PRELIMINARY REPORT ON THE OPTIMIZATION OF FUNGICIDE APPLICATION TIMINGS FOR MANAGEMENT OF CERCOSPORA LEAF SPOT IN SUGAR BEET CR+ VARIETIES

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Sugar beet (*Beta vulgaris* L.) is an important crop in North America, contributing 55-60% of US sugar production. The Red River Valley of North Dakota and Minnesota produce more than half of the nation's sugar beets (USDA-ERS 2023). However, the crop is susceptible to Cercospora leaf spot (CLS) disease, caused *by Cercospora beticola*, which can reduce 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). 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. Fungicides are an important management tool for CLS, and several applications may be required each year to protect yield and sugar. Recently, new varieties with increased CLS resistance are now available for growers in some areas and it is necessary to update fungicide timing recommendations. Therefore, the objective of this research is to evaluate fungicide application timings to control CLS in a standard susceptible sugar beet variety and two recently developed CLS resistant varieties containing the CR+ gene.

Materials and methods:

A field trial was conducted at Foxhome, MN in 2022. The experiment design was a split-plot design where varieties make up the main plots and fungicide treatments are the split plots. Field plots consisted of six 30-foot long rows spaced 22 inches apart. Plots were planted on 27 May with a variety susceptible to Cercospora Leaf Spot and two varieties highly tolerant to Cercospora Leaf Spot. Seeds were treated with Tachigaren and a treatment for controlling rhizoctonia. Seed spacing within the row was 4.7 inches. Weeds were controlled with herbicide applications (Nortron @ 6 pints) on 27 May, (Roundup Powermax @ 32fl oz; Outlook @ 12 fl oz; Class Act @ 1% v/v; Interlock @ 4 fl oz) 22 June and (Roundup Powermax @ 32 fl oz; Outlook 12 fl oz; Clean Slate @ 4 fl oz; Class Act @ 1% v/v; Interlock @ 4 fl oz) on 1 July as well as hand weeding throughout the summer. Quadris (14.3 fl oz) was applied on 28 June to control Rhizoctonia. Plots were inoculated on 8 July with C. beticola inoculum.

Fungicide spray treatments were applied with a CO2 pressurized 4 nozzle boom sprayer with 11002 TT TwinJet nozzles calibrated to deliver 17 gallons per acre of solution at 60 p.s.i. to the middle four rows of plots. Most fungicide treatments were initiated on 7 July and were continued, based on treatment requirements, on 21 July, 1 August, 12 August, 25 August and 7 September.

Fungicide treatment list:

1. Non-treated check
2. Prior row closure + 10-14 days interval
3. Row closure + 10-14 days interval
4. Row closure + 28 days interval
5. Row closure + Daily infection value (DIV)
6. Disease onset
7. Disease onset + 28 days interval
8. Disease onset + DIV
9. 3-5% disease severity + 10-14 days interval

10. 3-5% severity + DIV

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 12 September is reported.

Plots were defoliated mechanically and harvested using a mechanical harvester on 27 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.

<u>Results and discussion:</u>

The development of *C. beticola* was slow at the beginning, with the first symptoms observed about 30 days post-inoculation (dpi) in the susceptible variety Crystal 572, and 43 dpi in the Cr+ varieties (ACH 973 and Beta 7029). On August 16, the CLS rating on the non-treated ACH 973 and Beta 7029 was 0.8 and 1.0, respectively, while the susceptible check Crystal 572 had reached 2.3, which was still below the CLS rating (6.0) at which economic losses typically occur. Warmer conditions in late August and early September usually results in more favorable conditions for rapid disease development, as indicated by a CLS rating of 4.5 and 8.8 for the non-treated susceptible check on August 29 and September 12, respectively. However, the CLS rating in both Cr+ varieties (ACH 973 and Beta 7029) did not increase further and remained under 2.0 (1.5 and 1.8) until the middle of September.

The varietal effect resulted in significantly better disease control in both Cr+ varieties, as shown in Figure 1 (data were normalized in percentage scale). Even the non-treated check did not exceed CLS severity of 2.0. Additionally, the treatment effect indicated that seven out of ten treatments were able to significantly control the disease (P=0.05), as depicted in Figure 2. The interactions between cultivar and treatment revealed that most of the interactions effectively controlled the disease, except for three treatments: Trt1 (non-treated check), Trt9 (at 3-5% severity with 10 to 14 days), and Trt10 (3-5% severity followed by DIV) in susceptible variety, as illustrated in Figure 3. Although disease control was better in Cr+ varieties, there was a notable contrast in plot yield. Susceptible Crystal 572 yielded statistically similar sugar yield as of Cr+ 'Beta 7029' however ACH 793 resulted in significantly lower yield. This high sucrose yield (lb/Acre) was found to be significantly affected by a high stand count in susceptible varieties, in contrast to both Cr+ varieties (average stand count more than 55 in Crystal 572).

