Predicting Southern Corn Leaf Blight Development in 1971 by Computer Simulator EPIMAY[1]

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Abstract

A disease simulator model was used on an experimental basis during 1971 to evaluate the effects of weather on the spread and multiplication of Southern Corn Leaf Blight. Weather data consisting of hourly temperature, humidity, wind speed, sunshine, leaf wetness and precipitation were used in the computer program to provide daily values for new infections, lesion accumulations and per cent leaf area affected. Results were then compared to observations provided through pathological reports, ground observer data and aerial photo-multispectral scanner information.. Weekly EPIMAY predictions compared favorably with the observed weekly change in blight. At stations where starting dates of EPIMAY and the initial observed infection were close, good comparisons resulted for per cent leaf area infected.

Introduction

During 1970 southern corn leaf blight, race T of *Helminthosporium maydis*, reduced corn yields in the United States by an estimated 10 to 15% according to crop reports of the U.S.D.A. Statistical Reporting Service. Losses were confined mainly to corn hybrids containing Texas male sterile-cytoplasm. The disease started in the Southern United States in May and June, then spread rapidly into the midwest corn belt during July and August (1). Some fields of corn in Indiana were completely destroyed by the epidemic.

Considerable effort was made during and following the 1970 growing season to establish the effect of weather on the development of the disease. EPIMAY, a disease simulator model, was developed by Dr. Waggoner and associates at the Connecticut Agricultural Experiment Station (2). The model was based on application of 1970 observed weather-disease information and laboratory tests. The results showed promise for application as an objective indicator of the favorability of weather for the development of southern corn leaf blight.

Barger (NOAA, EDS, Wash., D.C.) suggested national use of EPIMAY for the corn blight problem and in June 1971 a program, under the direction of Regional Climatologist, L. A. Joos (Joos, unpublished data), was established using computer facilities at the National

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Weather Service Central Region in Kansas City. The program was conducted over a 12-state area and included about 20 stations. To supplement and assist in evaluating the national program, an intensive application of the EPIMAY model was conducted at Purdue University for 8 stations in Indiana.

The Indiana program was a joint cooperative effort by research and operation groups at Purdue to identify and evaluate southern corn leaf blight by aircraft sensing and by collection of field observations, and thus testing the predictability of EPIMAY (using weather data).

In addition to airborne information, the Corn Blight Watch Experiment conducted by the USDA, NASA and Universities in seven Corn Belt States provided an organized collection of ground truth by extension agents and pathologists in a specific series of fields along the designated flight paths for sensing aircraft (Bauer, M., unpublished data).

Methods

The disease simulator model estimated the effects of temperature, humidity, wind, light and leaf wetness on all stages of the disease cycle. Other factors involved were effects of wind and rainfall on wash off, dry out and transport of spores. To determine the number of lesions formed, the model systematically considered the factors relating to spore production, dissemination and infection by the blight fungus. This was accomplished by a series of laboratory developed curves relating the single and combined effects of weather on the disease. Some modifications were made in the model by Purdue researchers to adjust for change in leaf area available for infection and to adjust starting dates to fit planting and various development stages of the corn crop (Peart, R., and O. Loewer, unpublished data).

Weather input to EPIMAY for the national and Indiana programs were provided by the daily reports from the Indiana agriculture weather observation network and by hourly teletype reports from the National Weather Service and Federal Aviation Agency teletype reporting stations. Data for each 3-hour period through the day, beginning at midnight Greenwich time (7 PM EST), were summarized, resulting in 8 data readings per 24-hour period from June 11 through September 2. Dew or leaf wetness were rated in five classes: no dew—zero duration, light dew—3-hour duration, moderate dew—6-hour duration, heavy—9-hour duration, and very heavy—12-hour duration. Duration of classes was determined through instrument measurements and visual checks. When dew was present hygrothermograph traces usually indicated 80 to 100% relative humidity. Light or brightness of the sky information was based on cloud cover from sunrise to sunset using 50% or greater cloudiness as a cloudy day. The data were punched on computer cards each Friday for processing by the LARS computer facility.

The computer output consisted of a daily listing of weather data including the starting, ending and inches of rainfall for each precipi-

tation period, leaf wetness as yes or no, and hourly rate of rainfall for each 3-hour period for checking the input data. Next came the results, a daily listing of new infections, new lesions, accumulated lesions and per cent of leaf area infected by lesions. Map summaries showing accumulated lesions, weekly increase and per cent leaf area infected at each location were then prepared for distribution to all Purdue groups and by telecopier to Climatology Research Laboratory, NOAA, Silver Springs, Maryland.

Results

EPIMAY estimated the number of blight lesions formed daily and provided accumulative totals for each station. Flat plateau-like portions of the curves (Fig. 1) indicate when weather was unfavorable for blight

