Evaluation of fungicides for their efficacy against Phomopsis stem canker of sunflower

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Introduction

Phomopsis stem canker is a major disease of sunflower (*Helianthus annuus*) responsible for yield losses of up to 40% in the United States (Mathew et al. 2015). The disease has also been shown to reduce oil content by 15 to 20% (Aćimović 1986; Debaeke and Moinard 2010). In the United States, Phomopsis stem canker has compromised yield in the states of Minnesota, North Dakota, South Dakota and Nebraska, where 80% of the sunflower production takes place in the country. The disease is caused by several species of *Diaporthe*, of which *D. helianthi* (Munt.-Cvetk., Mihaljč. & Petrov) and *D. gulyae* (Shivas, Thompson & Young) are predominant in the United States (Mathew et al. 2015). The management options for Phomopsis stem canker are limited in the United States. The best option would be use of disease resistant sunflower hybrids. However, there are no resistant hybrids with complete disease resistance available in the market. Fungicides would be solution to manage Phomopsis stem canker at this time. Previous research in Europe by Debaeke and Estragnat (2003) demonstrated that spraying protectant fungicides in early growth stage reduced the disease incidence. In the United States, fungicides belonging to FRAC 11 seem to be effective against Phomopsis stem canker (Olson 2017). Olson (2017) observed less disease incidence and higher yield with a single application of fungicide Headline at R1 growth stage of crop development (when miniature floral head is formed; Berglund 2007). The objective of this study was to compare the efficacy of the fungicides against Phomopsis stem canker of sunflower at R1 growth stage of sunflower development.

Materials and Methods

The experiment was established at the South Dakota State University Research Farm (Felt Farm) in Brookings, South Dakota in 2019. The field is known to have a history of Phomopsis stem canker. The trial was planted with a susceptible hybrid (CHS genetics) at 18,000 seeds per acre and the plots were four row of size thirty inches long by ten feet wide. The trial design was a randomized complete block design, containing eighteen treatments and a non-treated control (Table 1) and four replications per treatment. The treatments were applied a single spray at R1 growth stage using a CO_2 powered backpack sprayer (Model T4, R&D Sprayers, Opelousas, LA) equipped with a 1.5 meter boom equipped with four TeeJet (Spraying Systems Co., Wheaton, IL) flat fan nozzle tips

spaced 0.51 meters apart (Fig.1). All the fungicides were with mixed adjuvant Induce (3 pints per 100 gallons). The fungicides were sprayed at the recommended rate from the manufacturer (Table 1). The plots were sprayed at 40 psi of pressure and approximately 30 gallons water per acre and walking on the middle two rows (Fig. 1). The disease severity was evaluated by plot at R6 to R7 growth stage, ten plants were randomly selected from the two middle rows and rated on a scale 0 to 5, where 0 means no infection and 5 means lodged or dead plants (Mathew et al. 2015). The disease severity index (DSI) was calculated from disease severity ratings by plot using the formula

$$\text{DSI (\%)} = \sum \left\{ \frac{(P \times Q)}{(M \times N)} \times 100 \right\}$$

where, P = class frequency, Q = score of rating class, M = total number of plants and N = maximal disease index (Chiang et al. 2017). The yield data was analyzed in R (https://rstudio.com).

Table 1. Treatments used in the field study to test the efficacy of fungicides against Phomopsis stem canker in Felt Farm, Brookings, South Dakota.

Treatments	
1 - Non treated control	11 - Zolera FX 4.4 oz/a, FRAC 11 + 3
2 - Headline 6 oz/a, FRAC 11	12 - Trivapro 13.7 oz/a, FRAC 3 + 7 + 11
3 - Aproach 6 oz/a, FRAC 11	13 - Aproach Prima 6.8 oz/a, FRAC 11 + 3
4 - Quadris 6 oz/a, FRAC 11	14 - BAS 75007F 3.5 oz/a, FRAC 3
5 - Priaxor 4 oz/a, FRAC 7 + 11	15 - BAS 75007F 5 oz/a, FRAC 3
6 - Luna 9 oz/a, FRAC 7 + 9	16 - BAS 75106F 7 oz/a, FRAC 11 + 3
7 - Luna 12.8 oz/a, FRAC 7 + 9	17 - BAS 75106F 10 oz/a, FRAC 11 + 3
8 - Miravis NEO 13.7 oz/a, FRAC 7	18 - BAS 75303F 8 oz/a, FRAC 11 + 3 + 7
9 - Lucento 5 oz/a, FRAC 7 + 3	19 - BAS 75303F 10 oz/a, FRAC 11 + 3 + 7
10 - Sovran 3.2 oz/a, FRAC 11	

Results

Overall, fungicides with FRAC 11 seems to be effective against Phomopsis stem canker (Fig 2). The fungicides that had low DSI and high yield compared to the non-treated control are either FRAC code 11 or premixed with FRAC code 11, with the exception of Miravis, which is FRAC code 7.

The results of this study indicate that seven fungicides, Headline, Approach, Priaxor, Aproach Prima, Miravis NEO, BAS75106F, BAS75303F, had significantly lower DSI compared to the non-treated control (Fig. 3).

