EFFICACY OF FUNGICIDES FOR CONTROLLING CERCOSPORA LEAF SPOT ON SUGARBEET

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Cercospora leaf spot (CLS), caused by the fungus *Cercospora beticola* Sacc., is the most economically damaging foliar disease of sugarbeet in Minnesota and North Dakota. The disease reduces root yield and sucrose concentration and increases impurity concentrations resulting in reduced extractable sucrose and higher processing losses (Smith and Ruppel, 1973; Khan and Smith, 2005). Roots of diseased plants do not store well in storage piles that are processed in a 7 to 9 month period in North Dakota and Minnesota (Smith and Ruppel, 1973). Cercospora leaf spot is managed by integrating the use of tolerant varieties, reducing inoculum by crop rotation and tillage, and fungicide applications (Khan et al; 2007). It is difficult to combine high levels of Cercospora leaf spot resistance with high recoverable sucrose in sugarbeet (Smith and Campbell, 1996). Consequently, commercial varieties generally have only moderate levels of resistance and require fungicide applications to obtain acceptable levels of protection against Cercospora leaf spot (Miller et al., 1994) under moderate and high disease severity.

The objective of this research was to evaluate the efficacy of fungicides used in rotation to control Cercospora leaf spot on sugarbeet.

MATERIALS AND METHODS

A field trial was conducted at Foxhome, MN in 2022. The experimental design was a randomized complete block with four replicates. Field plots comprised of six 30-feet long rows spaced 22 inches apart. Plots were planted on 29 May with a variety susceptible to Cercospora Leaf Spot. Seeds were treated with Tachigaren (45 g/kg seed), Poncho Beta and Systiva. Seed spacing within the row was 4.7 inches. Weeds were controlled with herbicide applications (Nortron @ 6 pt) on 27 May, (Roundup Powermax @ 32 fl oz; Outlook @ 12 fl oz; Class Act @ 1%v/v; Interlock @ 4 fl oz per acre) on 22 June and (Roundup Powermax @ 32 fl oz; Outlook @ 12 fl oz; Class Act @ 1% v/v; Interlock @ 4 fl oz per acre and Clean Slate @ 4 fl oz) on 1 July as well as hand weeding throughout the summer. Quadris (14.3 fl oz per acre) was applied on 28 June. Plots were inoculated on 30 June with *C. beticola* inoculum.

Fungicide spray treatments were applied with a CO_2 pressurized 4-nozzle boom sprayer with 11002 TT TwinJet nozzles calibrated to deliver 17 gpa of solution at 60 p.s.i pressure to the middle four rows of plots. Most fungicide treatments were initiated on 7 July. Treatments included six fungicide applications on 7 July (application A), 22 July (application B), 2 August (application C), 15 August (application D), 26 August (application E) and 8 September (application F). Treatments were applied at rates indicated in Table 1.

Cercospora leaf spot severity was rated on the leaf spot assessment scale of 1 to 10 (Jones and Windels, 1991). A rating of 1 indicated the presence of 1- 5 spots/leaf or 0.1% disease severity and a rating of 10 indicated 50% or higher disease severity. Cercospora leaf spot severity was assessed five times during the season. The rating performed on 12 September is reported.

Plots were defoliated mechanically and harvested using a mechanical harvester on 27 September. The middle two rows of each plot were harvested and weighed for root yield. Twelve to 15 representative roots from each plot, not including roots on the ends of the plot, were analyzed for quality at the American Crystal Sugar Company Quality Tare Laboratory, East Grand Forks, MN. The data analysis was performed with the ANOVA procedure of the Agriculture Research Manager, version 2019.4 software package (Gylling Data Management Inc., Brookings, South Dakota). The least significant difference (LSD) test was used to compare treatments when the F-test for treatments was significant.

