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 2017. 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 5 May with a variety susceptible to Cercospora Leaf Spot. Seeds were treated with Tachigaren (45 g/kg seed), Kabina 14g and Nipsit Inside. Seed spacing within the row was 4.7 inches. Weeds were controlled with two herbicide applications on 1 June and 19 June. Quadris was applied on 24 May and 6 June to control *Rhizoctonia solani*. Plots were inoculated on 29 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. All fungicide treatments were initiated on 19 July. Most treatments included four fungicide applications on 19 July, 31 July, 21 August and 6 September. One treatment received applications on a shorter interval and had application dates of 19 July, 31 July, 7 August, 21 August and 6 September. 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 20 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, 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 (especially moisture in the form of rainfall) were not favorable for rapid development of *C. beticola* after inoculation on 29 June and first symptoms at very low incidence were not visible until mid-July. On 11 August, CLS rating for the non-treated check was 4.2, still below the CLS rating (6.0) at which economic losses typically occur. Rainfall events during the week of 13 through 19 of August resulted in favorable conditions for rapid disease development as indicated by a CLS rating of 9.3 for the non-treated check on 24 August, followed by loss of mature leaves and re-growth of new leaves in the first week of September.

The CLS population was resistant to QoI fungicides and had the G143A mutation. CLS was effectively controlled when mixtures with different modes of action used individually at full or ¾ the recommended rates were used, and when applications were made at 14 day and 10 to 12 day intervals. It was not possible to apply treatments scheduled for 14 July because of wet field conditions, resulting to a later application date on 21 August. The non-treated check had significantly higher CLS ratings compared to the fungicide treatments (Table 1). The fungicide treatments provided effective control of CLS which resulted in significantly higher sugar concentration, recoverable sucrose per acre, 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 field 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 10 to 12 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 <u>where inoculum levels will probably be high in 2018 and CLS tolerant</u> (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). If the first application is late, control will be difficult all season.
2. Subsequent applications should be made when symptoms are present and environmental conditions (2 consecutive days DIV obtained at http://ndawn.ndsu.nodak.edu) are favorable (DIV $\geq$7) for disease development.
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 10 to 12 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 TPTH mixed with a QoI or DMI fungicides will increase the effectiveness of the QoIs and DMIs.
8. Limiting the use of Qoi's (strobilurins) to one application for control of QoI sensitive populations of *C. beticola* will prolong the effectiveness of these fungicides. Limit the total number of DMI fungicides to 50% or less of the total number of fungicide applications in a season for CLS.
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. Mix, mix, Mix! Try to alternate mixtures with different modes of action for controlling CLS and managing fungicide resistance.

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

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

<u>Benzimidazole</u>	**<u>TriphenylTin Hydroxide (TPTH)</u>**	**<u>Copper</u>**
Topsin	SuperTin	Kocide
	AgriTin	Badge
		Champion

Table 1. Effect of fungicides on Cercospora leaf spot control and sugarbeet yield and quality at Foxhome, MN in 2017.

