Management of Cercospora Leaf Spot of Sugarbeets: Decision Aids

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Cercospora leaf spot (CLS) is the primary disease of sugarbeets in Minnesota and North Dakota. The disease is caused by the fungal pathogen *Cercospora beticola*, which infects sugarbeet leaves and petioles and reduces sugar production (5). Sugarbeet growers witnessed severe CLS epidemics in their fields during 1981 due to the following factors: 1) the pathogen developed resistance to the benzimidazole fungicides (1) in use; 2) many growers had planted sugarbeet varieties that were very susceptible to CLS; 3) weather was very favorable to CLS development.

Following the 1981 season, growers had to switch to less-susceptible cultivars and use protectant-type fungicides. Protectant fungicides such as the triphenyl tin hydroxides or maneb type compounds break down more rapidly in the field and must be reapplied on a 10- to 14-day schedule in order to prevent severe CLS infection. The need for information to determine timing of fungicide applications became evident because spraying every two weeks in July, August and September is not always economically justifiable.

Research was initiated to provide information for timing protectant fungicide applications for management of Cercospora leaf spot disease of sugarbeets. The intent was to provide information that would allow a grower to tailor fungicide spray programs to the year and field rather than rely on a fixed schedule. In addition, the problem of information dissemination was a key issue in this research because information needed for decisions must be timely and easily obtained at reasonable cost in order to be useful.

Infection Model–A Cercospora leaf spot infection prediction model was developed from data collected in growth chamber studies (3). The model uses hourly temperature and relative humidity data collected in field sites to assign a number, called a "daily infection value" (DIV), on a scale of 0 to 7 to each day according to the perceived threat due to CLS. Values of 7 and 0 indicate that conditions have been most and least favorable for infection, respectively. The rationale behind the DIV model is that the fungus spore germinates under wet conditions and must gain entry into the sugarbeet leaf before dry conditions kill the spore. Once inside the leaf the pathogen is protected against dry weather. Under warm conditions (77 to 86°F) the fungus can germinate and penetrate the host very quickly compared to lower temperatures, especially those below 59°F when the fungus is essentially dormant.

The DIV approach summarizes fungal activity for each day. However, *C. beticola* infection activities may span more than one day. To obtain a more accurate picture of *C. beticola* infection activity, DIVs from adjacent days are combined to form a so-called "advisory." If the sum for two adjacent days is less than 6, then the possibilities of successful infection are considered low. A sum of 6 is considered a "marginal" situation. Sums of 7 or more indicate conditions favorable for infection.

The CLS infection prediction model is an integral part of a CLS disease management scheme being tested by the Department of Plant Pathology at the University of Minnesota and the North Dakota State University and University of Minnesota Extension Services (6). The CLS management scheme combines information from field monitoring and the infection model to tailor fungicide applications to the specific field and year. The CLS infection prediction model is useful alone, even without field monitoring, because it provides a general picture of predicted disease activity for the immediate vicinity of a weather instrument, as will be discussed later in this paper.

Use of the CLS Infection Model–The CLS infection model was prepared in hard copy (written) and also a computerized form.

The manual version was designed to be used in conjunction with a hygrothermograph, a mechanical instrument that records beet field temperature and relative humidity values on a revolving paper chart. The chart is removed at regular intervals and the information recorded and then DIVs are obtained from a reference chart (3), based on weather conditions for each day. Only five to 10 minutes are required to calculate DIVs for one week of weather information, after time needed for travel to and from the weather station.

In this pilot program, the infection model was translated into the computer languages Pascal and COBOL and placed on micro- and minicomputers at the American Crystal Sugar Company research center in Moorhead, Minnesota and the Minn-Dak Farmers Cooperative in Wahpeton, North Dakota, respectively. Automatic weather data

