EARLY DETECTION OF CERCOSPORA BETICOLA SPORE PRODUCTION IN COMMERCIAL SUGARBEET FIELDS

Gary Secor[1], Viviana Rivera[1], Nathan Wyatt[2], Melvin Bolton[2]

[1]Department of Plant Pathology, North Dakota State University, Fargo, ND 58108 and [2]USDA-ARS, Edward T. Schafer Agricultural Research Center, Fargo, ND 58102

Cercospora leaf spot (CLS), caused by the fungus *Cercospora beticola,* is the most important leaf spot disease of sugar beet and is endemic in sugarbeet fields in the Red River Valley. Severity of CLS varies from year to year and can cause serious economic losses if not managed by crop rotation, cultural practices, resistant cultivars, and application of fungicides. In recent years, fungicides were applied earlier and more often from two to six times per season.

Timing of fungicide applications, especially the first application, is highly variable. First applications are based on calendar, first appearance of disease (first spot in the field) or first observation CLS in the area. Subsequent fungicide applications are based on daily infection values (DIV's) calculated from using relative humidity (RH) and temperature in the field. As DIV's increase, disease favorability increases, and fungicide applications are recommended when a threshold is reached. Two models are most often used for forecasting conditions favorable for CLS infection in the field and subsequent fungicide application: the Shane and Teng model developed in the mid-1980's and BEETcast developed in 2004. Both use weather-based data (RH and temperature) to calculate DIV's to predict field infection by *C. beticola*. Both models monitor conditions favorable for disease development after conidia or disease are detected. The forecasting model does not include conditions favorable for spore production and germination, which may be important and overlooked parts of predicting early infection.

Recent work examining the optimal conditions for *C. beticola* spore germination identified the presence of free water at lengths of time greater-than or equal to 4 hours in vitro. Across all treatments, spore germination was higher when free water was present (95%) compared to 100% RH (30%). Germination begins in two hours at 10°C and increases with time and temperature. Additionally, in 2021 latent *C. beticola* infection was detected in asymptomatic sugarbeets as early as mid-June. Taken together, this new information raises questions regarding early season spore dispersal and early season environmental conditions that may be favorable to *C. beticola* spore germination and the beginning of infection. To address these questions, spore traps were deployed to detect *C. beticola* spores and monitor weather data relevant to disease progression throughout the year.

Objectives

1) To detect and monitor early *C. beticola* spore production in sugar beet fields using spore traps and to correlate spore production with temperature and leaf wetness conditions
2) To detect early season latent infection of sugar beet plants and fungicide resistance profile using PCR testing
3) To monitor the first appearance of CLS in commercial sugar beet fields
4) To correlate spore detection, latent detection and first leaf spot appearance and weather conditions to forecast date of first fungicide application for control of CLS in commercial sugarbeet fields

Materials and Methods

Spore traps (Spornado) and weather stations were installed in six commercial sugarbeet fields at the locations Renville, Oxbow, and Perley. Weather stations were equipped with leaf wetness sensors as earlier work in our lab verified the necessity of free water for spore germination. Spornado filters were collected three times/week from May 3 to August 2 and tested for the presence of *C. beticola* DNA by PCR. From early June to late July of 2021, leaves were sampled from 57 commercial fields in two production areas for the presence of *C. beticola* DNA by PCR. These sites were also monitored for appearance of CLS spots. Weather station data was used to identify likely environmental conditions favorable for *C. beticola* germination by examining patterns of leaf wetness in relation to collected weather data.

Results and Discussion

C. beticola spores were first detected May 3, and detection continued until August 2. *C. beticola* DNA was first detected in asymptomatic sugarbeet leaves in one production area (SMBSC) on June 17 in 12% of the leaf samples and in the second production area (ACSC) on June 14 in 8% of the leaf samples and 16% of the locations sampled. The incidence of *C. beticola* infection by PCR during the sampling period in 2021 ranged from 12% to 77% at SMBSC and 16% to 90% at ACSC. The first CLS spots were observed in the ACSC area on June 29.

