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 2016. 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 24 April with SV 633RR. Seeds were treated with Tachigaren (20 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 27 May and 7 July. Quadris was applied 27 May to help control Rhizoctonia. Lorsban Advanced was applied on 18 May. 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. One treatment received a fungicide application on 1 July as a protectant for *C. beticola*; all other fungicide treatments were initiated on 20 July. Most treatments included three fungicide applications on 20 July, 3 and 17 August and a few treatments had a fourth fungicide application on 1 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 28 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 were favorable for development of *C. beticola* and first symptoms were visible on 17 July.
Cercospora leaf spot progressed slowly in July and very rapidly thereafter so that by 10 August, the non-treated check already had economic damage with a rating of 7.3. On 1 September, the non-treated check had already lost its oldest leaves and re-growth of new leaves and a leaf spot rating of 10 (Table 1). Tank mixing triazoles fungicides

with TPTH for the first application provided good early season control. The use of fungicides or mixture of fungicides with different modes of action used in a rotation program starting at first symptoms resulted in effective control of *C. beticola*, However, CLS developed rapidly after fungicide application stopped. The pathogen population was very high in August and continued through September. Treatments with two applications provided effective control until August 19, and treatments with three applications provided effective control through the end of August. The high population of *C. beticola* present during September resulted in continued infection of all treatments that were not protected by an effective fungicide.

This research indicated that fungicides should be applied promptly at first symptoms of CLS; and the use of fungicides with different modes of action in mixtures or individually in a rotation program will typically provide effective disease control in high inoculum conditions. The mixture of TPTH and Topsin in the first application was not as effective at controlling *C. beticola* as in previous years, probably because the pathogen population present was becoming less sensitive to the fungicides as determined by fungicide amended media in the laboratory.

General comments for Cercospora leaf spot control in growers' fields in North Dakota and Minnesota where inoculum levels will probably be high in 2017 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). 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 ≥7) for disease development.
3. Use 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. Limit or avoid using fungicides to which the pathogen population has become resistant or less sensitive.
6. 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.
7. Avoid using the same fungicide or fungicides from the same class of chemistry or same mode of action 'back-to-back'.
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 5 to 7 gpa for aerial application) with fungicides for effective disease control.
10. Alternate, alternate, alternate! Always alternate different chemistries of fungicides.

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

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

Benzimidazole	**TriphenylTin Hydroxide (TPTH)**
Topsin	SuperTin
	AgriTin

Table 1. Efficacy of fungicides at controlling *C. beticola* sensitive to fungicides and impact on sugarbeet yield and quality at Foxhome, MN in 2016.