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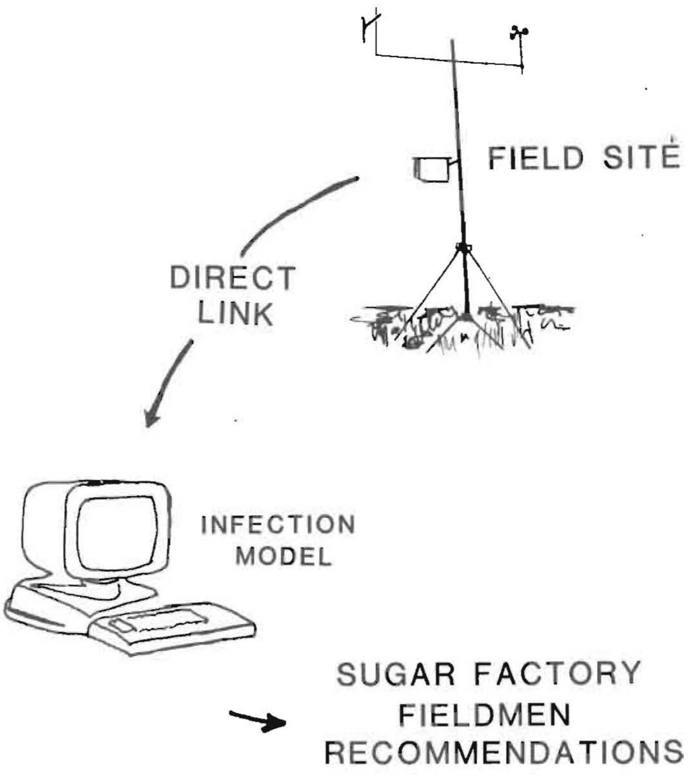

Figure 1.

recording stations were established by American Crystal and Minn-Dak in commercial fields in the Moorhead and Campbell, Minnesota regions, respectively. The weather stations, known as CR-21s (Campbell Scientific Inc.), record air temperature, relative humidity and other weather information in internal memory on site (Figure 1). The stored weather data at each monitoring site is obtained over telephone lines via a computer terminal at each of the sugar factories. The weather information is then analyzed by the infection model to derive the DIV and advisory for each day. Summaries of the daily infection values are then distributed to each factory agriculturist who in turn utilizes this information in his spray recommendations to growers.

Computer Newsfile System–To aid communication among persons concerned with Cercospora leaf spot, a computerized newsfile system was developed on the University of Minnesota mainframe computer (2). Anyone with access to a computer terminal capable of telecommunication could call the Minneapolis computer to receive the most recent information on Cercospora leaf spot. Users could enter their own observations on a general purpose newsletter or simply view comments left by previous users. In addition, daily infection values for weather stations in the southern beet growing regions were available in 1984 and 1985. The computerized newsfile system was used by extension, sugar factory and research personnel, and by agricultural consultants.

CONCLUSIONS

The daily infection values from the infection prediction model provide a convenient way to predict Cercospora leaf spot activity. The daily infection values can be scanned over time and those periods where fungicide coverage is likely to be important can be discerned. For example, daily infection values were relatively high at the beginning and end of August in 1985 across most Minnesota and North Dakota beet-growing areas (Table 1). Such information is best used in conjunction with field monitoring. In the CLS management scheme mentioned earlier, DIVs are consulted in situations where monitoring indicates that the disease severity is increasing to a cautionary level (6). According to this scheme, good fungicide coverage is recommended when the DIVs are above a threshold level.

The DIVs also provide a multi-month or multi-year perspective on weather trends in relations to CLS activity. It is very interesting to compare cumulative DIV on a monthly basis for the years 1982 through 1985 (Table 2). These values show cumulative DIVs were very low in 1985 for June and relatively low for July in both 1984 and 1985. This corresponded very well to general disease trends in these years (2,4,7). In general, first appearance of CLS for Minnesota and North Dakota in 1985 was at least two weeks behind that for the previous two seasons due to the unfavorable (for the fungus) weather during June. Disease progress and severities across the whole season were much lower for both 1984 and 1985 compared to the previous two years as would be expected due to the low DIVs during June and/or July.

It is difficult to measure the impact of the DIV information on the number of fungicide sprays applied to Minnesota and North Dakota fields. An appreciable drop in the numbers of sprays used per field by sugarbeet growers was noted during 1985 compared to the three previous seasons (Table 3). Growers and fieldmen decisions not to spray were likely based on field monitoring of slow CLS increases in commercial fields. However, we believe that the DIV information, distributed by mail, computer newsfile, and word of mouth, was instrumental in many decisions by the farming community not to spray. It provided that extra bit of knowledge so that consultants, growers, and agriculturists could follow the strength of their own convictions in their recommendations.

