EVALUATING 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). 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). 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).

The objective of this research was to evaluate the efficacy of labeled and experimental fungicides to control Cercospora leaf spot on sugarbeet.

MATERIALS AND METHODS

Field trial was conducted near Foxhome, MN in 2006. 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 25 April with a Betaseed variety resistant to Rhizomania but susceptible to Cercospora leaf spot. Terbufos (Counter 15G) was applied modified in-furrow at 12 lbs/A during planting to control sugarbeet root maggot (*Tetanops myopaeformis* von Röder; Diptera: Otitidae). Plots were thinned manually at the 6-leaf stage to 41,580 plants per acre. Weeds were controlled with recommended herbicides (Khan, 2006), and hand weeding. Plots were manually inoculated (4.5 lbs/A) with dried infected sugarbeet leaves mixed with talc (2:1 by weight) provided by Betaseed, Shakopee, MN on 27 June.

Treatments were applied with a 4-nozzle boom sprayer calibrated to deliver 20 gpa of solution at 100 p.s.i pressure to the middle four rows of plots. All treatments started on 17 July. Treatments that were on a 14 day application interval were applied on 17 July, 1, 14, and 31 August; treatments on a 21/14 day application interval were applied on 17 July, 7, and 21 August; treatments on 14/21 day application interval were applied on 17 July, 1, and 21 August. Fungicide application rates are in Table 1.

Cercospora leaf spot severity was rated on the KWS scale of 1 to 9. A rating of 1 indicated no disease, a rating of 3 indicated that all outer leaves displayed typical symptoms and was the early stages of economic loss level, and a rating of 9 indicated that the plants had only new leaf growth, all earlier leaves being dead. Cercospora leaf spot severity was assessed throughout the season. However, the rating done three days prior to harvest is reported.

Plots were defoliated mechanically and harvested using a mechanical harvester on 3 October. The middle two rows of each plot were harvested and weighed for root yield. Twelve to 15 random 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, East Grand Forks, MN. The least significant difference (LSD) test was used to compare treatments when the F-test for treatments was significant (p=0.05). The data analysis was performed with the ANOVA procedure of the Agriculture Research Manager, version 6.0 software package (Gylling Data Management Inc., Brookings, South Dakota, 1999).

RESULTS AND DISCUSSIONS

Cercospora leaf spot symptoms were observed in early July. Fungicide treatments commenced on July 17 when disease incidence was high and uniform in all plots. CLS progressed rapidly in the untreated check and in plots where treatments were not effective. At harvest, the untreated check had severe disease and a KWS Cercospora leaf

spot rating of 8.5 which was significantly higher than the fungicide treatments (Table 1). Fungicide treatments resulted in significantly higher root yield, sucrose concentration and recoverable sucrose compared to the untreated check.

Headline, Gem (strobilurins), Eminent, Enable (triazoles), and Super Tin were used as stand alone treatments throughout the season to determine efficacy against *C. beticola* (data not shown). Headline and Gem provided effective control against Cercospora leaf spot, probably because of their novel modes of action. Super Tin when used alone, from 1998 through 2000, did not consistently provide effective Cercospora control, probably because of the continued presence of a high population of *C. beticola* strains tolerant to TPTH (Weiland, 2000; Weiland, 2001; Khan and Smith, 2005). However, in 2006, as in the previous two years, Super Tin provided excellent Cercospora leaf spot control. The resurgence of Super Tin as an effective fungicide for controlling *C. beticola* is due to the fact that the pathogen population has reverted to one sensitive to TPTH. In 1998, 83% Cercospora leaf spot lesions tested from the Minn-Dak factory district, which included the Foxhome research site, were tolerant to 1 ppm of TPTH. In 2006, 100% of the *C. beticola* isolates collected from the Super Tin applied treatments and tested in Dr. Gary Secor's Laboratory, NDSU, were sensitive to 1 ppm TPTH. Eminent provided acceptable level of Cercospora leaf spot control but was not as efficacious as in previous years, probably an ominous sign of resistance developing in high disease severity conditions. Enable (newly registered for use on sugarbeet) provided poorer control of Cercospora leaf spot compared to Eminent. Super Tin and the strobilurins provided better disease control than the triazoles.

