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 2018. 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 12 May with a variety susceptible to Cercospora Leaf Spot. Seeds were treated with Tachigaren (45 g/kg seed), Vibrance and Cruiser Maxx. Seed spacing within the row was 4.7 inches. Weeds were controlled with herbicide applications (Roundup Powermax @ 32 fl oz; Outlook @ 12 fl oz; Savvy 1 pt; Interlock @ 4 fl oz per acre) on 8 June and (Roundup Powermax @ 32 fl oz; Outlook @ 12 fl oz; Npak @2.5% v/v; Interlock @ 4 fl oz per acre) 26 June. Quadris (14.3 fl oz per acre) was applied on 25 May and 19 June to control *Rhizoctonia solani*. Plots were inoculated on 28 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 18 July. Most treatments included four fungicide applications on 18 July, 31 July, 16 August and 31 August. One treatment received applications on a shorter interval and had application dates of 19 July, 27 July, 6 August, 16 August and 31 August. 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 16 September is reported.

Plots were defoliated mechanically and harvested using a mechanical harvester on 1 October. 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, Moorhead, MN. The data analysis was performed with the ANOVA procedure of the Agriculture Research Manager, version 8 software package (Gylling Data Management Inc., Brookings, South Dakota, 2010). 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 development of *C. beticola* after inoculation on 29 June and first symptoms at very low incidence were observed in mid-July when fungicide application started. On 9 August, CLS rating for the non-treated check was 3.5, still below the CLS rating (6.0) at which economic losses typically occur. Wet and warmer conditions in started in mid-August resulting in favorable conditions for rapid disease

development as indicated by a CLS rating of 9.5 for the non-treated check by 14 August, followed by loss of mature leaves and re-growth of new leaves in mid-September.
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 10 to 12 day and at 14 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 sugar concentration and recoverable sucrose per ton of sugarbeet compared to the non-treated check.

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. In this trial, fungicide application was discontinued in early September to facilitate harvesting in mid- to late-September.

General comments for Cercospora leaf spot control in growers' fields in North Dakota and Minnesota where inoculum levels will probably be high in 2019 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 after row closure) or soon after row closure. 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 SuperTin). 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 2018 *C. beticola* population and sensitivity testing, CLS spray applications should start early at first symptoms, or at disease onset just after row closure.

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

Strobilurins	**Sterol Inhibitors**	**Ethylenebisdithiocarbamate (EBDC)**
Headline/Pyrac	Eminent/Minerva	Penncozeb
Gem	Inspire XT	Manzate
Quadris	Proline	Mancozeb
(Priaxor)	Minerva Duo	Maneb
	Enable	(Mankocide)
	Topguard	

Benzimidazole	**TriphenylTin Hydroxide (TPTH)**	**Copper**
Topsin	SuperTin	Kocide
	AgriTin	Badge
		Champion
		(Mankocide)

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 2018.

Treatment and rate/A	CLS*	Root yield	Sucrose concentration	Recoverable sucrose		Returns**
	1-10	Ton/A	%	lb/Ton	lb/A	$/A
Minerva Duo 16 fl oz/ Topsin 10 fl oz + Super Tin 8 fl oz/ Proline 5 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt/ Mankocide 4.3 lb	3.3	35.45	17.10	319	11,255	1,320
Topsin 10 fl oz + Super Tin 8 fl oz/ Inspire XT 7 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb/ Minerva Duo 16 fl oz + Badge SC 2 pt	3.5	32.20	17.47	327	10,843	1,310
Super Tin 8 fl oz + Manzate Max 1.6 qt/ Mankocide 4.3 lb/ Super Tin 8 fl oz + Badge SC 4 pt/ Mankocide 4.3 lb	3.0	35.60	16.83	313	11,140	1,270
Super Tin 8 fl oz + Manzate Max 1.6 qt + Topsin 10 fl oz/ Inspire XT 7 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb/ Super Tin 8 fl oz + Badge SC 2 pt	3.8	35.00	16.79	310	10,855	1,228
Topsin 10 fl oz + Super Tin 8 fl oz/ Minerva Duo 16 fl oz/ Mankocide 4.3 lb/ Proline 5 fl oz + NIS 0.125 % v/v/ Badge SC 2 pt	3.0	35.25	16.57	308	10,889	1,226
Topsin 10 fl oz + Super Tin 8 fl oz/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Mankocide 4.3 lb/ Minerva Duo 16 fl oz	3.5	35.13	16.43	307	10,757	1,197
Inspire XT 7 fl oz + Super Tin 8 fl oz/ Topsin 10 fl oz + Super Tin 8 fl oz/ Proline 5 fl oz + NIS 0.125 % v/v + Manzate Max 1.6 qt/ Mankocide 4.3 lb	3.3	32.70	16.98	316	10,302	1,182
Inspire XT 5.3 fl oz + Topsin 7.6 fl oz/ Super Tin 6 fl oz + Manzate Max 1.2 qt/ Minerva Duo 16 fl oz/ Super Tin 6 fl oz + Manzate Max 1.2 Qt/ Proline 3.8 fl oz + NIS 0.125 % v/v + Manzate Max 1.2 qt***	4.0	33.88	16.20	305	10,317	1,140
Minerva Duo 16 fl oz/ Topsin 10 fl oz + Super Tin 8 fl oz/ Proline 5 fl oz + NIS 0.125 % v/v + Badge SC 2 pt/ Mankocide 4.3 lb	3.8	36.90	16.00	292	10,774	1,111
Inspire XT 7 fl oz + Topsin 10 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	4.8	34.30	16.19	298	10,180	1,091
Topsin 10 fl oz + Super Tin 8 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	4.8	32.56	16.45	305	9,884	1,082
ET-F 19.2 fl oz + Inspire XT 7 fl oz + Topsin 10 fl oz + Antero EA 16 fl oz/100 gal/ ET-F 19.2 fl oz + Antero EA 16 fl oz/100 gal + Super Tin 8 fl oz/ ET-F 19.2 fl oz + Anteroa EA 16 fl oz/100gal + Proline 5 fl oz/ ET-F 19.2 fl oz +Antero EA 16 fl oz/100gal + Super Tin 8 fl oz	4.5	31.85	16.28	303	9,647	1,061
Inspire XT 5.3 fl oz + Topsin 7.6 fl oz/ Super Tin 6 fl oz + Manzate Max 1.2 qt/ Minerva Duo 16 fl oz/ Super Tin 6 fl oz + Manzate Max 1.2 Qt	4.5	29.53	16.53	308	9,056	1,029
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	4.0	34.68	15.83	290	10,043	994
Untreated Check	9.8	29.75	14.23	262	7,891	761
LSD (P=0.10)	**0.76**	**3.08**	**1.17**	**25**	**1,175**	**248**

*Cercospora leaf spot measured on 1-10 scale (1 = 1- 5 spots/leaf or 0.1% severity and 10 = 50% severity) on 14 September.
**Returns based on American Crystal payment system and subtracting fungicide costs and application.
***Treatment applied on 10-12 day interval.

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