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 to control Cercospora leaf spot on sugarbeet.

MATERIALS AND METHODS

A field trial was conducted at Foxhome, MN in 2009. 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 Beta 86RR66 which is resistant to Rhizomania and has a Cercospora leaf spot KWS rating of 5.0. Sugarbeet seed was treated with Tachigaren at a rate of 20g/unit of seed and Poncho Beta. Plots were thinned manually on 1 July to 41,580 plants per acre. Weeds were controlled with recommended herbicides (Khan, 2009), and hand weeding. Plots were inoculated with *C. beticola* inoculum provided by Margaret Rekoske (Betaseed, Shakopee, MN) on 14 July.

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. Three treatments received a fungicide application on 16 June as would be applied for Rhizoctonia control; (however, please note that no Rhozoctonia symptoms were observed at this site). Treatments with four applications at 14 d intervals were applied on 3, 18 August, and 2, 16 September. Treatments with three applications at 14 d intervals were applied on 3, 18 August, and 2 September. Treatments were applied at rates as indicated in Table 1.

Cercospora leaf spot severity was rated on the leaf spot assessment scale of 1 to 10. A rating of 1 indicated the presence of 1- 5 spots/leaf or 0.1% severity and a rating of 10 indicated 50% or higher disease severity. Cercospora leaf spot severity was assessed throughout the season. However, the rating done 16 September when the greatest disease severity rating was attained in the nontreated check is reported.

Plots were defoliated mechanically and harvested using a mechanical harvester on 14 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 7.5 software package (Gylling Data Management Inc., Brookings, South Dakota, 1999). 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* in July and early August. Symptoms were first observed in early August but disease incidence was low. Fungicide treatments commenced just after first symptoms were observed. Cercospora leaf spot progressed very slowly in the non-treated check. Disease severity did not reach economic levels until early September. At harvest in October, the non-treated check had severe disease and a Cercospora leaf spot rating of 10.0 which was significantly greater than the fungicide treatments (Table 1). All fungicide treatments resulted in significantly greater root yield and recoverable sucrose compared to the non-treated check.

The alternation of different classes of fungicides provided effective disease control, and will also serve to prevent or delay the development of fungicide resistant isolates. Treatments where the first application was a triphenyltin hydroxide (TPTH) compound generally had poorer CLS control compared to the other fungicides used during the first disease evaluation. However, subsequent treatments with other classes of fungicides resulted in adequate CLS control. Generally, treatments with three applications gave similar levels of CLS protection and resulted in similar recoverable sucrose as treatments with four applications. As such, there was no need for a fourth application even when the conditions for disease development became favorable. Based on our results, one would expect fungicide applications to be lower on growers' fields where inoculum pressure has been low for the past seven 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 2009, conditions were favorable for *C. beticola* development mainly during the period of August 9 to 16 in all factory districts at American Crystal Sugar Company and at Minn-Dak Farmers Cooperative. In other NDSU trials at Prosper and St. Thomas, no Cercospora leaf spots were observed although environmental conditions were favorable for short periods; reinforcing the premise that inoculum pressure was low or inoculum was not present in most areas. It is possible that fungicide applications by growers could be reduced by scouting for the presence of the disease and using information on the favorability for Cercospora leaf spot development based on weather conditions that is available on http://ndawn.ndsu.edu/ to better time fungicide applications, and applying fungicides only when necessary.

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 <u>where inoculum levels are very low 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 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.
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.
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 chemistry 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	Manzate
Quadris	Proline	Maneb
	Enable	
	Tilt	
Benzimidazole	**TriphenylTin Hydroxide (TPTH)**	
Topsin	SuperTin	
	AgriTin	

References

Kerr, E.D., Weiss, A., 1990. Fungicide efficacy and yield responses to fungicide treatments based on predictions of Cercospora leaf spot of sugar beet. J. Sugar Beet Res. 27, 58-71.

Khan, J., del Rio, L.E., Nelson, R., Khan, M.F.R. 2007. Improving the Cercospora leaf spot management model for sugar beet in Minnesota and North Dakota. Plant Dis. 91, 1105-1108.

Khan, M. 2009. 2009 Sugarbeet Production Guide. North Dakota State University and University of Minnesota Extension Services, pp. 22-53.

Khan, M.F.R., Nelson, R. 2008. Efficacy of fungicides for controlling Cercospora leaf spot on sugarbeet. 2007 Sugarbeet Res. Ext. Rep. 38, 290-293.

Khan, M.F.R., Smith, L.J. 2005. Evaluating fungicides for controlling Cercospora leaf spot on sugarbeet. J. Crop Prot. 24, 79-86.

Lamey, H. A., Cattanach, A.W., Bugbee, W.M., Windels, C.E. 1996. Cercospora leaf spot of sugarbeet. North Dakota State Univ. Ext. Circ. PP- 764 Revised, 4 pp.

Miller, S.S., Rekoske, M., Quinn, A., 1994. Genetic resistance, fungicide protection and variety approval policies for controlling yield losses from Cercospora leaf spot infection. J. Sugar Beet Res. 31, 7-12.

