

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 2019. The experimental design was a randomized complete block with four replicates. Field plots comprised of six 30-foot long rows spaced 22 inches apart. Plots were planted on 14 May with a variety susceptible to *Cercospora* Leaf Spot. Seeds were treated with Tachigaren (45 g/kg seed), Kabina, Metlock Rizolex and Nipsit Suite. Seed spacing within the row was 4.7 inches. Weeds were controlled with herbicide applications (Roundup Powermax @ 28 fl oz; Outlook @ 6 fl oz; Class Act 2.5 % v/v; Interlock @ 4 fl oz per acre) on 10 June and (Roundup Powermax @ 28 fl oz; Outlook @ 6 fl oz; Class Act 2.5% v/v; Interlock @ 4 fl oz per acre) 27 June as well as hand weeding throughout the summer. Quadris (14.3 fl oz per acre) was applied on 5 June and 19 June to control *Rhizoctonia solani*. Plots were inoculated on 12 July with *C. beticola* inoculum.

Fungicide spray treatments were applied with a CO₂ 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 22 July. Most treatments included four fungicide applications on 22 July, 1 August, 15 August and 29 August. One treatment received applications on a shorter interval and had application dates of 22 July, 31 July, 13 August, 21 August and 29 August. Some treatments also received applications beginning at row closure and were treated on 8 July. 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 13 September is reported.

Plots were defoliated mechanically and harvested using a mechanical harvester on 25 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

Environmental conditions were not favorable for rapid plant growth resulting in row closure in mid-July. Likewise, development of *C. beticola* was very slow after inoculation with first observed symptoms about 10 days later. On 7

August, CLS rating for the non-treated check was 2.0, still below the CLS rating (6.0) at which economic losses typically occur. Warmer conditions in mid- to late-August and early September resulted in more favorable conditions for rapid disease development as indicated by a CLS rating of 5.5 and 8.8 for the non-treated check on August 20 and September 3, respectively.

The CLS population, which originated from growers' fields near Foxhome, MN, was resistant to QoI fungicides and had the G143A mutation. The use of fungicide mixtures in a rotation program applied at 14-day intervals and 10 to 12-day intervals effectively controlled CLS. The non-treated check had significantly higher CLS ratings compared to the fungicide treatments (Table 1). The fungicide treatments resulted in significantly higher tonnage, sugar concentration and recoverable sucrose per ton of sugarbeet compared to the non-treated check. The use of fungicide mixtures and timely fungicide applications resulted in effective disease control as measured by the leaf spot ratings through harvest. However, it should be noted that although several treatments had good leaf spot ratings (less than 6), their tonnage and recoverable sucrose were significantly lower than other treatments with similar leaf spot ratings. These differences in yield and recoverable sucrose were probably because plots in some areas were adversely impacted by too much standing water from heavy rainfall in August and September. 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 demethylation 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 comprise 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 and continued during the season once environmental conditions are favorable for disease development since our fields have a high pathogen population. 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.

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 2019 *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

Gem
(Priaxor)

Sterol Inhibitors

Eminent/Minerva
Inspire XT

Ethylenebisdithiocarbamate (EBDC)

Penncozeb
Manzate

	Proline	Mancozeb
	Revysol	Maneb
	Enable	(Mankocide)
	Topguard	
<u>Benzimidazole</u>	<u>TriphenylTin Hydroxide (TPTH)</u>	<u>Copper</u>
Topsin	SuperTin	Kocide 2000 and 3000
	AgriTin	Badge SC, Badge X2
		Champion, Champ DP and WG
		Cuprofix Ultra 40 Dispers
		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 2019.