Despite improved disease control in Cr+ varieties, there was a significant difference in sucrose yield. The susceptible variety Crystal 572 yielded statistically higher sugar (lb/acre) than ACH793 which was further found to be impacted by significantly lower stand count in Cr+ varieties compared to susceptible one. Regarding fungicide treatment, most treatments had resulted in similar root tonnage (ton/acre), sucrose concentration (%), and SLM (%) as the standard susceptible check except Trt-9, which was applied at 3-5% disease severity followed by 10-14 days interval. As expected, environmental ques had proven to be very important for disease control, as fungicide applications starting at 3-5% disease severity followed by DIV (Trt-8) had resulted in an economical control of disease in susceptible check costing just under $70.0.Summing up, *C. beticola* exhibited delayed growth in Cr+ varieties and all the fungicide treatments which applied before reaching 3-5% disease severity along with application made with close monitoring of DIV, effectively controlled the CLS.

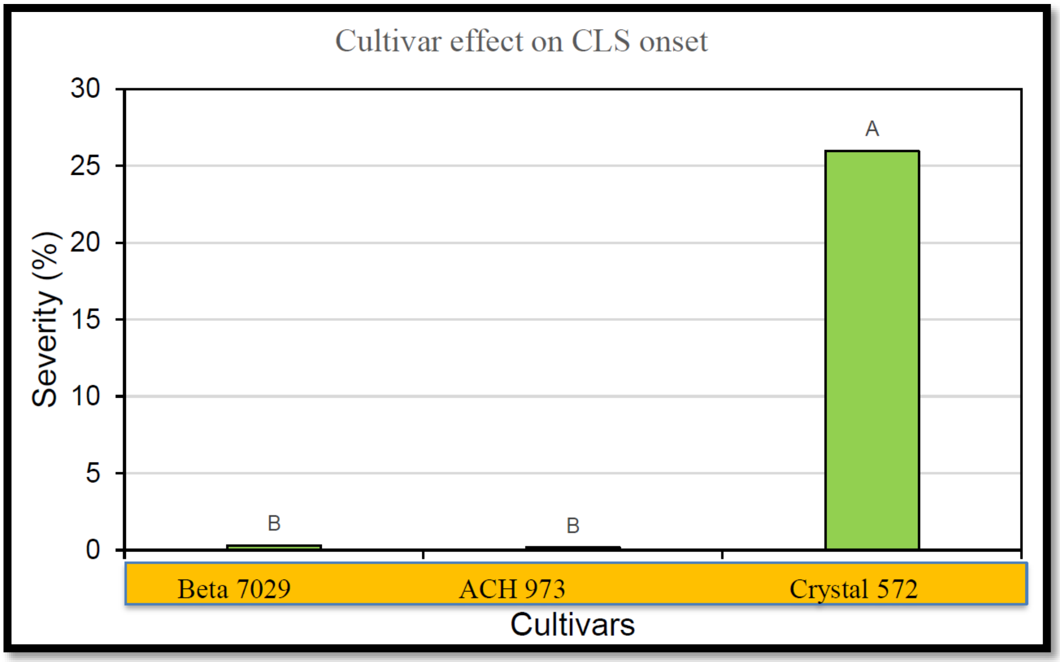

Fig 1: Varietal effect on Cercospora leaf spot control in sugar beets

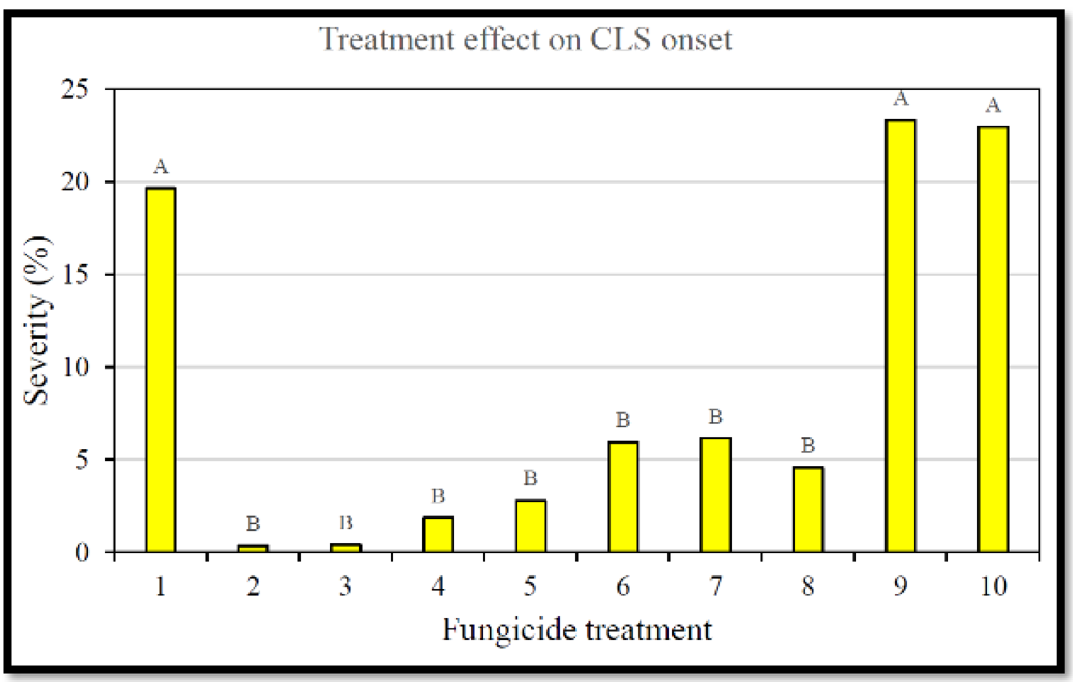

Fig 2: Fungicide treatment effect on control of Cercospora leaf spot in sugar beets

