SUGAR BEET (*Beta vulgaris* 'C-G932NT')
Cercospora Leaf Spot; *Cercospora beticola*

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Evaluation of cultural practices to manage Cercospora leaf spot of sugar beet in Michigan, 2020-21.

In 2020, the trial was established at the Saginaw Valley Research and Extension Center in Frankenmuth, MI. A randomized complete block design was used, and treatments were replicated four times. Beets were planted in a loam soil 17 Apr at a rate of 50,000 seed/A, using 30-in. row spacing. Plot dimensions were four rows wide by 60 ft long. Corn was planted in 10-ft buffer zones surrounding each plot. Inoculations were made 23 Jul using a tractor mounted field sprayer applying a *C. beticola* spore solution (approximately 100 spores/mL by hemocytometer) at 15 gal/A. The five treatments tested in this study included a non-treated control, plow with a 10-ft tandem disc set to invert soil 6 in. immediately post-harvest, heat treatments using a propane-fueled burner calibrated to heat foliage to 1200-1600°F at 1 mph and 3 mph prior to defoliation, and a desiccant (Sharpen 1 fl oz/A) applied seven days pre-harvest. Treatments were applied pre- or at-harvest on 8 Oct or 15 Oct, respectively. The desiccant was applied with a CO_2 powered backpack sprayer equipped with four TJ 8004XR nozzles (30-in. spacing) calibrated at 15 gal/A. Root subsamples were collected from the center two rows of each plot on 15 Oct and sent to Michigan Sugar Company (Bay City, MI) to determine percent sugar and recoverable white sugar per ton (RWST). Plots were scouted regularly to monitor Cercospora leaf spot (CLS) progression. In addition, four leaf samples were collected: one was destructively sampled and three were placed in mesh bags and left in each plot to be evaluated 45-, 90-, and 135-days post-harvest (DPH). Bags were incorporated into the soil to mimic soil conditions after treatment application, 6 in. for plow-treated plots and <1 in. for all other plots. At each timepoint, leaf samples were assessed for percent lesion sporulation, following a 3-d incubation in a moist chamber at 70-75°F, and frequency of *C. beticola* isolation, determined from morphological confirmation of *C. beticola* growth *in vitro*. Following harvest, winter wheat was planted in the 10-ft buffer zones surrounding each plot and maintained during the 2021 season.

In 2021, the trial was continued and planted on 7 May using the previously described experimental design and plot layout. Beginning 14 May, boxes of four sentinel beets (USDA germplasm F1042, highly susceptible to CLS) were placed in each plot for one week; sampling continued until 6 Jul. Total CLS lesions from sentinel beets were counted after beets were incubated for 3 d in a humidity chamber at 77°F and maintained for two weeks in a greenhouse. Plot CLS ratings were initiated 15 Jun and continued until 8 Aug. Plots were assigned a severity using the following scale based on infected leaf area: 1=0.1% (1-5 spots/leaf), 2=0.35% (6-12 spots/leaf), 3=0.75% (13-25 spots/leaf), 4=1.5% (26-50 spots/leaf), 5=2.5% (51-75 spots/leaf), 6=3%, 7=6%, 8=12% 9=25%, 10=50%. The ratings were used to calculate area under the disease progress curve for CLS severity (AUDPC). Roots were harvested from the center two rows of each plot 17 Sep and weights used to calculate yield relative to the control plot in each replicate. A generalized linear mixed model procedure was used to conduct the ANOVA and mean separations at the α=0.05 significance level (SAS version 9.4).

In 2020 following treatment applications, significant treatment differences were determined in percent lesion sporulation at-harvest ($P < 0.0001$), 45-DPH ($P < 0.01$), and 90-DPH ($P < 0.05$) leaf samples. No significant differences were determined in isolation frequencies of *C. beticola* from leaf samples evaluated at-harvest, 45-, 90-, and 135-DPH. Additionally, no significant differences were observed in percent sugar or RWST ($P < 0.05$) values.

In 2021, through the winter, significant differences in percent leaf degradation, calculated using initial leaf weight at-harvest and final weight post-harvest, were determined in 90- ($P < 0.05$) and 135-DPH ($P < 0.01$) leaf samples. In the 2021 growing season, both heat treatments resulted in significantly fewer lesions on sentinel beets from 1 Jun – 8 Jun ($P < 0.05$) and the 1 mph heat treatment resulted in significantly fewer lesions on sentinel beets 15 Jun – 22 Jun ($P < 0.05$) compared to the non-treated control. AUDPC values were significantly different among treatments ($P < 0.05$), and the plow and heat treatments resulted in significantly lower CLS than the non-treated control. Significant differences were also observed for relative yield ($P < 0.05$).

