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 2021. 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 2 May with a variety susceptible to Cercospora Leaf Spot. Seeds were treated with Tachigaren (45 g/kg seed), Poncho Beta and Kabina. Seed spacing within the row was 4.7 inches. Weeds were controlled with herbicide applications (Ethotron @ 6 pt) on 7 May, (Roundup Powermax @ 32 fl oz; Outlook @ 12 fl oz; Stinger @ 3 fl oz; Amsol @ 1%v/v; Interlock @ 4 fl oz per acre) on 26 May and (Roundup Powermax @ 32 fl oz; Outlook @ 12 fl oz; Amsol @ 1% v/v; Interlock @ 4 fl oz per acre) on 16 June as well as hand weeding throughout the summer. Azoxy 2SC (14.3 fl oz per acre) was applied on 28 May Quadris (14.3 fl oz) was applied on 17 June to control *Rhizoctonia solani*. Govern (1 pint per acre) was applied on 3 June to control insects. Plots were inoculated on 30 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. Most fungicide treatments were initiated on 9 July. Treatments included five fungicide applications on 9 July (application A), 21 July (application B), 3 August (application C), 16 August (application D) and 30 August (application E). Applications that were initiated at row closure were treated starting on 28 June. 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 31 August 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, East Grand Forks, MN. The data analysis was performed with the ANOVA procedure of the Agriculture Research Manager, version 2019.4 software package (Gylling Data Management Inc., Brookings, South Dakota). 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 plant growth resulting in row closure in mid-July. Likewise, development of *C. beticola* was very slow after inoculation with first observed symptoms about 10 days later. On 7 August, CLS rating for the non-treated check was 2.0, still below the CLS rating (6.0) at which economic losses typically occur. Warmer conditions in in mid- to late-August and early September resulted in more favorable conditions for rapid disease development as indicated by a CLS rating of 5.5 and 8.8 for the non-treated check on August 20 and September 3, respectively.

The CLS population, which originated from growers' fields near Foxhome, MN, was resistant to QoI fungicides and had the G143A mutation. The use of fungicide mixtures in a rotation program applied at 14-day intervals and 10 to 12-day intervals effectively controlled CLS. The non-treated check had significantly higher CLS ratings compared to the fungicide treatments (Table 1). The fungicide treatments resulted in significantly higher tonnage, sugar concentration and recoverable sucrose per ton of sugarbeet compared to the non-treated check. The use of fungicide mixtures and timely fungicide applications resulted in effective disease control as measured by the leaf spot ratings through harvest. However, it should be noted that although several treatments had good leaf spot ratings (less than 6), their tonnage and recoverable sucrose were significantly lower than other treatments with similar leaf spot ratings. These differences in yield and recoverable sucrose were probably because plots in some areas were adversely impacted by too much standing water from heavy rainfall in August and September. Treatments where the first fungicide application was made before row closure with subsequent applications at 14-day intervals did not result in any significant improvement in disease control nor recoverable sucrose compared to treatments where the first fungicide application was made at first symptoms and then at 14 day intervals. There were two treatments where no quinone outside inhibitor (QoI) nor demythylation inhibitor (DMI) fungicides were included in the mixtures of the rotation program that resulted in effective control of CLS and high recoverable sucrose. These treatments which comprise mainly of multi-site fungicides may be instrumental in reducing the population of QoI and DMI resistant populations of *C. beticola*.

This research indicated that fungicides should be applied starting promptly at first symptoms of CLS and continued during the season once environmental conditions are favorable for disease development since our fields have a high pathogen population. Each application should comprise of at least two modes of action, and when necessary such as during periods of regular rainfall, spray interval should be reduced from 14 to 12 or 10 days.