Treatment and rate/A	CLS*	Root yield	Sucrose concentration	Recoverable sucrose		Returns**
	1-10	Ton/A	%	lb/Ton	lb/A	$/A
Inspire XT 5.3 fl oz + Topsin 7.6 fl oz/ Super Tin 6 fl oz + Manzate 1.2 qt/ Minerva Duo 16 fl oz/ Super Tin 6 fl oz + Manzate 1.2 qt/ Proline 3.8 fl oz + NIS 0.125 %v/v + Manzate 1.2 qt***	4.3	36.48	17.63	331.6	12,085	1,449.47
Minerva Duo 16 fl oz/ Super Tin 6 fl oz + Manzate 1.2 qt/ Priaxor 6 fl oz + Manzate 1.2 qt/ Inspire XT 5.3 fl oz + Manzate 1.2 qt	4.8	34.93	18.05	338.2	11,774	1,448.65
Inspire XT 7 fl oz + Topsin 10 fl oz/ Super Tin 8 fl oz + Manzate 1.6 qt/ Minerva Duo 16 fl oz/ Super Tin 8 fl oz + Manzate 1.6 qt	4.8	34.38	17.53	329.2	11,309	1,349.46
Inspire XT 5.3 fl oz + Manzate 1.2 qt/ Super Tin 6 fl oz + Manzate 1.2 qt/ Minerva Duo 16 fl oz/ Super Tin 6 fl oz + Manzate 1.2 qt	5.0	34.68	17.38	325.5	11,271	1,338.25
Inspire XT 5.3 fl oz + Super Tin 6 fl oz/ Super Tin 6 fl oz + Manzate 1.2 qt/ Priaxor 6 fl oz + Manzate 1.2 qt/ Minerva Duo 12 fl oz + Manzate 1.2 qt	4.8	33.00	17.65	331.5	10,923	1,305.95
Manzate 1.2 qt + Topsin 7.6 fl oz/ Inspire XT 5.3 fl oz + Super Tin 6 fl oz/ Priaxor 6 fl oz + Super Tin 6 fl oz/ Minerva Duo 16 fl oz	5.5	33.85	17.45	325.5	11,015	1,298.22
Inspire XT 5.3 fl oz + Topsin 7.6 fl oz/ Super Tin 6 fl oz + Manzate 1.2 qt/ Minerva Duo 16 fl oz/ Super Tin 6 fl oz + Manzate 1.2 qt	5.5	32.60	17.43	328.6	10,704	1,288.07
Super Tin 6 fl oz + Topsin 7.6 fl oz/ Inspire XT 5.3 fl oz + Badge 3 pt/ Super Tin 6 fl oz + Manzate 1.2 qt/ Minerva Duo 12 fl oz + Badge 3 pt	5.3	34.28	17.43	327.7	11,218	1,278.67
Super Tin 6 fl oz + Manzate 1.2 qt + Topsin 7.6 fl oz/ Inspire XT 5.3 fl oz + Manzate 1.2 qt/ Super Tin 6 fl oz + Manzate 1.2 qt	5.3	35.23	16.83	312.2	10,957	1,245.46
Inspire XT 5.3 fl oz + Manzate 1.2 qt/ Super Tin 6 fl oz + Manzate 1.2 qt/ Priaxor 6 fl oz + Super Tin 6 fl oz/ Proline 3.8 fl oz + NIS 0.125 % v/v + Manzate 1.2 qt	5.3	33.15	17.33	323.6	10,716	1,238.33
Super Tin 6 fl oz + Manzate 1.2 qt + Topsin 7.6 fl oz/ Inspire XT 5.3 fl oz + Manzate 1.2 qt/ Super Tin 6 fl oz + Manzate 1.2 qt/ Priaxor 6 fl oz + Super Tin 6 fl oz	5.0	34.18	17.18	318.6	10,853	1,235.36
Super Tin 6 fl oz + Topsin 7.6 fl oz/ Inspire XT 7 fl oz/ Priaxor 8 fl oz/ Super Tin 8 fl oz	5.8	33.95	16.95	315.1	10,692	1,220.30
Inspire XT 7 fl oz + Manzate 1.6 qt/ Manzate 1.6 qt/ Proline 5 fl oz + NIS 0.125 %v/v + Topsin 10 fl oz/ Manzate 1.6 qt	5.5	34.58	16.95	315.0	10,900	1,219.74
Super Tin 8 fl oz + Topsin 10 fl oz/ Inspire XT 7 fl oz + Manzate 1.6 qt/ Super Tin 8 fl oz + Manzate 1.6 qt/ Minerva Duo 16 fl oz	4.8	34.63	17.00	313.9	10,847	1,206.47
Super Tin 8 fl oz + Topsin 10 fl oz/ Inspire XT 7 fl oz + Badge 4 pt/ Super Tin 8 fl oz + Manzate 1.6 qt/ Minerva Duo 16 fl oz + Badge 1.6 qt	4.8	34.70	17.66	329.8	11,439	1,154.38
Super Tin 6 fl oz + Manzate 1.2 qt + Topsin 7.6 fl oz/ Inspire XT 5.3 fl oz + Manzate 1.2 qt	5.3	34.03	16.86	314.3	10,696	1,122.37
Untreated Check	10.0	29.90	15.13	277.0	8,289	831.06
LSD (P=0.05)	**0.75**	**3.68**	**0.69**	**17.18**	**1,160**	**225.93**

*Cercospora leaf spot measured on 1-10 scale (1 = 1- 5 spots/leaf or 0.1% severity and 10 = 50% severity) on 8 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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