Treatment and rate/A	CLS*	Root yield	Sucrose concentration	Recoverable sucrose	
	1-10	Ton/A	%	lb/Ton	lb/A
Super Tin 6 fl oz + Proline 3.75 fl oz*** / Super Tin 6 fl oz + Topsin 7.6 fl oz/ Priaxor 6.7 fl oz	7.5	34.75	13.78	245.8	8,545
Super Tin 6 fl oz + Inspire XT 5.25 fl oz***/ Super Tin 6 fl oz + Topsin 8 fl oz/ Priaxor 6.7 fl oz	6.8	35.92	13.15	235.8	8,478.9
Super Tin 6 fl oz + Topsin 7.6 fl oz**/ Inspire XT 7 fl oz/ Priaxor 6.7 fl oz/ Super Tin 8 fl oz	9.5	33.08	13.43	235.3	7,761
Inspire XT 7 fl oz/ Super Tin 8 fl oz/ Priaxor 6.7 fl oz	7.3	34.20	13.00	225.8	7,740
Proline 5 fl oz + NIS 0.125% v/v/ Super Tin 8 fl oz/ Priaxor 6.7 fl oz/ Super Tin 8 fl oz	7.3	33.20	13.20	232.8	7,730
Priaxor 6.7 fl oz/ Super Tin 8 fl oz/ Inspire XT 7 fl oz	6.8	31.09	13.90	245.3	7,682
Inspire XT 7 fl oz/ Super Tin 8 fl oz/ Priaxor 6.7 fl oz/ Super Tin 8 fl oz	7.0	33.29	12.98	230.5	7,643
Eminent 13 fl oz/ Super Tin 8 fl oz/ Priaxor 6.7 fl oz	7.3	35.83	12.13	211.0	7,540
Super Tin 6 fl oz + Topsin 7.6 fl oz/ Inspire XT 5.25 fl oz + Badge SC 3.2 pt/ Priaxor 6.7 fl oz	7.5	33.93	12.70	220.0	7,463
Minerva 13 fl oz/ Super Tin 8 fl oz/ Priaxor 6.7 fl oz	7.5	32.38	12.43	229.3	7,459
Super Tin 6 fl oz + Topsin 7.6 fl oz/ Inspire XT 7 fl oz/ Priaxor 6.7 fl oz	8.8	31.85	13.23	231.8	7,375
Priaxor 6.7 fl oz/ Super Tin 8 fl oz/ Proline 5 fl oz + NIS 0.125% v/v	7.3	32.17	12.50	226.3	7,296
Super Tin 8 fl oz/ Proline 5 fl oz + NIS 0.125% v/v/ Priaxor 6.7 fl oz	8.3	33.33	12.35	215.8	7,207
Super Tin 6 fl oz + Topsin 7.6 fl oz/ Proline 5 fl oz + NIS 0.125% v/v + Manzate FL 2.6 pt/ Priaxor 6.7 fl oz	7.8	33.58	12.28	213.0	7,172
Minerva Duo 16 fl oz/ Super Tin 8 fl oz/ Priaxor 6.7 fl oz	7.5	33.05	12.55	217.5	7,162
Inspire XT 5.25 fl oz + Manzate FL 2.6 pt/ Super Tin 6 fl oz + Topsin 7.6 fl oz/ Priaxor 6.7 fl oz	6.8	32.70	12.58	216.0	7,144
Super Tin 6 fl oz + Topsin 7.6 fl oz***/ Inspire XT 7 fl oz/ Priaxor 6.7 fl oz	8.5	30.90	13.18	231.0	7,133
Super Tin 6 fl oz + Topsin 7.6 fl oz/ Proline 3.75 fl oz + NIS 0.125% v/v +Badge SC 3.2 pt/ Priaxor 6.7 fl oz	9.0	33.43	12.30	211.8	7,058
Super Tin 6 fl oz + Topsin 7.6 fl oz/ Inspire XT 5.25 fl oz + Badge SC 3.2 pt/ Priaxor 6.7 fl oz	8.5	30.98	12.90	228.3	7,050
Super Tin 6 fl oz + Topsin 7.6 fl oz/ Eminent 13 fl oz/ Priaxor 6.7 fl oz	9.5	33.13	1230	211.8	7,010
Proline 3.75 fl oz + NIS 0.125% v/v + Badge SC 3.2 pt/ Super Tin 6 fl oz + Topsin 7.6 fl oz/ Priaxor 6.7 fl oz	8.8	30.15	12.98	229.3	6,896
Super Tin 6 fl oz + Topsin 7.6 fl oz/ Proline 5 fl oz + NIS 0.125% v/v/ Priaxor 6.7 fl oz	8.0	33.33	12.05	206.5	6,836
Inspire XT 5.25 fl oz + Badge SC 3.2 pt/ Super Tin 6 fl oz + Topsin 7.6 fl oz/ Priaxor 6.7 fl oz	8.5	33.18	12.23	208.5	6,828
Super Tin 8 fl oz/ Inspire XT 7 fl oz/ Priaxor 6.7 fl oz	8.3	29.93	12.43	216.8	6,478
Proline 5 fl oz + NIS 0.125% v/v/ Super Tin 8 fl oz/ Priaxor 6.7 fl oz	7.0	28.88	12.35	219.3	6,287
Super Tin 6 fl oz + Topsin 7.6 fl oz/ Priaxor 6.7 fl oz	9.8	30.75	11.93	203.3	6,278
Priaxor 6.7 fl oz/ Super Tin 6 fl oz + Topsin 7.6 fl oz/ Inspire XT 7 fl oz	8.0	28.33	12.48	220.0	6,255
Nontreated Check	10.0	27.70	11.78	200.8	6,150
LSD (P=0.05)	**1.06**	**3.51**	**0.95**	**20.34**	**1,025**

*Cercospora leaf spot measured on 1-10 scale (1 = 1- 5 spots/leaf or 0.1% severity and 10 = 50% severity) on 1 September.
** Treatment applied on 1 July
*** Roundup 22 fl oz + Class Act NG 2.5% v/v included in treatment

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