EFFICACY OF FUNGICIDES FOR CONTROLLING CERCOSPORA LEAF SPOT ON SUGARBEET

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Cercospora leaf spot, caused by the fungus *Cercospora beticola* Sacc., is present in all sugarbeet (*Beta vulgaris* L.) production areas in the United States (Ruppel, 1986; Kerr and Weiss, 1990), and is the most economically damaging foliar disease of sugarbeet in Minnesota and North Dakota. The disease reduces root and extractable sucrose yields, and increases impurity concentrations resulting in higher processing losses (Smith and Ruppel, 1973; Lamey et al., 1987; Shane and Teng, 1992; Lamey et al., 1996; 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 planting disease tolerant varieties, reducing inoculum by crop rotation and tillage, and fungicide applications (Miller et al., 1994; Khan et al; 2007). Combining high levels of Cercospora leaf spot resistance with high yield in sugarbeet is difficult (Smith and Campbell, 1996). As a result, 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 2010. 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 19 May with a Roundup Ready sugarbeet cultivar (Proprietary material, Betaseed) resistant to Rhizomania and with a Cercospora leaf spot KWS rating of 5.0. Seeds were treated with Tachigaren (20 g/kg seed) and Poncho beta, and Counter was applied in-furrow at planting. The center two-rows of plots were thinned manually on 28 June to 41,580 plants per acre. Weeds were controlled with two applications of glyphosate. Plots were inoculated on 6 July with *C. beticola* inoculum not previously exposed to fungicides (Betaseed, Shakopee, MN).

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. Two treatments received a fungicide application on 23 June for Rhizoctonia root rot control; however, only one will be reported. Treatments with four applications for *C. beticola* at 14 d intervals were applied on 26 July, 9, 20 August, and 2 September. Treatments with three applications for *C. beticola* at 14 d intervals were applied on 26 July, 9 and 20 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 four times through the season. The rating done on 11 September when the greatest disease severity rating was recorded in the nontreated check is reported.

Plots were defoliated mechanically and harvested using a mechanical harvester on 29 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 during the week of 19 July. Fungicide treatments started one week after first symptoms were observed; wet field conditions prevented an earlier start. Cercospora leaf spot progressed very rapidly in the non-treated check and reached economic injury level by mid-August. At harvest, the non-treated check had severe disease and a Cercospora leaf spot rating of 10 which was significantly greater than the fungicide treatments (Table 1). All fungicide treatments resulted in significantly greater root yield, sucrose concentration, and recoverable sucrose compared to the non-treated check.

The rotation of different classes of fungicides provided effective disease control when all the fungicides used in the rotation, especially those used for the first two applications, were effective. Treatments where Eminent was applied first resulted in poor leaf spot control and lower recoverable sucrose. Similarly, in some treatments where SuperTin alone was used for the first or second application resulted in poor disease control early in the season. However, when SuperTin was mixed with Topsin and used in the first application, leaf spot control was excellent and resulted in high recoverable sucrose. Generally, treatments with three applications gave similar levels of leaf spot protection and resulted in similar recoverable sucrose as treatments with four applications. In the treatment where Quadris was applied for controlling Rhizoctonia root rot, plants were vigorous and showed no symptoms of root rot. It is possible that the Quadris may have provided some leaf spot control, thereby contributing to the effectiveness of the fungicides used starting from July 26. Based on our results, one would expect fungicide applications to be fewer on growers' fields where inoculum pressure has been low for the past eight years because of fungicide use, crop rotation, incorporation of crop debris by tillage operations, and usage of varieties with improved Cercospora leaf spot resistance. In 2010, conditions were favorable for *C. beticola* development towards the end of July. In some commercial fields, it was observed that a few random plants had high leaf spot severity and may have served as point-sources of inoculum. Some fields from Moorhead south to southern Minnesota, where disease control started late or where the first fungicide was ineffective, may have suffered economic losses. Efforts will be made to determine the cause for isolated plants with severe disease early in the season and to prevent a recurrence. Growers can access http://ndawn.ndsu.edu/ during the growing season to get information on weather conditions that will help in making decisions on when to apply fungicides for leaf spot control.

This research suggests that fungicides with different modes of action should be used in alternation to provide effective disease control and maintain high yield of recoverable sucrose.