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 Super Tin alone, Headline or Gem were used in the first application always provided better disease control compared to the use of triazoles as the first application. The alternation of Super Tin, followed by Eminent and Headline provided excellent disease control and high recoverable sucrose. Although disease pressure was high, three applications of the most efficacious fungicides in alternation provided similar disease control as four applications. It was economical to apply fungicides for disease control.

This research indicates that fungicides with different modes of action that are effective at controlling Cercospora leaf spot when used alone, should be used in alternation to provide effective disease control and maintain high yield of recoverable sucrose while reducing selection pressure for the development of fungicide resistant *C. beticola* isolates.

General comments for Cercospora leaf spot control in growers' fields in North Dakota and Minnesota where inoculum levels are very low and more leaf spot 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 available at NDAWN website) are favorable for disease development.
3. Use the recommended rates of fungicides to control Cercospora leaf spot.
4. Use fungicides that are effective at controlling Cercospora leaf spot in an alternation program.
5. In the southern Minnesota, Minn-Dak, and Moorhead factory districts, the use of Super Tin, Headline or Gem, Eminent or Enable in an alternation program will control Cercospora leaf spot.
6. In Hillsboro, East Grand Forks, Crookston, and Drayton factory districts, the use of Super Tin, Headline or Gem, Eminent or Enable, and a tank-mix of Topsin and Super Tin, in an alternation program will control Cercospora leaf spot.
7. Only one application of a benzimidazole fungicide (such as Topsin 4.5 L) in combination with a protectant fungicide (such as Super Tin) should be used in the Hillsboro, East Grand Forks, Crookston, and Drayton factory districts.
8. Never use the same fungicide or fungicides from the same class of chemistry or same mode of action 'back-to-back'.
9. The use of one application of a triazole and a strobilurin per season will prolong the effectiveness of these fungicides.
10. Use high volumes of water – 20 gpa for ground-rigs and 5 to 7 gpa for aerial application – with fungicides for effective disease control.
11. Alternate, alternate, alternate! Always alternate fungicides with different modes of action.

The following shows fungicides registered for sugarbeet and their class of chemistry:

Strobilurins	**Sterol Inhibitors**	**Ethylenebisdithiocarbamate (EBDC)**
Headline	Eminent	Penncozeb
Gem	Enable	Manzate
Quadris		Maneb

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, M. 2006. 2006 Sugarbeet Production Guide. North Dakota State University and University of Minnesota Extension Services, pp. 24-55.

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

Lamey, H. A., Cattanach, A.W., Bugbee, W.M., 1987. Cercospora leaf spot of sugarbeet. North Dakota State Uni. Ext. Cir. PP-764 Revised, 4 pp.

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 politics for controlling yield losses from Cercospora leaf spot infection. J. Sugar Beet Res. 31, 7-12.

Niehaus, W. S. 2005. Results of American Crystal's 2004 Official Coded Variety trials. 2004b Sugarbeet Res. Ext. Rep. 35, pp. 259-317.

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.

Weiland, J.J., 2000. A survey for the prevalence and distribution of *Cercospora beticola* tolerant to triphenyltin hydroxide and mancozeb and resistant to thiophanate methyl in 1999. 1999 Sugarbeet Res. Ext. Rep. 30, pp. 236-239.

Weiland, J.J., 2001. A survey for the prevalence and distribution of *Cercospora beticola* tolerant to triphenyltin hydroxide and mancozeb and resistant to thiophanate methyl in 2000. 2000 Sugarbeet Res. Ext. Rep. 31, pp. 266-271.

Table 1. Cercospora leaf spot control at Foxhome in 2006 with labeled fungicides.