The automatic weather station and microcomputer-based infection models represent an important step in the management of the sugarbeet crop. Other mathematical models have been developed for guiding disease and insect management decisions on various crops. Their drawback has almost always been the excessive work involved in collecting and processing environmental data. Utilizing this system, a person with minimal training can immediately access the predicted CLS activity that has occurred miles away in a beet field. The major disadvantage, of course, is money. Computer hardware is expensive, and so a primary question is the relative benefit versus cost. The CR-21 weather stations serve a dual purpose and are being used by the two cooperatives to gather soil and root temperature data to make harvest management decisions.

Table 1. Cercospora Leaf Spot Infection Prediction Model Daily Infection Values for Sugar Beet Fields in Minnesota and North Dakota during August 1985.

Week beginning On Date	1	2	3	4	5	6	7	8	9
1	0	2	0	0	0	0	0	0	0
2	0	2	0	0	0	0	2	3	2
3	0	2	2	3	3	3	3	4	6
4	3	3	4	3	4	3	3	4	6
5	0	3	3	2	0	0	4	4	6
6	0	3	2	0	4	4	0	2	2
7	0	3	3	0	0	0	0	0	3
8	3	3	1	3	2	2	0	4	3
9	3	0	0	0	2	2	0	2	2
10	0	0	2	0	0	0	3	0	0
11	0	0	*	2	0	0	0	2	0
12	3	4	*	4	4	5	0	5	4
13	0	2	*	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
SITE:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
16	1	*	0	4	0	3	0	4	1
17	0	3	2	0	2	0	0	3	0
18	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0
20	0	*	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0
22	5	6	3	3	*	5	2	3	5
23	0	3	2	0	*	0	0	3	3
24	1	0	0	0	0	0	0	0	0
25	0	*	0	0	0	0	0	0	0
26	0	1	3	2	0	0	0	0	0
27	4	6	0	0	0	0	0	0	0
28	5	6	0	0	0	0	0	0	0
29	5	*	0	2	5	5	4	2	0
30	0	2	2	0	4	3	1	5	1
31	4	*	*	4	5	5	5	5	5

* = data not available.

Sites:
1 = Chippewa Co., Clara City; 2 = Renville Co., Bird Island;
3 = Wilkin Co., Foxhome; 4 = Richland Co., Abercrombie;
5 = Wilkin Co., Wolverton; 6 = Clay Co., Holy Cross Twp.;
7 = Clay Co., Elmwood Twp.; 8 = Cass Co., Rush River Twp.;
9 = Traill Co., Wold Twp.

Table 2. Historic Average Accumulated Daily Infection Values for the Minnesota and North Dakota Beet Growing Regions.

	June	July	August	September
1982	*	50	43	29
1983	53	65	52	41
1984	58	17	48	2
1985	6	30	42	*

* = Information not available.
Averages are derived from a minimum of 4 sites in southwestern and west central Minnesota and southeastern North Dakota.

Table 3. Frequency of Fungicide Application to Minnesota and North Dakota Sugar Beet Fields.

Counties Included in Regional Average	Average Number of Full-Rate Fungicide Sprays Per Sugar Beet Field 1982	1983	1984	1985
REGION 1				
Chippewa, Renville, Yellow Medicine, Swift, Kandiyohi, and Redwood.	4.1	4.4	4.4	2.1
Number of farms surveyed =	16	17	7	8
REGION 2				
Grant, Wilkin, Traverse, and Richland.	3.0	3.5	2.9	2.1
Number of farms surveyed =	9	16	7	7

Information for 1982, 1983, and 1984 is from reference 6.

Another important issue is the problem of gaining access to information such as the daily infection values described here. Most growers do not have computer terminals for contacting weather stations or mainframe information systems. It remains to be seen if in the future each farming unit will use telecommunication devices to acquire pest management information. We anticipate that in the near future local "experts" such as consultants, factory agriculturists, or university extension personnel will develop computerized data collection systems and communication networks among themselves. Communication between experts and growers will probably continue to be primarily along traditional lines such as radio, telephone calls, mailings, and meetings.

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