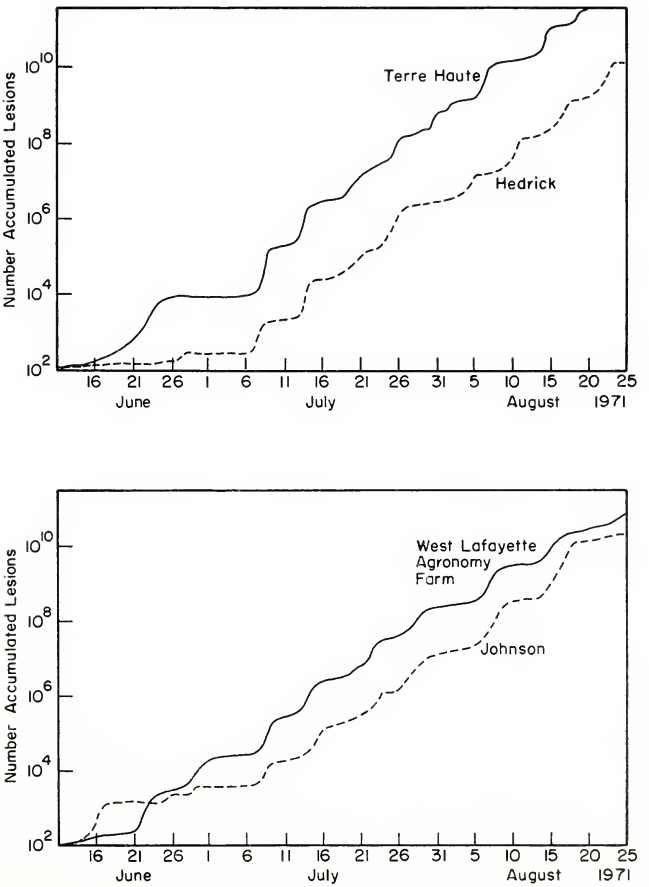

FIGURE 1. *Accumulated southern corn leaf blight lesions during the 1971 growing season as predicted by EPIMAY for West Lafayette Agronomy Farm, Johnson, Hedrick and Terre Haute, Indiana.*

development. During favorable periods sharp increases in the anticipated lesion numbers followed 72 hours after the onset of infection. This reflects the time interval from when fungus spores land on the corn plant until lesions become visible.

Curves showing accumulated lesions (Fig. 1) reached 10^8 values (level corresponding to approximately 20% leaf area coverage of lesions) 10 days earlier at West Lafayette Agronomy Farm and Terre Haute than at Johnson and 15 days earlier than at Hedrick. Accumulated

TABLE 1. *Comparison of EPIMAY predictions and field observations of per cent leaf area infected by southern corn leaf blight.*

Location	Starting Date 100 Lesions/ha)	Observation Date	Per cent of Leaf Area Infected	
			EPIMAY	Field Observations
Wanatah	6/21	7/31	2.5	0.5
Lafayette	6/11	7/26	8.5	1.0
Lafayette (Agron. Farm)	6/11	7/29	17.3	11.0 (Inoculated 7/1)
Hedrick	6/11	7/27	0.2	0.5
Indianapolis	6/11	7/28	0.5	32.0
Terre Haute	6/11	7/27	18.8	12.0
Vincennes	6/1	7/26	4.6	15.0
Evansville	6/1	7/27	9.8	8.0

lesion curves at all 8 stations showed similar slope but were displaced by 0 to 20 days for an equal level of lesions.

Per cent leaf area infected as predicted by EPIMAY, was compared to levels observed in corn fields of susceptible varieties (Table 1).

TABLE 2. *Weekly increase factors in number of lesions as predicted by EPIMAY.*

	Factors in the Increase in Numbers of Lesion Over Number Previous Week						
Date	Wanatah	W.Laf.	Hendrick	T.Haute	Vincennes	Johnson	New Augusta
6/11-6/17	0	1	0	1	1	6	3
6/18-6/24	6	8	0	39	12	4	2
6/25-7/1	9	6	2	4	1	1	2
7/2-7/8	2	3	3	2	3	10	7
7/9-7/15	24	19	19	11	3	4	4
7/16-7/22	9	8	3	6	7	3	2
7/23-7/29	6	19	27	13	14	14	6
7/30-8/5	2	2	7	5	3	4	3
8/6-8/12	4	3	15	11	12	11	7
8/13-8/19	4	10	4	23	20	10	9
8/20-8/26	5	12	16	3	1	4	3
8/27-9/2	9	3	6	2	6	12	24

Reasonable agreement was found at 5 of the 8 locations where weather data and sample fields were near and quite poor agreement elsewhere.

Weekly increases in number of lesions were used to indicate the degree of favorability of weather for blight development (Table 2). Favorable weather produced 7 day lesion increases up to 39 times the number for the previous week.

Discussion

A number of limitations prevent conclusive evaluation of EPIMAY. In most cases, except at the Purdue Agronomy Farm, West Lafayette, and at Wanatah, weather stations were at distances of several miles to over 20 miles from the sampled corn fields. Variation from local influences of topography, soil moisture and rainfall patterns for these distances could account for some of the differences between observed and predicted disease levels (Table 1). A starting condition of 100 initial lesions per hectare were used for EPIMAY but large variation could occur in this level due to local inoculum sources.

It was also necessary to adjust EPIMAY to account for per cent of leaf area remaining available for new infections (Peart, R., and O. Loewer, unpublished data). Further adjustments of leaf area indices are needed to account for different planting dates and stages of development of corn.

Other factors contributing to variation in results that should be considered are the susceptibility of different corn hybrids and the general physical status of the crop from other diseases and insects. In 1971, early planted susceptible corn varieties matured far enough ahead of the late developing southern corn leaf blight to limit damage mainly to foliage and stalks.

The overall effects of the 1971 corn growing season also has some bearing on the 1971 southern corn leaf blight situation. Winter and early spring dryness and summer coolness were effective in reducing spore viability in the 1970 crop residue. No large scale influx of spores were noted by pathologists as in the previous year. Early planting plus a warm very rapid spring growth period caused corn development earlier than usual before blight fungus development. These plus other factors, such as reduced acreage of susceptible corn, were among the reasons for Indiana's improved blight picture.

Literature Cited

1. Moore, W. F., 1970. Origin and spread of southern corn leaf blight in 1970. Plant Dis. Rep. 54:1104-1108.

2. Waggoner, P. E., 1971. EPIMAY. Conn. Agr. Exp. Sta. New Haven. Conn. 48 p.