General comments for Cercospora leaf spot control in growers' fields in North Dakota and Minnesota where inoculum levels are very low 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 day DIV obtained at http://ndawn.ndsu.nodak.edu) are favorable (DIV $\geq$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. Only one application of a benzimidazole fungicide (such as Topsin M 4.5F) in combination with a protectant fungicide (such as SuperTin) should be used in the Hillsboro, East Grand Forks, Crookston, and Drayton factory districts. SuperTin (6 fl oz) and Topsin (7.6 fl oz) provided the best early season leaf spot control.
6. Never use the same fungicide or fungicides from the same class of chemistry or same mode of action 'back-to-back'.
7. Limiting the use of triazoles and strobilurins to one application per season will prolong the effectiveness of these fungicides. In 2010, Eminent was not effective when used alone or when used in a rotation with other fungicides. Both Inspire XT and Proline were effective when used alone and in rotation with other effective fungicides.
8. Use high volumes of water (20 gpa for ground-rigs and 5 to 7 gpa for aerial application) with fungicides for effective disease control.
9. 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	
	Enable	
	Tilt	

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

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Table 1. Effect of fungicides on Cercospora leaf spot control, and sugarbeet yield and quality at Foxhome, MN in 2010.

Treatment and rate/A	App. Interval	CLS*	Yield	Sucrose Concentration	Recoverable sucrose		Gross Return**
Three Applications	days	1-10	tons/A	%	lb/ton	lb/A	$/A
Super Tin 4SC 6 fl oz +Topsin M 4.5F 7.6 oz / Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Headline 2.09 EC 9 fl oz	14	5.0	32.5	16.4	305	9901	1584
Headline 2.09 EC 9 fl oz / Super Tin 4SC 8 fl oz / Proline 5 fl oz + Premier 90 NIS 0.125%v/v	14	6.5	31.4	15.9	292	9164	1466
Headline 2.09 EC 9 fl oz / Super Tin 4SC 8 fl oz / Inspire XT 2.08 EC 7 fl oz	14	5.8	30.0	16.0	295	8829	1413
Super Tin 4SC 8fl oz / Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Headline 2.09 EC 9 fl oz /	14	7.0	29.4	15.9	293	8601	1376
Inspire XT 2.08 EC 7 fl oz Super Tin 4SC 8 fl oz Headline 2.09 EC 9 fl oz	14	6.8	28.6	16.0	296	8440	1350
Super Tin 4SC 8fl oz / Eminent 125 SL 13 fl oz/ Headline 2.09 EC 9 fl oz	14	6.8	28.8	15.7	288	8309	1329
Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Super Tin 4SC 8fl oz / Headline 2.09 EC 9 fl oz	14	7.3	28.9	15.4	283	8174	1308
Eminent 125 SL 13 fl oz / Super Tin 4SC 8 fl oz / Headline 2.09 EC 9 fl oz	14	8.5	27.2	14.9	272	7402	1184
Four Applications († applied 23 June in a 7'' band)							
†Quadris 14.25 fl oz / Inspire XT 2.08 EC 7 fl oz / Super Tin 4SC 8 fl oz / Headline 2.09 EC 9 fl oz	14	5.8	31.9	16.1	300	9557	1529
Super Tin 4L 8 fl oz / Inspire XT 2.08 EC 7 fl oz Super Tin 4SC 6 fl oz +Topsin M 4.5F 7.6 oz Headline 2.09 EC 9 fl oz	14	6.5	29.1	16.0	295	8577	1372
Inspire XT 2.08 EC 7 fl oz Super Tin 4SC 8 fl oz Headline 2.09 EC 9 fl oz Super Tin 4SC 8 fl oz	14	6.3	27.9	16.1	298	8310	1330
Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Super Tin 4SC 8fl oz / Headline 2.09 EC 9 fl oz/ Super Tin 4SC 8fl oz	14	7.5	28.5	15.6	286	8122	1300
Eminent 125 SL 13 fl oz / Super Tin 4SC 8 fl oz / Headline 2.09 EC 9 fl oz / Super Tin 4SC 8 fl oz	14	8.5	29.0	15.1	275	7964	1274
Nontreated Check	-	10.0	22.7	13.5	241	5451	872
LSD (P=0.05)	**-**	**0.86**	**2.5**	**0.7**	**17**	**973**	**156**

*Cercospora leaf spot measured on 1-10 scale (1 = 1- 5 spots/leaf or 0.1% severity and 10≥50% severity) on 11 September.
**Gross Return based on Minn-Dak payment system.