Given the early detection of *C. beticola* spores on May 3 and the early detection of *C. beticola* DNA on June 17, weather data from May and June collected at spore trap locations was examined. Each location was equipped with leaf wetness sensors. Average temperatures across all time points surpassed 10°C necessary for the *C. beticola* spore germination initiation. Leaf wetness data corresponding to continuous four-hour windows was extracted from the data and compared to collected weather data. The most closely associated weather phenomena was rainfall and was the best predictor of subsequent leaf wetness for a four hour period. This data however was inconsistent at various location-month combinations (Figures 1-6). The Renville location data showed the best level of prediction for rainfall data and leaf wetness in both May and June with rainfall immediately precluding increases in leaf wetness (Figures 1 and 2). The Oxbow location showed consistent data for the month of June but not May with rainfall data in June predicting increased leaf wetness for continuous four hour periods (Figures 3 and 4). The Perley location was the most unreliable of the three locations with inference related to leaf wetness difficult to make (Figures 5 and 6). Data from the Perley location shows a pattern more indicative of leaf wetness based on a daily cycle. This indicates that there are more factors involved in predicting leaf wetness from weather data.

Based on our data, we suggest that forecasting models be adjusted to recommend fungicide application early in the growing season before CLS is observed. This study also confirms the utility of *C. beticola* spore trapping and PCR detection of infection by *C. beticola* before CLS is observed. It is of note that 2021 was a drought year and we plan to repeat this study in 2022.

Figures

Figure 1: The two panel figure below shows leaf wetness data (top) and rainfall data (bottom) taken on an hourly basis for the month of May at the Renville location. Each point in the top leaf wetness panel shows the relative leaf wetness with brown points representing timepoints belonging to a >4 hour window of time where leaf wetness was elevated. This is a condition for *Cercospora beticola* spore germination. The bottom panel depicts hourly rainfall with blue dots representing rain and black dots representing no rainfall.

