Relation of Weather Factors to Dispersal of Conidia of Cercospora beticola (Sacc.)[1]

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Introduction

Leaf spot, caused by *Cercospora beticola* Sacc., is a common foliage disease of sugar beets throughout central and southern Europe and in the United States, east of the Rocky Mountains. It is a serious problem to the development of an eastern South Dakota sugar beet industry. Its build-up has been long associated with high relative humidity and damp weather conditions (4,5,6)[3]. Wenzl (7) reported high rainfall and temperatures of circa 67°F favorable to beet seed infection.

Cercospora conidia form between 41°F and 95°F, optimally at 86°F (1). They are liberated in water and at high relative humidity. Generally they are considered to be wind borne (2). Wind-blown rain or mist droplets have been suggested as principal agents of their dispersal (3).

This study was made to determine spore dispersal in the field in relation to weather as a basis for devising a disease forecasting system for disease control.

Materials and Methods

Spore traps were of two kinds: glass rods covered with petrolatum-coated polyethylene strips, and potted sugar beet plants. Glass rod traps, four to a plot, were set upright at the top of separate poles in four plots of nonsprayed sugar beets. The plots were 150 ft by 20 ft with approximately 150 ft by 100 ft of sprayed beets between them. The four traps in each plot were set side by side at one site and at different heights above the ground (6 in, 1 ft, 2 ft and 5 ft). Three pots of variety R-5651 beet plants, eight weeks old and two per pot, were also placed near the glass rod traps at each site. The petrolatum-coated polyethylene strips and beet plants were changed daily from July 1 to October 1. Spores were trapped over the entire exposed area of the polyethylene strips and were counted as single spores. Spores on plants were counted as total number of spots per plant after the plants were held 48 hours in a moist chamber and 2-3 weeks thereafter in a greenhouse. Each spot

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[3] Numbers in parentheses refer to literature cited.

was counted as one infection point and as one spore. It is the nature of Cercospora spores to be tangled and disseminated in bunches, rather than as single spores. The number of spots/cm² of leaf surface reflected the concentration of inoculum available.

During a rainy period on August 27 and 28 and again on September 18, 19 and 20, 1964, three pots of sugar beet plants were placed in one of the nonsprayed plots and changed every 3 hours. The plants were placed in the moist chamber and handled as described above.

Temperature, relative humidity, and rainfall were recorded throughout the summer with a hygrothermograph and a rain gauge. The hygrothermograph was located 8 in above the ground and enclosed in a vented shelter. General weather conditions for July, August, and September of 1964 and 1965 are shown in Table 1.

Table 1.—General weather conditions during July, August and September of 1964 and 1965.

	Temperature °F			Rainfall
	Avg.	Max.	Min.	inches
1964—July	70	93	46	3.20
Aug.	61	90	31	4.24
Sept.	54	83	26	1.94
1965—July	64	94	42	1.75
Aug.	62	95	32	3.94
*Sept.	52	75	30	0.72

*Weather data only through Sept. 10, 1965.

Results

Cercospora spores were trapped on polyethylene strips throughout the summer, but the greatest number was trapped on rainy days and on days immediately after rain (Table 2). In 1964, 5.4 to 150.5 spores were trapped on rainy days compared to 0.3 to 10.9 spores on days without rain. In 1965, the ranges were 0.7 to 108.7 and 0 to 5.6, respectively. Generally, the daily average number of spores trapped on days following a rain was higher than on rainless days. Most spores on polyethylene strips were associated with areas of water droplets. Other spores were present on areas of the strip where bits of debris and other wind-

Table 2.—Daily average of the number of spores trapped by the glass rod method.

	1964			1965		
	July	Aug.	Sept.	July	Aug.	Sept.
Rain	5.8	5.4	150.5	0.7	18.7	108.7
Day after rain	24.7	0	0	0	7.7	1.5
No rain	10.9	0.3	0.5	0	5.6	0.8

borne spores were present. Spores were collected more often at the 6-inch and 1-foot heights than at the 2-foot and 5-foot heights.