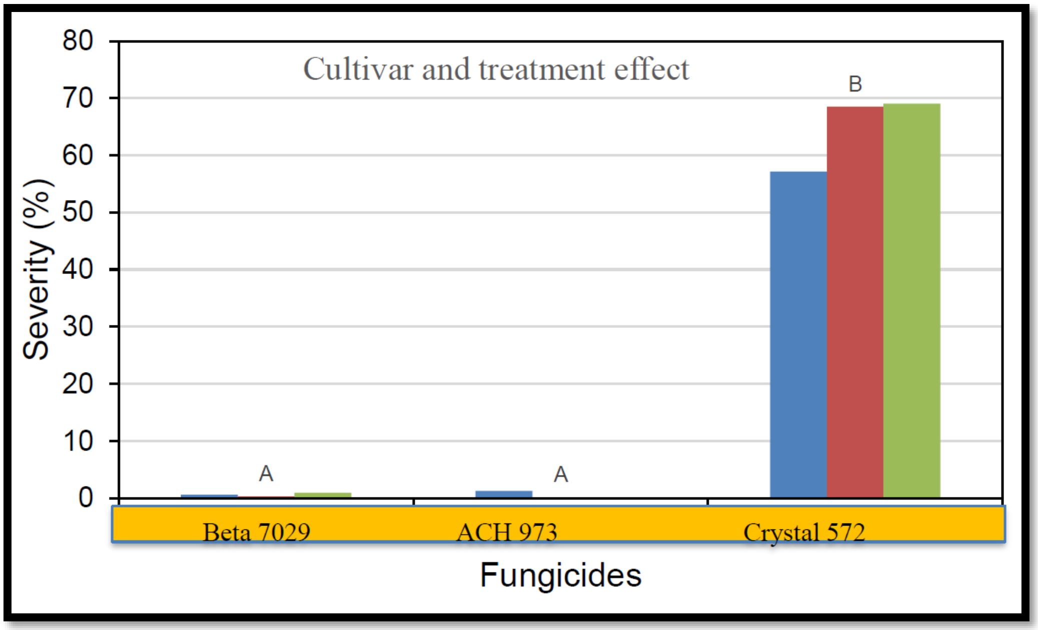

Fig3: Cultivar and treatment interactions effect on control of CLS in sugar beets

Treatment and rate/A amd timing	CLS rating	Root yield (Ton/Acre)	Sucrose %	Recoverable sucrose Lb/Ton Lb/Acre	
TABLE OF B (Fungicide Treatments) MEANS 1 Untreated	4.0	24.73	19.509	366.23	9076.2
2 Super Tin;Badge SC;Minerva;Manzate Max;Inspire XT;Proline;Preference	1.8	24.88	19.799	373.03	9239.8
3 Super Tin;Badge SC;Minerva;Manzate Max;Inspire XT;Proline;Preference	2.5	28.14	19.595	368.43	10340.2
4 Super Tin;Badge SC;Minerva;Manzate Max;Inspire XT;Proline;Preference	2.4	24.56	19.888	369.93	9078.5
5 Super Tin;Badge SC;Minerva;Manzate Max;Inspire XT;Proline;Preference	2.7	26.81	19.520	368.36	9856.5
6 Super Tin;Badge SC;Minerva;Manzate Max;Inspire XT;Proline;Preference	4.0	24.10	19.787	372.82	8914.2
7 Super Tin;Badge SC;Minerva;Manzate Max;Inspire XT;Proline;Preference	1.8	25.71	20.126	381.43	9779.8
8 Super Tin;Badge SC;Minerva;Manzate Max;Inspire XT;Proline;Preference	2.2	25.04	19.380	364.55	9064.8
9 Super Tin;Badge SC;Minerva;Manzate Max;Inspire XT;Proline;Preference	1.7	26.76	19.628	370.68	9899.1
10 Treatment 10	3.8	22.08	20.315	384.66	8456.8
Untreated check					

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