RESULTS AND DISCUSSIONS

The research site received adequate amounts of rainfall (Figure 1) and heat units resulting in good crop growth and row closure early July. However, there was not much rainfall in July through mid-August and the temperature was high with at least 10 days that reached 90 F (Figure 1 and 2). The hot and dry environment was not favorable for development of *C. beticola*. As such, disease severity ratings done in July and August showed that the disease had not reached economic damaging threshold in the non-treated inoculated check on August 17. However, after about 2 inches of rainfall from August 20 through 28, *C. beticola* developed rapidly resulting in death of the oldest leaves and regrowth in the check.

The high disease severity in the non-treated check, especially during September, resulted in significantly lower tonnage, sugar concentration, and recoverable sucrose per acre compared to all fungicide treatments. Since there were few rainfall events during July and August (Figure 2), all fungicide treatments were effective at significantly reducing disease severity. Treatments where the first fungicide application was made before row closure with subsequent applications at 14-day intervals did not result in any significant improvement in disease control nor recoverable sucrose compared to treatments where the first fungicide application was made at first symptoms and then at 14 day intervals. There were two treatments where no quinone outside inhibitor (QoI) nor demythylation inhibitor (DMI) fungicides were included in the mixtures of the rotation program that resulted in effective control of CLS and high recoverable sucrose. These treatments which comprised mainly of multi-site fungicides may be instrumental in reducing the population of QoI and DMI resistant populations of *C. beticola*.

This research indicated that fungicides should be applied starting promptly at first symptoms of CLS or at disease onset and continued during the season once environmental conditions are favorable for disease development. Each application should comprise of at least two modes of action, and when necessary such as during periods of regular rainfall, spray interval should be reduced from 14 to 12 or 10 days. In 2021, the most critical fungicide mixture applications were those made on or after August 16 when the environment became very favorable for infection and disease development.

General comments for Cercospora leaf spot control in growers' fields in North Dakota and Minnesota where inoculum levels will probably be high in 2020 and CLS tolerant (KWS ratings of 5.2 and less) varieties are grown:

1. The first fungicide application should be made when disease symptoms are first observed (which entails scouting) or soon after row closure especially if the crop was planted early and environmental conditions were favorable for good crop growth. If the first application is late, control will be difficult all season.
2. Since the pathogen population is very high, especially from the central Red River Valley going south, fungicide applications should be made at regular intervals (14 or 10 to 12 during periods with more rainfall).
3. Use mixtures of fungicides that are effective at controlling Cercospora leaf spot in an alternation program.
4. Use the recommended rates of fungicides to control Cercospora leaf spot.
5. During periods of regular rainfall, shorten application interval from 14 days to 12 or 10 days; use aerial applicators during periods when wet field conditions prevent the use of ground rigs.
6. Limit or avoid using fungicides to which the pathogen population has become resistant or less sensitive.
7. Only one application of a benzimidazole fungicide (such as Topsin M 4.5F) in combination with a protectant fungicide (such as Super Tin). The use of multi-site fungicides such as TPTH, Copper, and EBDCs mixed with a QoI or DMI fungicides will increase the effectiveness of the QoIs and DMIs.
8. Avoid using fungicides in an area where laboratory testing shows that the fungus has developed resistance or reduced sensitivity to that particular fungicide or particular mode of action.
9. Use high volumes of water (15 to 20 gpa for ground-rigs and 3 to 5 gpa for aerial application) with fungicides for effective disease control.
10. Based on the 2022 *C. beticola* population and sensitivity testing, CLS spray applications should start at disease onset just after row closure, or when symptoms are first observed in the field, factory district, sentinel plants or in CLS inoculated trials.

The following fungicides in several classes of chemistry are registered for use in sugarbeet:

Strobilurins	**Sterol Inhibitors**	**Ethylenebisdithiocarbamate (EBDC)**
Gem	Eminent/Minerva	Penncozeb
(Priaxor)	Inspire XT	Manzate
	Proline	Mancozeb
	Revysol	Maneb

	Enable	(Mankocide)
	Topguard	
Benzimidazole	**TriphenylTin Hydroxide (TPTH)**	**Copper**
Topsin	SuperTin	Kocide 2000 and 3000
	AgriTin	Badge SC, Badge X2
		ChampION, Champ DP and WG
		Cuprofix Ultra 40 Disperss
		MasterCop

Products with multiple modes of action include Priaxor, Minerva Duo, Acropolis, Lucento, Mankocide, ProPulse, Delaro, Dexter Max, and Brixen. See publication PP622-20 for more details.

