

### The Increase of *Cercospora* Leaf Spot in Sugar Beets and Periodicity of Spore Release

Jack R. Wallin and Daniel V. Loonan

Research Plant Pathologist and Research Technician, respectively, Plant Science Research Division, ARS, USDA, Iowa State University, Ames 50010.

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#### ABSTRACT

An exponential increase in the *Cercospora* leaf spot disease occurred over 18 days in August. Disease spread was fastest downwind from the inoculated row. Spore release increased sharply at 0800 hr, 1 hour after dew "burn off" was well underway and relative humidity had

dropped below 90%, and was greatest at 1100 hr. Long nocturnal dew periods resulted in few spores aloft at night and more spores over the sugar beets the next day.

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*Additional key words:* *Cercospora beticola*, *Beta vulgaris*.

Spore production and liberation, so essential to the success or failure of the development of *Cercospora beticola* Sacc. on sugar beets, have not been well documented. Spore formation in the field takes only a few hours during the night, and supposedly, liberation occurs in the presence of water or high relative humidity (2). The number of spores of *Cercospora apii* in the field (1), 60% of which were trapped between 1100 and 1500 hr, increased progressively with each successive night of 8 hr or more of relative humidity near 100% and temperatures of 15 to 30 C, and was associated with the rapid drop in relative humidity that usually occurred from 0800 to 1100 hr. Spores of *Cercospora* spp. (5) were trapped night and day, but predominantly during the day, and were most

abundant in the morning hours shortly after the dew dried off the foliage. In the tropics (4), *C. hayi* spores occurred in greatest numbers from 1400 to 1800 hr on rainless days. On rainy days, the peak occurred after the rain ceased. Mature spores formed within 16 hr at 23 and 26 C on young banana fruit. Spores started to germinate in 1 hr, and 85% had germinated within 3 hr. In South Dakota, *C. beticola* spores were most abundant on rainy days and days immediately after rain (3). Periods of 100% relative humidity ranging from 10 to 24 hr were most conducive to sporulation, and rain was suggested as the principal means of spreading the fungus.

The purpose of our investigation was to document the spread of *C. beticola*, and to determine the concentrations of air-borne spores throughout the

24-hr day as affected by coincident weather conditions.

**MATERIALS AND METHODS.**—On 29 April, 2 plots of a susceptible sugar beet cultivar were planted. Each plot had eleven 30-ft rows spaced 22 inches apart. On 17 June, when the sugar beet plants were 12 inches high, the center row in each plot was inoculated with an aqueous suspension of 2,500 spores/cc of *C. beticola* obtained from cultures grown on soybean meal-dextrose agar at room temperature.

Leaf spot counts were initiated on 17 July as soon as spots began to appear in the inoculated rows. Additional counts were made on 6, 11, and 18 August.

A Metronics rotorod sampler with clear plastic rods was placed in each of the plots on 18 July. The silicone-greased, clear-plastic rods were examined under a microscope. The sampler rods were changed at 0700, 1300, and 1600 hr.

On 31 July, a Kramer-Collins spore sampler was placed in the beet plots. This instrument samples for 8 min every hour and collects spores on a silicone-greased microscope slide over a 24-hr period. Slides were changed at 0800 hr. This sampler was operated through 12 September.

Weather data were obtained with a recording rain gauge, a sheltered hygrothermograph, and a glass plate dew recorder (Taylor).

**RESULTS AND DISCUSSION.**—Leaf spots were first noted on beets in the inoculated row on 1 July. By 17 July, spot counts on the 60 plants in the inoculated row ranged from 4 to 261. On the same date, the spot count on plants the first row south of the inoculated row ranged from 1 to 32 and from 1 to 50 on the first row north of the inoculated row.

On 6 August, 892 *Cercospora* spots were counted on four leaves of each of 24 plants located throughout the plot. On 11 August, there were 17,865 spots on the 24 plants; and by 18 August, 12 days after the first count, the number of spots had risen to 29,123, indicating that weather conditions had been favorable for sporulation, germination, and infection. Observations of the infected plants in the plot revealed that the greatest disease spread was downwind north and slightly northeast of the inoculated center row. The lowest disease count was in the southwest quadrate.

The rotorod spore sampler was used for trapping until 31 July, then was abandoned because on dry windy days the spinning rods collected so much debris and so many soil particles that the colorless *Cercospora* spores could not be detected. The Kramer-Collins sampler was set out 31 July, and was more effective because it did not collect so much particulate material.

From 18 to 31 July, the daily spore count was low. The greatest number of spores trapped during this time was 257 over a 4-hr period. Usually, the counts were 20 to 30 over a 10-hr period.

Spores began to increase on 1 August, with a significant increase on 7 August. Another increase in spore number was noted on 19 August, and an additional increase in spore numbers was recorded on

21 August. The increase in the number of leaf spots is correlated with this increase in spore numbers. The greatest number of spores trapped, 500 during a given hour, occurred on the 19th between 0500 and 0600 hr during a rain squall.

Spore catch for 19 individual days during August was greatest at 1100 hr each day. In the morning, a sharp increase in the spores trapped occurred at 0800 hr when dew "burn-off" was nearly complete. Seventy-two per cent of the spores were trapped from 0900 through 1700 hr. Thirty-four per cent of the spores were trapped during the 4-hr period 0900 through 1200 hr; and 35% from 1000 through 1300 hr. Eight per cent of the spores were trapped at 1500 hr.