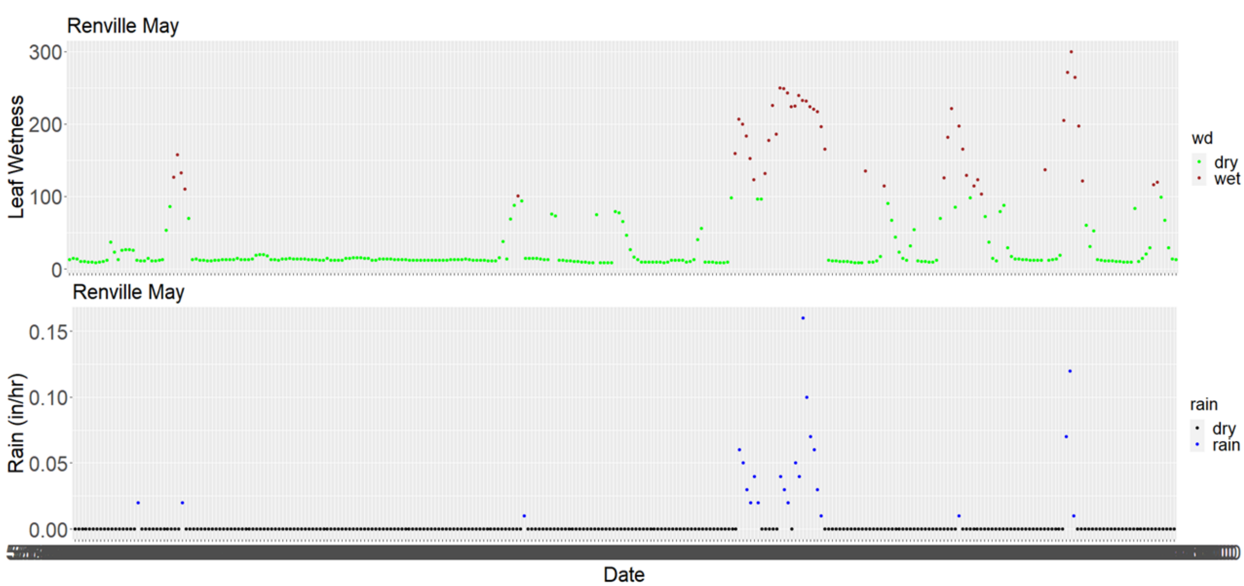

Figure 2: The two-panel figure below shows leaf wetness data (top) and rainfall data (bottom) taken on an hourly basis for the month of June at the Renville location. Each point in the top leaf wetness panel shows the relative leaf wetness with brown points representing timepoints belonging to a >4 hour window of time where leaf wetness was elevated. This is a condition for *Cercospora beticola* spore germination. The bottom panel depicts hourly rainfall with blue dots representing rain and black dots representing no rainfall.

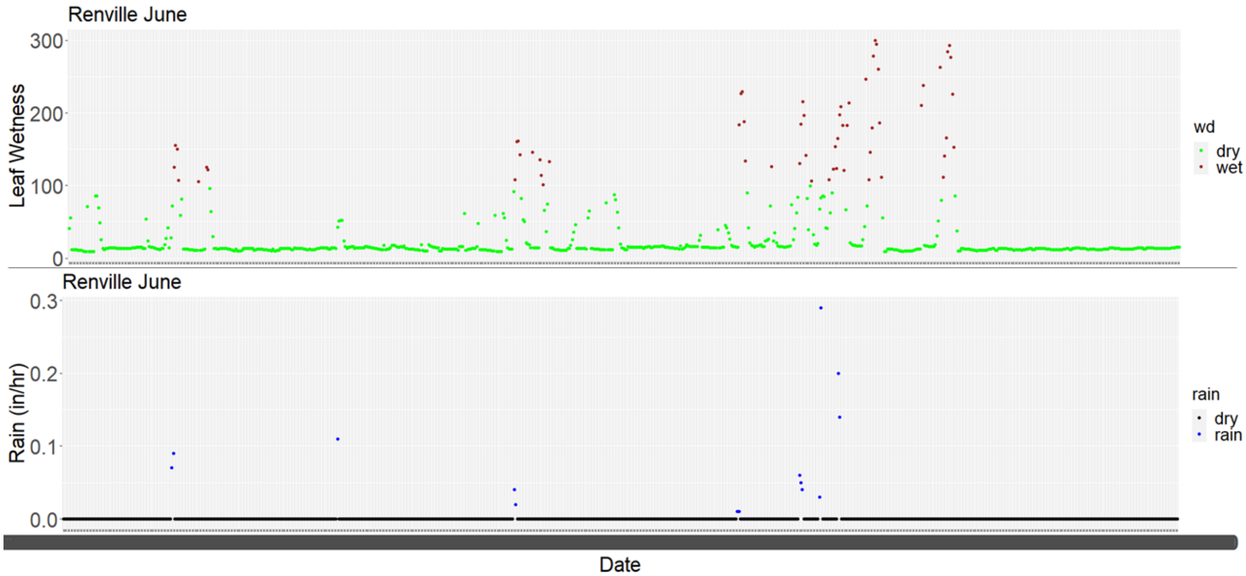

Figure 3: The two-panel figure below shows leaf wetness data (top) and rainfall data (bottom) taken on an hourly basis for the month of May at the Oxbow location. Each point in the top leaf wetness panel shows the relative leaf wetness with brown points representing timepoints belonging to a >4 hour window of time where leaf wetness was elevated. This is a condition for *Cercospora beticola* spore germination. The bottom panel depicts hourly rainfall with blue dots representing rain and black dots representing no rainfall.