Ruppel, E.G., 1986. Cercospora leaf spot. In: Compendium of Beet Diseases and Insects. E. D. Whitney and J. E. Duffus, (Eds.), APS Press, St. Paul, MN, pp. 8-9.

Shane, W.W., Teng, P.S., 1992. Impact of Cercospora leaf spot on root weight, sugar yield and purity. Plant Dis. 76, 812-820.

Smith, G.A., Campbell, L.G., 1996. Association between resistance to *Cercospora* and yield in commercial sugarbeet. Plant Breed. 115, 28-32.

Smith, G.A., Ruppel, E.G., 1973. Association of Cercospora leaf spot, gross sugar, percentage sucrose and root weight in sugarbeet. Can. J. Plant Sci. 53, 695-696.

Table 1. Effect of fungicides on Cercospora leaf spot control and sugarbeet yield and quality at Foxhome, MN in 2009.

Treatment and rate/A	App. Interval	CLS*	Root yield	Sucrose concenration	Recoverable sucrose		Gross Return
Three Applications	days	1-10	tons/A	%	lb/ton	lb/A	$/A**
Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Super Tin 4L 6 fl oz +Topsin M 4.5F 7.6 oz / Gem 3.6 fl oz	14	2	35.3	15.8	292	10294	1647
Inspire XT 7 fl oz / Super Tin 4L 8 fl oz / Headline 2.09 EC 9 fl oz	14	5	35.1	15.6	292	10223	1636
Headline 2.09 EC 9 fl oz / Super Tin 4L 8 oz / Inspire XT 7 fl oz	14	4	33.4	16.0	298	9948	1592
Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Super Tin 4L 8 fl oz / Gem 3.6 fl oz	14	5	33.3	15.9	296	9812	1570
Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Super Tin 4L 8 fl oz / Headline 2.09 EC 9 fl oz	14	5	33.7	15.7	291	9794	1567
Headline 2.09 EC 9 fl oz / Super Tin 4L 8 fl oz / Proline 5 fl oz + Premier 90 NIS 0.125%v/v	14	4	33.5	15.6	289	9672	1547
Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Super Tin 4L 6 fl oz +Topsin M 4.5F 7.6 oz / Headline 2.09 EC 9 fl oz	14	3	33.6	15.5	288	9657	1545
Super Tin 4L 8fl oz / Inspire XT 7 fl oz / Headline 2.09 EC 9 fl oz	14	3	33.0	15.7	292	9587	1534
Agri Tin 80 WP 5 oz / Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Headline 2.09 EC 9 fl oz	14	4	34.3	15.2	280	9533	1526
Eminent 125 SL 13 fl oz / TPTH 5 oz / Headline 2.09 EC 9 fl oz	14	6	31.9	15.9	295	9386	1502
Super Tin 4L 8fl oz / Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Headline 2.09 EC 9 fl oz /	14	3	32.2	15.5	287	9240	1479
Headline 2.09 EC 9 fl oz / Super Tin 4L 8 oz / Eminent 125 SL 13 fl oz	14	2	30.8	15.8	294	9089	1454
Super Tin 4L 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	1	30.6	15.7	292	8908	1426
Four Applications († applied at 4-lf stage)							
Inspire XT 7 fl oz / Super Tin 4L 8 fl oz / Headline 2.09 EC 9 fl oz / Super Tin 4L 8 fl oz	14	3	34.9	15.9	295	10304	1649
Eminent 125 SL 13 fl oz / Super Tin 4L 8 fl oz / Headline 2.09 EC 9 fl oz / Super Tin 4L 8 fl oz	14	5	35.4	15.5	286	10125	1620
Super Tin 4L 8 fl oz / Inspire XT 7 fl oz / Super Tin 4L 6 fl oz +Topsin M 4.5F 7.6 oz / Headline 2.09 EC 9 fl oz	14	3	34.0	15.8	293	9958	1593
Proline 5 fl oz + Premier 90 NIS 0.125%v/v Super Tin 4L 8 fl oz/ Headline 2.09 EC 9 fl oz / Super Tin 4L 8 fl oz	14	4	33.1	15.7	290	9613	1538
†Quadris 14.25 fl oz / Inspire XT 7 fl oz / Super Tin 4L 8 fl oz / Headline 2.09 EC 9 fl oz	14	3	34.6	15.9	295	10187	1630
† Proline 5.7 fl oz + Premier 90 NIS 0.125%v/v / Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Super Tin 4L 8 fl oz / Headline 2.09 EC 9 fl oz	14	4	34.0	15.8	294	10000	1600
† Proline 5.7 fl oz + Premier 90 NIS 0.125%v/v / Proline 5 fl oz + Premier 90 NIS 0.125%v/v / Super Tin 4L 8 fl oz / Gem 3.6 fl oz	14	5	34.0	15.8	291	9868	1579
Nontreated Check	14	10	27.2	14.9	272	7386	1182
LSD (P=0.05)		**1.7**	**3.90**	**0.55**	**12.8**	**1226**	**196**

*Cercospora leaf spot measured on 1-10 scale (1 = 1- 5 spots/leaf or 0.1% severity and 10≥50% severity) on 16 September.

**Gross Return based on Minn-Dak payment system.