Spores were trapped on plants throughout the summer, and most abundantly during rainy periods (Table 3). In 1964, the average inoculum density, measured as spots/cm², ranged from 1.93 to 7.08 on rainy days and from 0.15 to 0.63 on rainless days; in 1965, the density ranged from 0.02 to 0.11 and from 0.005 to 0.05, respectively. As on polyethylene strips, inoculum concentration on plants generally was higher on the day following a rain than on rainless days.

Table 3.—Daily average of the number of spots/cm² on trap plants.

	1964			1965		
	July	Aug.	Sept.	July	Aug.	Sept.
Rain	1.93	7.08	4.05	0.11	0.11	0.02
Day after rain	0.43	0.98	0.13	0.07	0.01	0.02
No rain	0.15	0.47	0.63	0.05	0.005	0.005

Table 4.—Spore dispersal during a selected rainy period—August 27-28, 1964.

Time	Rainfall inches	High R.H. %	Low R.H. %	Duration of 100% R.H. hrs	High temp. °F	Low temp. °F	Spots per cm²
12-3 PM	0.83	100	96	2.5	72	55	10.20
3-6	0.24	100	100	3	55	52	6.91
6-9	T	100	100	3	53	51	1.50
9-12	0	100	100	3	52	51	0.93
12-3 AM	T	100	100	3	52	51	1.14
3-6	T	100	100	3	51	49	0.83
6-9	0	100	100	3	50	49	0.55
9-12	0	100	76	1	67	59	0.77

Table 5.—Spore dispersal during a selected rainy period—September 18-20, 1964.

Time	Rainfall inches	R.H. % High	Low R.H. %	Duration of 100% R.H. hrs	High temp. °F	Low temp. °F	Spots per cm²
1-4 PM	0	90	78	0	70	69	0
4-7	0	100	82	2	69	57	0
7-10	0	100	100	3	57	52	0
10-1 AM	0	100	100	3	57	53	0
1-4	0	100	100	3	57	55	0
4-7	0	100	100	3	56	56	0
7-10	0.27	100	100	3	56	55	3.66
10-1 PM	0.51	100	100	3	58	56	0.95
1-4	0.27	100	100	3	58	58	2.26
4-7	0.09	100	100	3	58	57	0.53
7-10	0.13	100	100	3	57	55	2.73
10-1 AM	0	100	100	3	55	55	0.28
1-4	0	100	100	3	55	55	0
4-7	0	100	100	3	56	55	0

A more direct relationship of inoculum dispersal to rain is shown in Tables 4 and 5. High dispersal during a 3-hour period corresponded to rain falling during that period. Rain and not the amount of it seemed to be the determining factor. Changes in relative humidity (R.H.) during the experiment were correlated with rainfall and temperature changes.

In the September 1964 rainy period, the inoculum concentration was alternately high and low every 3 hours. The first rain shower may have removed the greatest part of the available inoculum from the spots, while subsequent showers may have removed new mature spores, which take up to 6 hours to be formed.

Inoculum dispersal was absent or low when the daily mean temperature was below 50°F or above 79°F; abundant when the daily mean temperature was about 65°F. Inoculum dispersal generally occurred on days when the minimum R.H. was greater than 60%, and it occurred in 86% of the days when the R.H. was 80-100% for 18 hours or more. Abundant dispersal occurred on days when 100% R.H. lasted 10 to 24 hours.

Summary

Dispersal of conidia of *Cercospora beticola* (Sacc.) in sugar beet fields was related to certain weather factors by trapping conidia on glass rod traps and on potted sugar beet plants.

Rain appears to be the principal dispersing agent of Cercospora conidia. Wind appears to play only a secondary role in inoculum dispersal. Few spores were trapped at 5 ft above ground. Most spores were trapped in areas of water droplets on polyethylene strips. Temperatures below 50°F and above 79°F and relative humidity below 60% limited spore dispersal.

Because rain is important in spreading sugar beet leaf spot, fungicidal spray programs should be designed to protect sugar beet plants during rain periods. Because the onset of rain in many areas is unpredictable, it is important to keep a 10-day spraying schedule for maximum protection.

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