/ac **(R2 + 14 days)** | **76** a | **73** a | **79** a | **77** a | | | | |
| **Topsin** 20 fl oz/ac **(R2 growth stage) + Endura** 5.5 oz/ac **(7 days later)** | **76** a | **72** a | **79** a | **77** a | | | | |
| *F*: | 1.09 | 1.14 | 0.96 | 1.06 | | | | |
| *P>F*: | 0.369 | 0.3491 | 0.4781 | 0.4018 | | | | |
| CV: | 3.7 | 3.9 | 3.5 | 3.8 | | | | |

* Within-column means followed by different, non-overlapping ranges of letters are significantly different (P<0.05; Tukey multiple comparison procedure).

To meet model assumptions of normality and/or homoskedasticity, analysis of variance was conducted on data subjected to a systematic natural-log transformation (‡) or cube-root transformation (‡‡). For ease of interpretation, treatments means are presented for the non-transformed data.