Table 1. Overwintered leaf sample information collected in 2020-2021

Treatment[z]	At-harvest		45 DPH[y]		90 DPH		135 DPH		At-harvest	
	Sp[x, w] (%)	Is[v] (%)	Sp (%)	Is (%)	Sp (%)	Is (%)	Sp (%)	Is (%)	RWST[u]	Sugar (%)
Control	77.9 a	5.0	22.2 a	0.0	7.2 a	2.5	8.8	0.0	221.3	15.2
Plow	66.4 ab	2.5	0.0 b	0.0	0.0 b	0.0	1.6	0.0	214.6	14.8
Heat (1mph)	0.0 c	0.0	0.0 b	0.0	0.0 b	0.0	0.0	0.0	216.1	14.9
Desiccant	50.1 b	7.5	32.2 a	0.0	7.5 a	0.0	0.9	0.0	220.3	15.1
Heat (3mph)	0.0 c	0.0	0.0 b	0.0	0.3 b	0.0	0.3	0.0	223.5	15.3

[z] Non-treated control, plow with a 10-ft tandem disc set to invert soil 6 in. immediately post-harvest 15 Oct, heat treatment using a propane-fueled burner (Multi-Trail Enterprises LLC) calibrated to heat foliage to 1200-1600°F at 1 mph and 3 mph prior to defoliation 15 Oct, and a desiccant (Sharpen 1 fl oz/A, methylated seed oil 1% v/v, ammonium sulfate 17 lb/100 gal) applied seven days pre-harvest 8 Oct.
[y] Days post-harvest (DPH).
[x] Percent lesion sporulation (Sp) determined following a 3-d incubation in a moist chamber at 70-75°F.
[w] Column values followed by the same letter were not significantly different based on Fisher's Protected LSD (α=0.05).
[v] Frequency of *C. beticola* isolation (Is) determined from morphological confirmation of *C. beticola* growth from 15 representative lesions plated on half-strength clarified V8 juice agar amended with 0.5 g/L streptomycin and 0.25 g/L ampicillin.
[u] Pounds recoverable white sugar per ton (RWST).

Table 2. Sentinel beet, CLS severity, and leaf degradation information collected in 2021

Treatment[z]	% Leaf Degradation[y]		Sentinel[w, v] (1 Jun – 8 Jun)	Sentinel (15 Jun – 22 Jun)	Sentinel (29 Jun – 6 Jul)	AUDPC[u]	Relative Yield[t] (%)
	90-DPH[x]	135-DPH					
Control	72.6 bc	80.4 bc	19 a	888 ab	1514	137 a	100 ab
Plow	82.6 a	86.2 ab	9 ab	628 bc	1397	96 c	97 ab
Heat (1mph)	81.9 ab	89.3 a	4 b	144 c	1189	96 c	126 a
Desiccant	67.7 c	74.3 c	15 a	1239 a	1222	126 ab	64 b
Heat (3mph)	71.1 c	86.2 ab	2 b	396 bc	1498	105 bc	79 b

[z] Non-treated control, plow with a 10-ft tandem disc set to invert soil 6 in. immediately post-harvest 15 Oct, heat treatment using a propane-fueled burner (Multi-Trail Enterprises LLC) calibrated to heat foliage to 1200-1600°F at 1 mph and 3 mph prior to defoliation 15 Oct, and a desiccant (Sharpen 1 fl oz/A, methylated seed oil 1% v/v, ammonium sulfate 17 lb/100 gal) applied seven days pre-harvest 8 Oct.
[y] Percent leaf degradation calculated using initial leaf weight at-harvest and final weight post-harvest.
[x] Days post-harvest (DPH).
[w] Total CLS lesions were counted on sentinel beets (USDA germplasm F1042, highly susceptible to CLS) after one-week exposure in the field, 3 d incubation in a 77°F humidity chamber, and two weeks in a greenhouse.
[v] Column values followed by the same letter were not significantly different based on Fisher's Protected LSD (α=0.05).
[u] Area under the disease progress curve (AUDPC) was calculated using disease severity (0-10 scale).
AUDPC=[((DS1+DS0)/2)*TI1]+…+[((DS4+DS3)/2)*TI4], where DS0 (collected Jun 15), DS1 (Jun 29), DS2 (Jul 13), DS3 (Jul 27), DS4 (Aug 10) and TI1 through TI4=14 days.
[t] Relative yield calculated by dividing the yield per plot (t/A) by the yield in the control plot for each replicate and multiplying by 100.