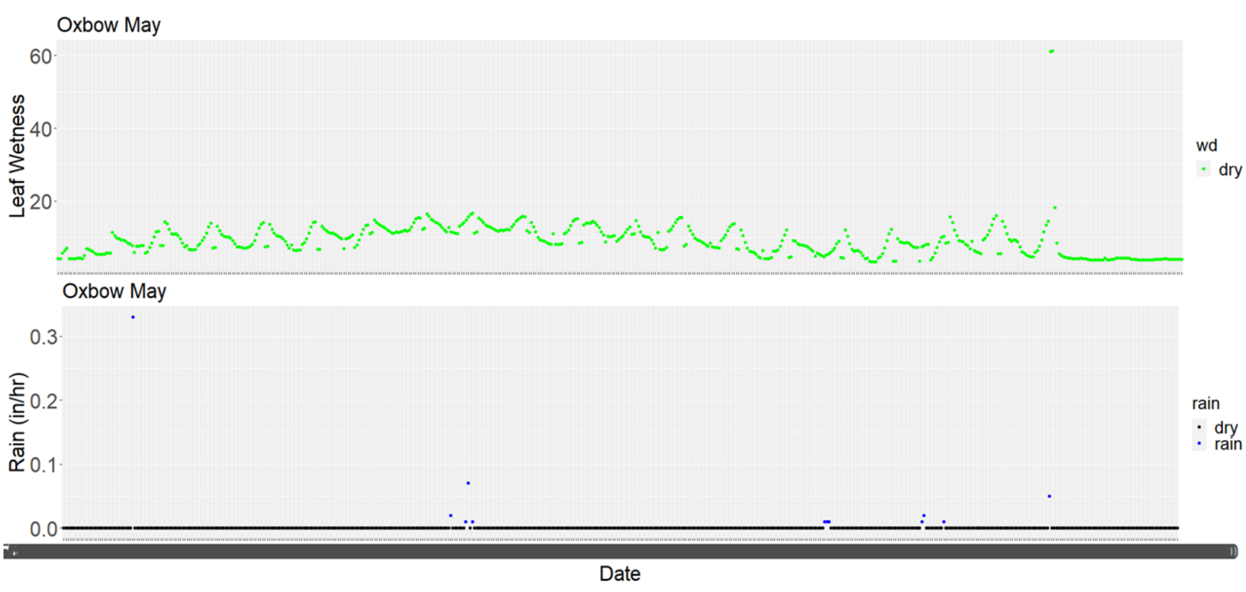

Figure 4: The two-panel figure below shows leaf wetness data (top) and rainfall data (bottom) taken on an hourly basis for the month of June at the Oxbow location. Each point in the top leaf wetness panel shows the relative leaf wetness with brown points representing timepoints belonging to a >4 hour window of time where leaf wetness was elevated. This is a condition for *Cercospora beticola* spore germination. The bottom panel depicts hourly rainfall with blue dots representing rain and black dots representing no rainfall.