Treatment and rate/A	CLS*	Root yield Ton/A	Sucrose concentration %	Recoverable sucrose lb/Ton	lb/A	Returns** \$/A
Topsin 20 fl oz + Super Tin 8 fl oz + Manzate Max 1.6 qt/ Inspire XT 7 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb/ Super Tin 8 fl oz + Badge SC 2 pt	4.5	29.43	15.84	290	8,534	932
Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Topsin 20 fl oz/ Proline 5.7 fl oz + NIS 0.125% + Manzate Max 1.6 qt/ Manzate Max 1.6 qt/ Super Tin 8 fl oz + Priaxor 8 fl oz****	4.3	31.28	15.31	280	8,774	883
Inspire XT 7 fl oz + Super Tin 8 fl oz/ Topsin 20 fl oz + Super Tin 8 fl oz/ Proline 5.7 fl oz + NIS 0.125% + Manzate Max 1.6 qt/ Mankocide 4.3 lb	4.3	29.75	15.55	283	8,433	881
Super Tin 8 fl oz + Topsin 20 fl oz/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Priaxor 8 fl oz + Badge SC 2 pt/ Super Tin 8 fl oz + Badge SC 2 pt	5.0	28.38	15.45	281	8,037	848
Super Tin 8 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb/ Super Tin 8 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb	5.0	30.43	15.08	275	8,398	848
Topsin 20 fl oz + Super Tin 8 fl oz/ Minerva Duo 16 fl oz/ Mankocide 4.3 lb/ Proline 5.7 fl oz + NIS 0.125% + Manzate Max 1.6 qt	5.5	29.08	15.33	280	8,153	837
Super Tin 8 fl oz + Manzate Max 1.6 qt/ Mankocide 4.3 lb/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Mankocide 4.3 lb/	5.0	29.15	15.31	280	8,165	829
Minerva Duo 16 fl oz/ Topsin 20 fl oz + Super Tin 8 fl oz/ Proline 5.7 fl oz + NIS 0.125% + Manzate Max 1.6 qt/ Mankocide 4.3 lb	4.8	28.30	15.16	276	7,829	782
Inspire XT 7 fl oz + Topsin 20 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Minerva Duo 16 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Proline 5.7 fl oz + NIS 0.125% + Manzate Max 1.6 qt***	4.5	29.60	15.08	274	8,105	782
Super Tin 8 fl oz + Manzate Max 1.6 qt/ Mankocide 4.3 lb/ Super Tin 8 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb	4.8	27.70	15.12	277	7,675	764

Super Tin 8 fl oz + Manzate Max 1.6 qt/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Badge SC 2 pt/ Proline 5.7 fl oz + NIS 0.125% + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Manzate Max 1.6 qt	4.3	26.85	15.47	283	7,589	760
Mankocide 4.3 lb/ Badge SC 2 pt + Super Tin 8 fl oz/ Mankocide 4.3 lb/ Super Tin 8 fl oz + Manzate Max 1.6 qt	4.3	29.78	14.74	269	7,996	760
Minerva Duo 16 fl oz + Mankocide 4.3 lb/ Super Tin 8 fl oz + Badge SC 2 pt/ Proline 5.7 fl oz + NIS 0.125% + Mankocide 4.3 lb/ Super Tin 8 fl oz + Badge SC 2 pt	5.0	29.55	14.90	273	8,083	756
Mankocide 4.3 lb/ Super Tin 8 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb/ Super Tin 8 fl oz + Badge SC 2 pt	4.8	29.10	14.54	266	7,795	741
Inspire XT 7 fl oz + Topsin 20 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Minerva Duo 16 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt	5.3	29.35	14.51	264	7,725	731
Mankocide 4.3 lb/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Mankocide 4.3 lb/ Super Tin 8 fl oz + Manzate Max 1.6 qt	5.0	27.00	15.03	275	7,445	724
Super Tin 8 fl oz + Badge SC 2 pt/ Mankocide 2.2 lb + Minerva 13 fl oz/ Super Tin 8 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb + Proline 5.7 fl oz + NIS 0.125%	5.0	28.63	14.64	267	7,661	707
Minerva Duo 16 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Priaxor 8 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb	5.0	27.23	14.85	271	7,400	701
Super Tin 8 fl oz + Mankocide 4.3 lb/ Inspire XT 7 fl oz + Badge SC 2 pt/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Proline 5.7 fl oz + NIS 0.125% + Badge SC 2 pt/ Super Tin 8 fl oz + Manzate Max 1.6 qt****	4.2	27.08	15.05	276	7,472	698
Topsin 20 fl oz + Super Tin 8 fl oz/ Badge SC 2 pt + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Proline 5.7 fl oz + NIS 0.125% + Badge SC 2 pt	5.0	27.68	14.54	265	7,346	697
Inspire XT 7 fl oz + Topsin 20 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Minerva Duo 16 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Proline 5.7 fl oz + NIS 0.125% + Manzate Max 1.6 qt****	5.5	27.83	14.68	268	7,475	686
Untreated Check	9.5	23.15	13.51	264	5,687	547
LSD (P=0.05)	0.7	3.0	1.1	20	1023	197

*Cercospora leaf spot measured on 1-10 scale (1 = 1-5 spots/leaf or 0.1% severity and 10 = 50% severity) on 13 September.

**Returns based on American Crystal payment system and subtracting fungicide costs and application.

***Treatment applied on 10-12 day interval.

****Treatment applications began on 8 July before artificial inoculation

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