Treatment and rate/A	App. interval (days)	CLS*	Recoverable Sucrose (lb/A)	Recoverable Sucrose (lb/T)	Root yield (t/A)	Sucrose concentration (%)	LTM** (%)	Return ($/A)***
Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz / Headline 2.09 EC 9 fl oz	14/21	2.6	9548	231	41.4	13.41	1.70	1296
Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz / Eminent 125 SL 13 fl oz	14/14	2.5	9501	231	41.2	13.26	1.58	1290
Super Tin 80 WP 5 oz + Manzate 75 DF 2 lb / Eminent 125 SL 13 fl oz/Headline 2.09 EC 9 fl oz	14/21	3.1	9037	234	38.7	13.51	1.65	1227
Headline 2.09 EC 9 fl oz / Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz	21/14	2.8	8951	234	38.2	13.55	1.67	1215
Headline 2.09 EC 9 fl oz / Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz	14/14	2.9	8726	223	39.1	13.03	1.70	1184
Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz / Headline 2.09 EC 9 fl oz	14/14	2.4	8696	221	39.3	13.02	1.82	1180
Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz	14/14	3.5	8696	224	38.8	13.17	1.77	1180
Gem 500 SC 3.5 fl oz / Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz	21/14	3.0	8553	221	38.7	12.99	1.75	1161
Enable 2 F 8 fl oz / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz	14/14	3.8	8538	228	37.5	13.22	1.65	1159
Super Tin 80 WP 3.75 oz + Manzate 75 DF 2 lb / Eminent 125 SL 13 fl oz / Headline 2.09 EC 9 fl oz	14/21	3.0	8429	217	38.8	12.69	1.67	1144
Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz / Gem 500 SC 3.5 fl oz	21/14	3.6	8376	226	37.1	13.10	1.65	1137
Eminent 125 SL 13 fl oz / Super Tin 80 WP 3.75 oz + Topsin 4.5 FL 7.6 fl oz / Gem 500 SC 3.5 fl oz	14/14	3.4	8363	221	37.9	12.91	1.73	1135
Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz	21/14	3.5	8358	223	37.5	13.10	1.78	1134
Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz / Eminent 125 SL 13 fl oz	14/21	2.5	8336	217	38.4	12.74	1.70	1131
Enable 2 F 8 fl oz / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz / Super Tin 80 WP 5 oz	14/14/14	3.9	8323	223	37.4	13.03	1.72	1130
Enable 2 F 8 fl oz + Crop Oil Concentrate 1% v/v / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz	14/14	3.5	8226	222	37.0	12.99	1.67	1116
Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz / Super Tin WP 5 oz	14/14/14	3.4	8180	230	35.6	13.32	1.65	1110
Gem 500 SC 3.5 fl oz / Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz	14/14	3.0	8121	211	38.4	12.49	1.77	1102
Eminent 125 SL 13 fl oz / Super Tin 80 WP 3.75 oz + Topsin 4.5 FL 7.6 fl oz / Headline 2.09 EC 9 fl oz	21/14	3.8	8101	225	36.0	13.04	1.67	1099
Eminent 125 SL 13 fl oz / Gem 500 SC 3.5 fl oz / Super Tin 80 WP 3.75 oz + Topsin 4.5 FL 7.6 fl oz	14/14	3.6	7900	209	37.8	12.44	1.77	1072
Eminent 125 SL 13 fl oz / Super Tin 80 WP 3.75 oz + Topsin 4.5 FL 7.6 fl oz / Headline 2.09 EC 9 fl oz / Super Tin 80 WP 5 oz	14/14/14	3.9	7893	218	36.2	12.83	1.75	1071
Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz / Gem 500 SC 3.5 fl oz	14/14	3.5	7262	213	34.1	12.60	1.75	985
Untreated Check		8.5	5707	190	30.1	11.44	1.80	775
LSD (P= 0.05)		0.9	1265	22	3.3	0.97	0.22	172

*Cercospora leaf spot measured on KWS scale 1-9 (1 = no leaf spot; 9 = dead outer leaves, inner leaves severely damaged, regrowth of new leaves).
**LTM: Sucrose loss to molasses.
***Return based on Minn-Dak payment system.