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).

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

MATERIALS AND METHODS

Field trial was conducted near Foxhome, MN in 2007. 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 4 May 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: Ulidiidae). Plots were thinned manually at the 6-leaf stage to 41,580 plants per acre. Weeds were controlled with recommended herbicides (Khan, 2007), and hand weeding. Plots were inoculated with inoculum provided by Margaret Rekoske (Betaseed, Shakopee, MN) on 3 July.

Fungicide spray 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. Treatments with four applications at 14 d intervals were applied on 23 July, 6, 20 and 31 August. Treatments with three applications at 14 d intervals were applied on 23 July, 6 and 20 August. Treatments with three applications where the first was used to provide protection for 21 d were applied on 23 July, 13 and 31 August. Treatments with three applications where the second was used to provide protection for 21 d were applied on 23 July, 6 and 31 August. Treatments were applied at rates as indicated 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 24 September. 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 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). The least significant difference (LSD) test was used to compare treatments when the F-test for treatments was significant (P=0.05).

RESULTS AND DISCUSSIONS

Cercospora leaf spot symptoms were observed in mid July. Fungicide treatments commenced on July 23 when disease incidence was 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 higher root yield, sucrose concentration, and recoverable sucrose compared to the untreated 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 SuperTin used in a mixture with Topsin or Eminent, consistently provided better disease control and higher recoverable sucrose compared to the use of SuperTin or Eminent alone in the first application. The triazoles Eminent and Enable, in the first application, provided better disease when used in a mixture with SuperTin or Dithane compared to when used alone. Treatments that had the best disease control at harvest were the ones where the first application provided the best control. Relatively dry condition during July and August (particularly August when there was 60% less than the average rainfall) was the probable cause for the reduced efficacy of Eminent, Enable, SuperTin and Headline, particularly when used in the first application. However, an experimental triazole (A7402 at 7 oz/A, Syngenta Crop Protection, Greensboro, NC) provided excellent disease control when used in the first application in an alternation program, and when used as a stand alone (data not shown). Although disease pressure was high, three applications of effective fungicides in alternation provided similar disease control as four applications. The use of four different modes of action during three applications provides an excellent strategy for managing resistance management. It was economical to apply fungicides for disease control.

This research indicates that fungicides with different modes of action 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 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 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 SuperTin, Headline or Gem, or Eminent in an alternation program will control Cercospora leaf spot.
6. In Hillsboro, East Grand Forks, Crookston, and Drayton factory districts, the use of SuperTin, Headline or Gem, or Eminent, and a tank-mix of Topsin and SuperTin, in an alternation program will effectively control Cercospora leaf spot.
7. Please note that in high disease conditions, Eminent should be mixed with triphenyltin hydroxide for improved efficacy especially when used in the first application. Enable does not provide acceptable levels of control when used alone in the first application under high disease conditions; mixing with Dithane will provide better control.
8. 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.
9. Never use the same fungicide or fungicides from the same class of chemistry or same mode of action 'back-to-back'.
10. Limiting the use of triazoles and strobilurins to one application per season will prolong the effectiveness of these fungicides.
11. Use high volumes of water – 20 gpa for ground-rigs and 5 to 7 gpa for aerial application – with fungicides for effective disease control.
12. Alternate, alternate, alternate! Always alternate different chemistry fungicides.

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

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

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

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Table 1. Cercospora leaf spot control at Foxhome in 2007 with labeled fungicides.

Treatment and rate/A	App. interval (days)	CLS*	Recoverable Sucrose (lb/A)	Recoverable Sucrose (lb/T)	Root yield (t/A)	Sucrose concen-tration (%)	LTM** (%)	Return ($/A)***
Topsin M 4.5F 7.6 oz + Super Tin 80 WP 3.75 oz / Headline 2.09 EC 9 fl oz / Super Tin 80 WP 5 oz	14	2.3	7508	319	23.8	17.6	1.68	999
Topsin M 4.5F 7.6 oz + Super Tin 80 WP 3.75 oz / Headline 2.09 EC 9 fl oz / Eminent 125 SL 13 fl oz	14	2.3	7477	324	23.3	17.9	1.70	994
Eminent 125 SL 10 fl oz + Super Tin 80 WP 4 oz / Headline 2.09 EC 9 fl oz / Eminent 125 SL 10 fl oz + Super Tin 80 WP 4 oz	14	1.8	7185	320	22.8	17.8	1.8	956
Topsin M 4.5F 7.6 oz + Super Tin 80 WP 3.75 oz / Eminent 125 SL 13 fl oz / Headline 2.09 EC 9 fl oz	14/21	2.5	6995	331	21.4	18.1	1.6	930
Topsin M 4.5F 7.6 oz + Super Tin 80 WP 3.75 oz / Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz	14	2.5	6913	332	21.1	18.3	1.65	919
Topsin M 4.5F 7.6 oz + Super Tin 80 WP 3.75 oz / Eminent 125 SL 13 fl oz / Headline 2.09 EC 9 fl oz	14	2.3	6866	322	21.6	17.8	1.67	913
Headline 2.09 EC 9 fl oz / Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz /	14	3.0	6853	325	21.4	18.0	1.75	911
Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz / Gem 500 SC 3.5 fl oz	14	3.2	6707	320	21.2	17.9	1.77	892
Headline 2.09 EC 9 fl oz / Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz	14	2.5	6662	329	20.6	18.1	1.68	886
Headline 2.09 EC 9 fl oz / Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz	21/14	3.5	6551	319	20.9	17.5	1.63	871
Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz Headline 2.09 EC 9 fl oz / Super Tin 80 WP 5 oz	14	3.4	6361	320	20.3	17.7	1.75	846
Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz / Headline 2.09 EC 9 fl oz	14/21	3.5	6310	325	19.6	18.0	1.83	839
Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz / Super Tin 80 WP 5 oz	14	3.2	6306	317	20.1	17.7	1.83	839
Headline 2.09 EC 9 fl oz / Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz	21/14	3.3	6285	320	19.8	17.8	1.82	836
Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz / Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz	14	3.3	6267	319	19.9	17.8	1.80	834
Super Tin 80 WP 5 oz / Eminent 125 SL 13 fl oz / Headline 2.09 EC 9 fl oz	14	3.5	6212	323	19.6	17.9	1.72	826
Eminent 125 SL 9 fl oz + Dithane 75DF 2 lb / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz	14	3.3	6154	305	20.4	17.1	1.82	818
Super Tin 80 WP 5 oz / Enable 2F 8 oz / Headline 2.09 EC 9 fl oz /	14	3.3	5947	301	20.0	17.0	2.00	791
Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz	14	3.9	5930	296	20.3	16.8	1.97	789
Enable 2F 8 oz + Dithane 75DF 2 lb / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz	14	4.0	5854	309	19.1	17.2	1.78	779
Eminent 125 SL 13 fl oz / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz	21/14	4.5	5644	304	18.9	17.2	2.03	751
Enable 2F 8 oz / Super Tin 80 WP 5 oz / Headline 2.09 EC 9 fl oz	14	5.0	4819	277	17.7	15.8	1.95	641
Untreated Check		8.5	3483	255	13.9	14.9	2.17	463
LSD (P= 0.05)			771	19	2.5	0.86	NS	103

*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: Sugar loss to molasses.

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