Products within ( ) indicate that they comprise of more than one mode of action.

Table 1. Effect of fungicides on Cercospora leaf spot control and sugarbeet yield and quality at Foxhome, MN in 2022.

Treatment and rate/A	CLS*	Root yield	Sucrose concentration	Recoverable sucrose		Returns**
	1-10	Ton/A	%	lb/Ton	lb/A	$/A
Inspire XT 7 fl oz + Manzate Max 1.6 qt***/ Super Tin 8 fl oz + Topsin 20 fl oz/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Manzate Max 1.6 qt/ Super Tin 8 fl oz + Priaxor 6.7 fl oz	2.5	22.1	20.6	392.2	8,643	1,728
Manzate Max 1.6 qt/ Proline 5.7 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt/ Manzate Max 1.6 qt + Super Tin 8 fl oz/ Provysol 4 fl oz + Badge SC 32 fl oz/ Manzate Max 1.6 fl oz + Super Tin 8 fl oz/ Inspire XT 7 fl oz + Manzate Max 1.6 qt	2.8	20.3	21.0	399.7	8,104	1,598
Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Manzate Max 1.6 qt/ Super Tin 8 fl oz + Topdin 20 fl oz/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Manzate Max 1.6 qt/ Priaxor 8 fl oz + Super Tin 8 fl oz	3.0	23.4	21.4	408.1	9,565	1,963
Manzate Max 1.6 qt/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Manzate Max 1.6 qt + Super Tin 8 fl oz/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Manzate Max 1.6 qt + Super Tin 8 fl oz/ Inspire XT 7 fl oz + Badge SC 32 fl oz	3.0	21.4	21.4	405.7	8,687	1,754
Manzate Max 1.6 qt***/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Manzate Max 1.6 qt + Badge SC 32 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Manzate Max 1.6 qt + Badge SC 32 fl oz	3.0	20.9	21.2	405.1	8,458	1,753
Manzate Max 1.6 qt/ Super Tin 8 fl oz/ Inspire XT 7 fl oz/ Super Tin 8 fl oz/ Minerva 13 fl oz/ Super Tin 8 fl oz	3.0	23.6	20.8	396.1	9,302	1,928
Inspire XT 7 fl oz + Badge SC 32 fl oz****/ Super Tin 8 fl oz + Topsin 20 fl oz/ Minerva 13 fl oz + Manzate Max 1.6 qt/ Manzate Max 1.6 qt + Super Tin 8 fl oz	3.3	23.4	20.8	396.5	9,256	1,925
Super Tin 8 fl oz + Manzate Max 1.6 qt****/ Inspire XT 7 fl oz + Badge SC 32 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Proline 5.7 fl oz + NIS 0.125% v/v + Badge SC 32 fl oz	3.5	20.8	21.0	400.2	8,299	1,783
Super Tin 8 fl oz + Manzate Max 1.6 qt****/ Manzate Max 1.6 qt + Badge SC 32 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Manzate Max 1.6 qt + Badge SC 32 fl oz	3.5	22.4	20.9	399.0	8,948	1,868
Untreated Check	5.5	20.7	20.5	387.9	8,029	1,765
LSD (P=0.05)	**0.7**	**NS**	**NS**	**NS**	**NS**	**NS**

*Cercospora leaf spot measured on 1-10 scale (1 = 1- 5 spots/leaf or 0.1% severity and 10 = 50% severity) on 12 September.
**Returns based on American Crystal payment system and subtracting fungicide costs and application.
***Treatment started at row closure on 22 July
****Treatment started on 2 August