Among the seven fungicides, three of them, Headline, Aproach Prima, BAS75106F, had significantly higher yield compared to the non-treated control (Fig. 4).

The correlation between DSI and yield was significant and high ($r = -0.82$; $P = 0.001$).

Future work

In 2020, fungicides will be evaluated at multiple rates under field conditions in Nebraska, North Dakota and South Dakota. Additionally, the effect of mobility of fungicides belonging to FRAC 3, 7 and 11 will be evaluated on *Diaporthe helianthi* and *D. gulyae* in the greenhouse.

References

Aćimović, M. 1986. The effect of *Phomopsis* sp. infection on grain yield and oil content of sunflower plants. Helia 9: 73–76.

Berglund, D. R. (eds.) 2007. Sunflower production. North Dakota State University Extension Service Report No. 25. Fargo, ND, USA.

Chiang, K., Liu, H., and Bock, C. H. 2017. A discussion on disease severity index values. Part I: Warning on inherent errors and suggestions to maximize accuracy. Ann. Appl. Biol. 171:139-154.

Debaeke, P., and Moinard,J. 2010. Effect of crop management on epidemics of Phomopsis stem canker (*Diaporthe helianthi*) for susceptible and tolerant sunflower cultivars. Field Crops Research 115: 50-60.

Debaeke, P., Estragnat, A., and Reau, R. 2003. Influence of crop management on sunflower stem canker (*Diaporthe helianthi*). Agronomie 23: 581-592.

Mathew, F. M., Alananbeh, K. M., Jordahl, J. G., Meyer, S. M., Castlebury, L. A., Gulya, T. J., and Markell, S. G. 2015. Phomopsis stem canker: A reemerging threat to sunflower (*Helianthus annuus*) in the United States. Phytopathology 105:990-997.

Mihaljčević, M., Muntanõla-Cvetković, M., Vukojević, J., and Petrov, M. 1985. Source of infection of sunflower plants by *Diaporthe helianthi* in Yugoslavia. Phytopathol. Z. 113:334-342.

Olson, T. R. 2017. "Managing Phomopsis Stem Canker of Sunflower Using Improved Diagnosis and Quantification of the Causal Pathogens". Electronic Theses and Dissertations. 1184. https://openprairie.sdstate.edu/etd/1184

Thompson, S. M., Tan, Y. P., Young, A. J., Neate, S. M., Aitken, E. A. B., and Shivas, R. G. 2011. Stem cankers on sunflower (*Helianthus annuus*) in Australia reveal a complex of pathogenic *Diaporthe* (*Phomopsis*) species. Persoonia 27:80-89.

Figure 1. CO_2 powered backpack sprayer equipped with a 1.5 meter boom

Figure 2. Drone picture of the field trial showing the Headline-treated plots (red box) compared to non-treated control plots (yellow box)

Figure 3. Disease severity index as observed from fungicide treatments from the field trial in Felt Farm, Brookings, South Dakota

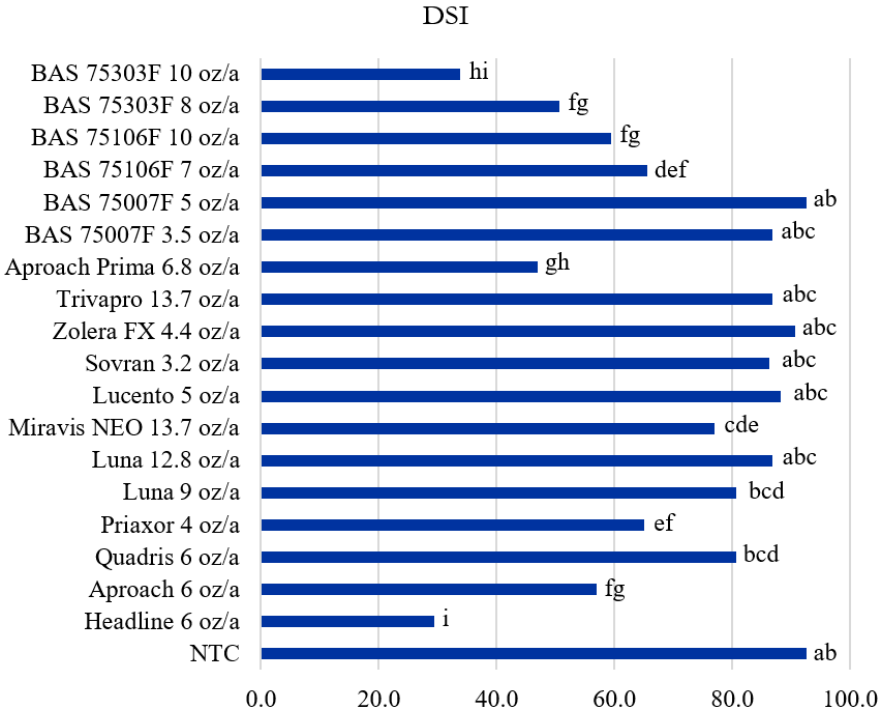

Figure 4. Sunflower yield in pounds per acre as observed from fungicide treatments from the field trial in Felt Farm, Brookings, South Dakota