Development and validation of a spore-based *Cercospora beticola* risk model for improved application timing and management of Cercospora leaf spot on sugar beets, 2022-23

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Methods: A preliminary model was created in 2021 to predict elevated *C. beticola* spore numbers using a threshold of 35 spores. The model was created using daily numbers of aerial spores collected in sugar beet fields using a Burkard spore trap in Michigan from 2019, 2020, 2021 and 2022 and from Ontario, Canada 2019, 2020, and 2021 early in the season (May to July). Environmental factors were evaluated for their impact of spore number. Stepwise regression analyses were conducted to assess potential models.

Weather variables highly correlated to spore counts were identified and logistic modeling was used to predict elevated spore levels ($R^2 = 0.18$, $P < 0.0001$). The model predicted the chance that daily spore abundance was ≥35 (Spore35) based on number of hours with leaf wetness (≥ 25%) from 11AM to 10AM (DurLW), average daily air temperature (°C) from 11AM to 10AM (AvgTemp), and maximum daily wind speed (km/h) (MaxWS). The following equation was used to predict risk for elevated aerial spores:

$$\textbf{Spore35} = 0.1132*\textbf{DurLW} + 0.1285*\textbf{AvgTemp} + 0.0369*\textbf{MaxWS} - 5.0814$$

A validation field study was conducted to test the ability of this model to assist in fungicide application timing and improved management (details below). The field treatments were arranged in a randomized complete block design with three treatments applied to a CLS-susceptible variety in 2023.

Location: Frankenmuth, MI (SVREC)	**Treatment Timings:** see table
Planting Dates: May 12, 2023 (Harvest: October 2)	**Pesticides:** see table
Soil Type: Loam	**O.M.:** 5.0 **pH:** 7.5
Replicates: 4	**Variety:** SX-1278

Table 1. Model validation treatment programs tested in 2023. All models were based off of the Spore35 model at using various initiation criteria. After initiation, subsequent spray timings followed a 14-day (calendar) or model-based interval.

Trt	Program	Initiation Criteria [a]	Actual Initiation Date	# App.	App. Interval
1	Non-treated control	-			
2	Model 1	50% + DSV 3 or 4	6/30/23	6	14-day
3	Grower standard [b] + calendar interval	50 DSV	7/10/23	6	14-day
4	Grower standard + model interval	50 DSV	7/10/23	4	After 14 days, apply when 50% + DSV 3 or 4
5	Model 2	50% + DSV 3 or 4 + 40% row closure	7/19/23	5	14-day
6	Model 3	40% + DSV 3 or 4 + 50% row closure	7/25/23	5	14-day

[a] Model 1, 2, and 3 programs were initiated based on the Spore35 model threshold of 50% likelihood of 35 or more *C. beticola* spores paired with a BEETcast DSV value of 3 or 4 on the same day.
[b] Grower standard program as follows: Manzate Max (1.6 qt) ABCDE; Inspire XT (7 fl oz) BD; Badge (1.5 pt) F. Application letters code for the following dates: A=10 Jul, B= 25 Jul, C=8 Aug, D=22 Aug, E=5 Sept, F=16 Aug, and G=30 Aug.

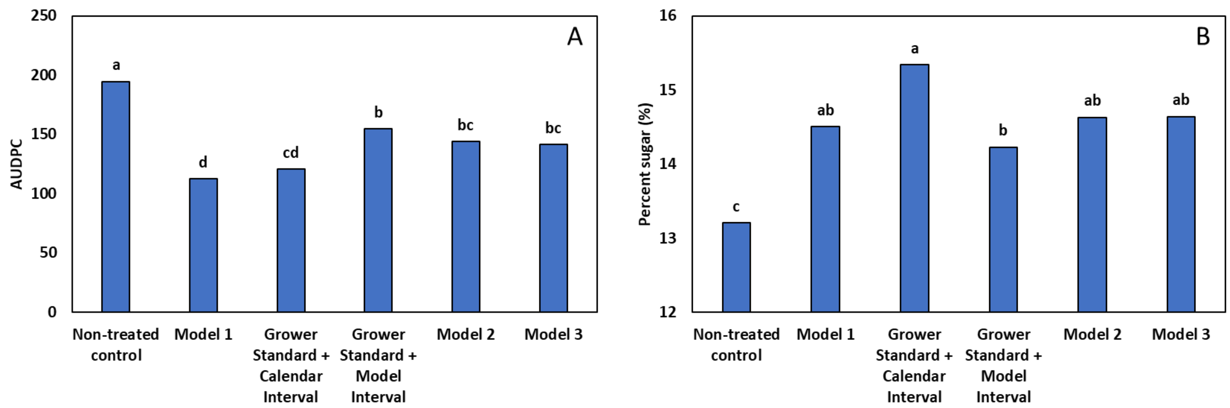

Figure 1. Area under the disease progress curve (A) was calculated using disease severity scores (0-10 scale) collected July 7 to Aug 5, 2023. Percent sugar (B) was measured post-harvest. Significant differences are indicated by different letters based on Fisher's Protected LSD (α=0.05).

Summary: The treatments in this study did not result in any significant differences in yield. All treatments resulted in significantly reduced AUDPC compared to the non-treatment control. The earliest model initiation (Model 1) showed a significant reduction in AUDPC compared to the Grower standard with the extended model interval and the two delayed model initiations (Model 2 and 3). Numerically, Model 1 resulted in the lowest AUDPC, which was not significantly different from the grower standard with calendar interval. The grower standard with the extended model interval had significantly higher disease pressure compared to the grower standard with the calendar interval.

All spray programs resulted in significantly greater sugar content than the non-treated control. The percent sugar was greatest in the grower standard with the calendar spray interval but was not significantly different from treatments based on Model 1, 2, or 3. Percent sugar was significantly reduced in the grower standard program with extended model-based spray interval. In this study, where a highly CLS-susceptible variety was combined with severe CLS pressure, extending the interval between applications based on spore-based risk was not beneficial, as indicated by the increase in AUDPC and the reduction in sugar percentage. Early-season suppression of CLS using model-based initiation thresholds, however, shows potential to improve foliar management. Further model refinement is in progress.

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