A period of 6 successive days was selected to illustrate the average count of *C. beticola* in relation to the average hourly temperature and relative humidity in August (Fig. 1). When the temperature rose and the relative humidity dropped below 90%, there was a sharp increase in the number of spores trapped. This increase continued to a maximum at 1100 hr, then fell off toward evening when the temperature dropped and the relative humidity rose.

Surprisingly, many spores were released at night (Fig. 2). A number of spores were trapped between 2400 and 0600 hr, indicating that spores were available for landing on wet foliage. These moist conditions favor spore germination and infection. During the night of 12 August, for example, as many or more spores were trapped at 2000, 2100, 2200, 2400, and 0100 hr as at 1300, 1400, and 1500 hr.

During the night of 12 September, relatively high numbers of spores, 22 to 25, were trapped during the period 2000 through 0200 hr (Fig. 3). Only a 4-hr dew period was recorded this night, and dew occurred just before 2400 hr. During the night of 19 August, a number of spores were trapped from 2000 to 0200 hr. The relative humidity rose above 90%, dew formed about 0200 hr, and the number of spores trapped decreased.

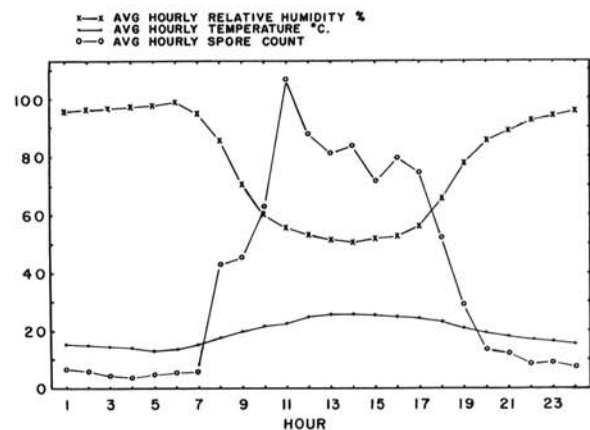


Fig. 1. Average number of spores of *Cercospora beticola* trapped for 6 successive days, 20-26 August 1969, in relation to the average hourly temperature and humidity.

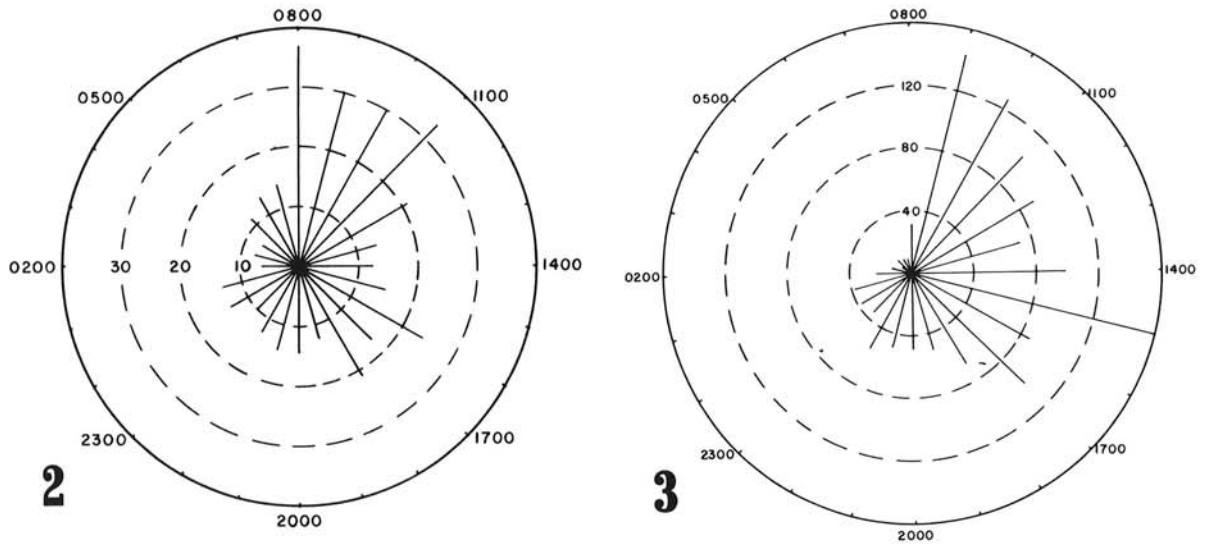


Fig. 2-3. 2) Number of spores of *Cercospora beticola* trapped (dash lines) from 0800 hr on 12 August to 0700 hr on 13 August. The solid lines radiating out from the center indicate the actual number of spores trapped at the hours of the day indicated by the numbers outside the circle. 3) Number of spores of *C. beticola* trapped from 0800 hr on 12 September to 0700 hr on 13 September.

Most spores were trapped during the daylight hours, but some nocturnal hourly counts were high. The high night counts were associated either with only a few hours of relative humidity equal to or greater than 90% or relative humidity not reaching 90% until shortly before or after 2400 hr. There were a few spores trapped on those nights when relative humidity was equal to or greater than 90% for 6 hr or more. The greater the number of hours of equal to or greater than 90% relative humidity, the fewer the number of spores caught.

The highest daily count, 1,773 spores, however, occurred not immediately, but the day after a rain and a 29-hr dew period. The next highest daily count occurred 2 days after a rain. In general, the longer dew period at night resulted in greater spore production the next day. With but two exceptions during a 22-day period, spores were trapped every hour, day and night. Spores were omnipresent to

continue the inoculum increase throughout the season.

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