General comments for Cercospora leaf spot control in growers' fields in North Dakota and Minnesota <u>where inoculum levels will probably be high in 2020 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) or soon after row closure especially if the crop was planted early and environmental conditions were favorable for good crop growth. If the first application is late, control will be difficult all season.
2. Since the pathogen population is very high, especially from the central Red River Valley going south, fungicide applications should be made at regular intervals (14 or 10 to 12 during periods with more rainfall).
3. Use mixtures of 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. During periods of regular rainfall, shorten application interval from 14 days to 12 or 10 days; use aerial applicators during periods when wet field conditions prevent the use of ground rigs.
6. Limit or avoid using fungicides to which the pathogen population has become resistant or less sensitive.
7. Only one application of a benzimidazole fungicide (such as Topsin M 4.5F) in combination with a protectant fungicide (such as Super Tin). The use of multi-site fungicides such as TPTH, Copper, and EBDCs mixed with a QoI or DMI fungicides will increase the effectiveness of the QoIs and DMIs.
8. Avoid using fungicides in an area where laboratory testing shows that the fungus has developed resistance or reduced sensitivity to that particular fungicide or particular mode of action.
9. Use high volumes of water (15 to 20 gpa for ground-rigs and 3 to 5 gpa for aerial application) with fungicides for effective disease control.
10. Based on the 2019 *C. beticola* population and sensitivity testing, CLS spray applications should start at disease onset just after row closure, or when symptoms are first observed in the field, factory district, sentinel plants or in CLS inoculated trials.

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

Strobilurins	**Sterol Inhibitors**	**Ethylenebisdithiocarbamate (EBDC)**
Gem	Eminent/Minerva	Penncozeb
(Priaxor)	Inspire XT	Manzate
	Proline	Mancozeb
	Revysol	Maneb
	Enable	(Mankocide)
	Topguard	

Benzimidazole	**TriphenylTin Hydroxide (TPTH)**	**Copper**
Topsin	SuperTin	Kocide 2000 and 3000
	AgriTin	Badge SC, Badge X2
		ChampION, Champ DP and WG
		Cuprofix Ultra 40 Disperss
		MasterCop

Products with multiple modes of action include Priaxor, Minerva Duo, Acropolis, Lucento, Mankocide, ProPulse, Delaro, Dexter Max, and Brixen. See publication PP622-20 for more details.

Products within ( ) indicate that they comprise of more than one mode of action.

Table 1. Effect of fungicides on Cercospora leaf spot control and sugarbeet yield and quality at Foxhome, MN in 2021.

Treatment and rate/A	CLS*	Root yield	Sucrose concentration	Recoverable sucrose		Returns**
	1-10	Ton/A	%	lb/Ton	lb/A	$/A
Inspire XT 7 fl oz + Manzate Max 1.6 qt***/Manzate Max 1.6 qt/ Super Tin 8 fl oz + Topsin 20 fl oz/ Proline 5.7 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt/ Manzate Max 1.6 qt/ Super Tin 8 fl oz + Priaxor 6.7 fl oz	3.8	42.10	17.75	328.6	13,863	2,203
Inspire XT 7 fl oz + Badge SC 32 fl oz/ Super Tin 8 fl oz + Topsin WSB 10 oz wt/ Proline 5.7 fl oz + Induce 0.125% v/v + Manzate Prostick 2 lb/ Super Tin 8 fl oz + Priaxor 6.7 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt	4.3	40.82	17.71	329.3	13,460	2,155
Provysol 4 fl oz + Induce 0.125% v/v + Manzate Prostick 2 lb/ Super Tin 8 fl oz + Badge SC 32 fl oz/ Proline 5.7 fl oz + Induce 0.125% v/v + Manzate Prostick 2 lb/ Super Tin 8 fl oz + Priaxor 6.7 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt	4.3	43.59	17.20	317.4	13,812	2,118
Manzate Max 1.6 qt + Super Tin 8 fl oz/ Proline 5.7 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Badge SC 32 fl oz/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Badge SC 32 fl oz	4.8	38.04	18.17	336.8	12,829	2,082
Manzate Max 1.6 qt***/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Proline 5.7 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Manzate Max 1.6 qt	3.8	41.15	17.56	324.6	13,396	2,076
Manzate Max 1.6 qt + Badge SC 32 fl oz/ Super Tin 8 fl oz + Badge SC 32 fl oz/ Manzate Max 1.6 qt + Badge SC 32 fl oz/ Super Tin 8 fl oz + Badge SC 32 fl oz/ Manzate Max 1.6 qt + Badge SC 32 fl oz	4.5	37.80	17.96	333.5	12,639	2,072