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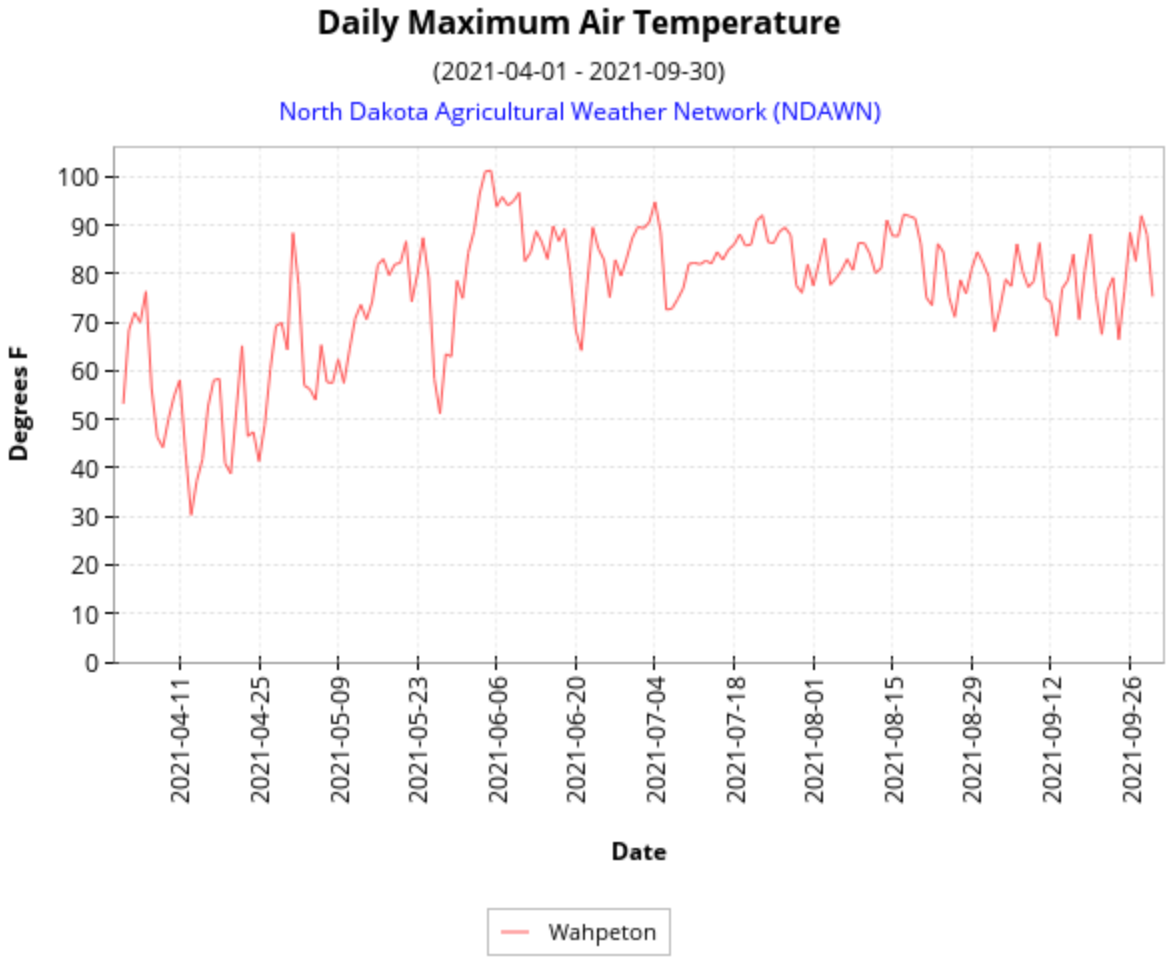
Daily Maximum Air Temperature
(2021-04-01 - 2021-09-30)
North Dakota Agricultural Weather Network (NDAWN)
Degrees F
100
90
80
70
60
50
40
30
20
10
0
2021-04-11
2021-04-25
2021-05-09
2021-05-23
2021-06-06
2021-06-20
2021-07-04
2021-07-18
2021-08-01
2021-08-15
2021-08-29
2021-09-12
2021-09-26
Date
Wahpeton

Figure 2.

Total Rainfall

(2021-04-01 - 2021-09-30)

North Dakota Agricultural Weather Network (NDAWN)