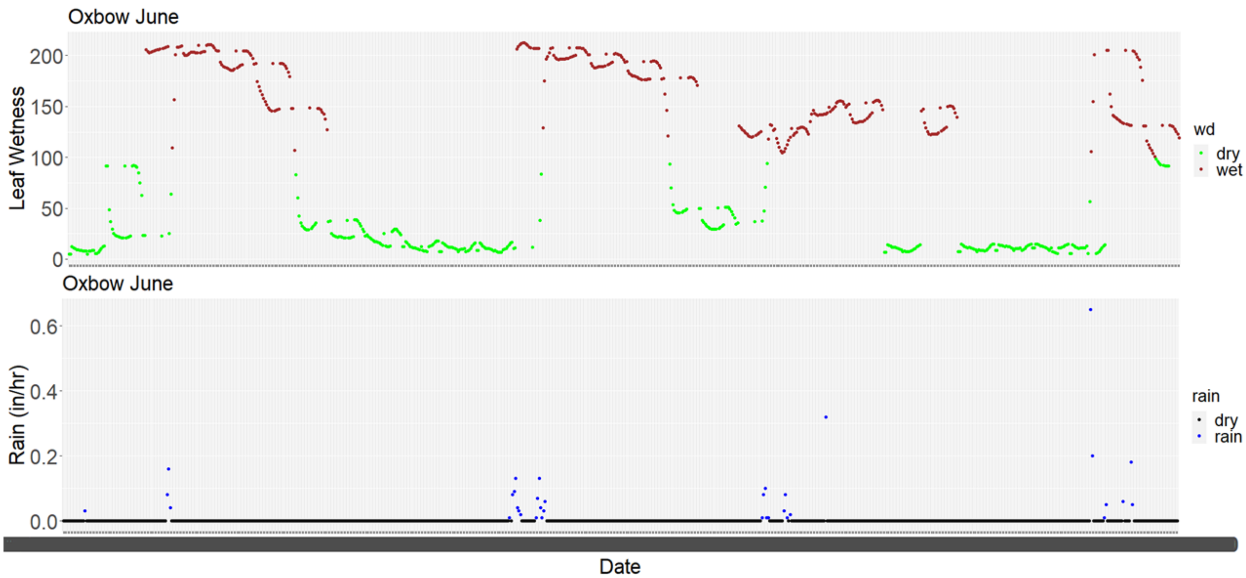

Figure 5: The two-panel figure below shows leaf wetness data (top) and rainfall data (bottom) taken on an hourly basis for the month of May at the Perley location. Each point in the top leaf wetness panel shows the relative leaf wetness with brown points representing timepoints belonging to a >4 hour window of time where leaf wetness was elevated. This is a condition for *Cercospora beticola* spore germination. The bottom panel depicts hourly rainfall with blue dots representing rain and black dots representing no rainfall.

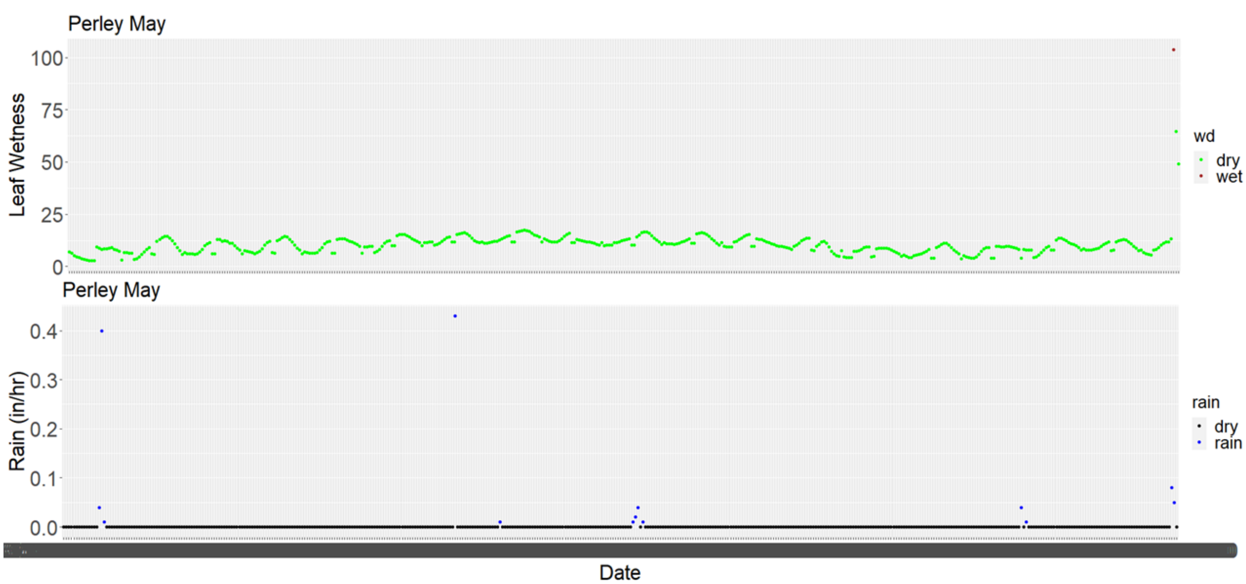

Figure 6: The two-panel figure below shows leaf wetness data (top) and rainfall data (bottom) taken on an hourly basis for the month of June at the Perley location. Each point in the top leaf wetness panel shows the relative leaf wetness with brown points representing timepoints belonging to a >4 hour window of time where leaf wetness was elevated. This is a condition for *Cercospora beticola* spore germination. The bottom panel depicts hourly rainfall with blue dots representing rain and black dots representing no rainfall.