Manzate Maz 1.6 qt***/ Proline 5.7 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Minerva 13 fl oz + Manzate Max 1.6 qt	3.5	41.34	17.44	321.7	13,322	2,050
Manzate Max 1.6 qt***/Proline 5.7 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Provysol 4 fl oz + Manzate Max 1.6 qt	4.0	38.00	17.94	331.7	12,658	1,998
Regev 8.5 fl oz + Badge SC 32 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Minerva 13 fl oz + Badge SC 32 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Proline 5.7 fl oz + NIS 0.125% v/v + Badge SC 32 fl oz	3.8	42.56	16.95	310.2	13,245	1,967
Lucento 5.5 fl oz + Manzate Prostick 2 lb/ Super Tin 8 fl oz + Topsin WSB 10 oz/ Topguard 14 fl oz + Manzate Prostick 2 lb/ Super Tin 8 fl oz + Priaxor 6.7 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt	4.0	39.66	17.29	318.7	12,645	1,966
Manzate Max 1.6 qt + Badge SC 32 fl oz/ Super Tin 8 fl oz + Badge SC 32 fl oz/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Badge SC 32 fl oz/ Proline 5.7 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt	4.5	39.54	17.31	319.1	12,643	1,958
Manzate Max 1.6 qt + Super Tin 8 fl oz/ Minerva 13 fl oz + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Badge SC 32 fl oz/ Manzate Max 1.6 qt + Inspire XT 7 fl oz/ Manzate Max 1.6 qt + Super Tin 8 fl oz/	4.0	42.83	16.74	307.5	13,152	1,946
Regev 8.5 fl oz + Super Tin 8 fl oz/ Badge SC 32 fl oz + Manzate Max 1.6 qt/ Minerva 13 fl oz + Badge SC 32 fl oz/ Super Tin 8 fl oz +Manzate Max 1.6 qt/ Proline 5.7 fl oz + NIS 0.125% v/v + Badge SC 32 fl oz	4.5	40.13	16.98	313.9	12,659	1,920
Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Topsin 20 fl oz/ Proline 5.7 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt/ Manzate Max 1.6 qt/ Super Tin 8 fl oz + Priaxor 6.7 fl oz	4.5	39.46	17.16	315.6	12,507	1,909
Provysol 4 fl oz + Manzate Max 1.6 qt****/ Super Tin 8 fl oz + Topsin 20 fl oz/ Proline 5.7 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt/ Super Tin 8 fl oz + Priaxor 6.7 fl oz	4.8	39.31	17.02	311.5	12,249	1,857
Manzate Max 1.6 qt + Badge SC 32 fl oz/ Proline 5.7 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt/ Manzate Max 1.6 qt + Badge SC 32 fl oz/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Manzate Max 1.6 qt + Badge SC 32 fl oz	4.0	36.81	17.33	320.1	11,787	1,826
Regev 8.5 fl oz + Topsin 10 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Minerva 13 fl oz + Badge SC 32 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Proline 5.7 fl oz + NIS 0.125% v/v + Badge SC 32 fl oz	4.3	39.61	16.59	303.8	11,994	1,736
Untreated Check	10.0	31.86	15.07	274.2	8,759	1,253
LSD (P=0.05)	**0.79**	**4.49**	**0.89**	**20.3**	**1,301**	**282**

*Cercospora leaf spot measured on 1-10 scale (1 = 1- 5 spots/leaf or 0.1% severity and 10 = 50% severity) on 10 September.
**Returns based on American Crystal payment system and subtracting fungicide costs and application.
***Treatment started at row closure on 28 June
****Treatment started on 21 July

References

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Treatment in blue is MDF (although according to their website the first application should have been Manzate + Badge instead of Priaxor + Badge like we had); 6 sprays

Treatment in green is ACSC; 5 sprays

Treatment in orange is SMBSC (although they recommended 6 sprays and we only did first 5)