Southern Corn Leaf Blight Development Relative to Temperature, Moisture, and Fungicide Applications

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ABSTRACT

Southern corn leaf blight (SCLB) became severe on field corn at Gainesville and Lakeland, Florida, when minimum temp were 20 C or above and relative humidity (RH) was 100% for 6 h or more on several consecutive nights. These parameters for severe SCLB development in the field agree with results of others and indicate warm, moist weather favors SCLB epidemics. SCLB severity and rate of development were greater on Texas male-sterile than on normal cytoplasm hybrids, indicating that race T of the pathogen was predominant. SCLB became moderately severe on nonsprayed plants 12-14 days earlier than on plants sprayed weekly beginning at or before tasseling. Mancozeb at 1.7 kg/ha effectively controlled SCLB when applied by airplane in 28.0 or 23.4 liters of water/ha or when applied with ground equipment in 935 liters of water/ha. Yields from plants with effective disease control were consistently better than nonsprayed plants, but yields were not statistically correlated with disease incidence.

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Southern corn leaf blight (SCLB), caused by *Cochliobolus heterostrophus* Drechsler (*Helminthosporium maydis* Nisik. & Miy.), was largely responsible for the yield reductions (878 kg/ha, or 36%) of field corn (*Zea mays* L.) which occurred in Florida in 1970 (5). The total production value of field corn in Florida dropped $5 million from 1969. Because of the seriousness of the 1970 epidemic, it seemed desirable to study the epidemiology of SCLB on Texas male-sterile (Tms) and normal (N) cytoplasm hybrids, and to evaluate the effect of fungicidal applications on disease development. Field corn growers are not generally equipped for making ground-spray applications, thus, aerial applications seemed the most feasible means of fungus control, if economical and effective. A study for these purposes was initiated; the intent of this paper is to relate the effects of temp, moisture, and timing of fungicidal spray applications on SCLB development.

MATERIALS AND METHODS.—In 1971, SCLB development on field corn in Florida was evaluated at Lakeland, Newberry, and Gainesville. The procedures followed at each location are detailed elsewhere (10), but were generally as follows: at Lakeland and Newberry, N and Tms cytoplasm types of an early (G-4444), midseason (G-4697) and late (G-4949) corn hybrid were planted. At Lakeland, the test site (4.5 ha) followed a 1970 planting of field corn which had been infected with SCLB. At Newberry the test site (2.1 ha) followed a 1970 peanut planting. The experimental design at Lakeland was a randomized block and at Newberry an incomplete block design, both with three replications. The experimental design at Gainesville was a randomized block with six replications. Four replications consisted of hybrid Florida 200 A (Tms cytoplasm) and two replications consisted of inbred line F 44 (Tms cytoplasm). The test area was previously cropped to peanuts.

A spore trap (8) was located at Gainesville in one of the nonsprayed plots to monitor airborne spores of fungi. Meteorological data were recorded over sod 305 m from the corn planting. Relative humidity (RH) was recorded on a hygrothermograph and minimum temp were taken from a maximum-minimum thermometer 120 cm over sod. Total rainfall was obtained from a conventional U.S. Weather Bureau rain gauge. Rainfall, relative humidity, and temperature data for the Lakeland site were obtained from the U.S. Weather Station at Lakeland, approximately 18 km south of the test site.

At Lakeland, three weekly SCLB ratings were made using Ullstrup's method (4). A total of eight 20-plant samples from the center of each plot were rated for SCLB. At Newberry, five weekly disease ratings were made in a similar manner using twelve 20-plant samples from each plot. At Gainesville, SCLB was rated at approximately weekly intervals, beginning May 3, for each plant in every plot.

Disease rates (r) were calculated using van der Plank's formula (11):

$$r = \frac{2.3}{t_2 - t_1}\left(\text{Log}_{10}\frac{x_2}{1-x_2} - \text{Log}_{10}\frac{x_a}{1-x_1}\right)$$

in which t_1 = date one; t_2 = date two; x_1 = % disease at date one; and x_2 = % disease at date two. Values for "r" represent daily increases in the percent foliage with visible SCLB lesions.

The fungicide mancozeb (80% active, wettable powder, Dithane® M-45, Rohm and Haas Co., Philadelphia, PA) at 1.7 kg/ha (1.5 lb/A) was used in all treatments except for the nonsprayed plots. Adjuvants were added to the fungicide at Lakeland and Newberry (Triton® CS-7, Rohm and Haas Co., Philadelphia, PA, at 2.5 ml/liter or Sun Oil 11E, Sun Oil Co., Marcus Hook, PA, at 1.2 liters/ha). A Piper Pawnee 235 C aircraft with a fixed-wing boom was used to apply the mancozeb in 28.9 liters of water/ha (3.1 gal/A) at Lakeland. At Newberry, a Stearman aircraft with a fixed-wing boom was used to apply the mancozeb in 23.4 liters of water/ha (2.5 gal/A). Plot size was four aircraft spray swaths wide with treatments being applied at right angles to the row direction. Sprays were applied at approximately weekly intervals. At Gainesville, mancozeb at 1.7 kg/ha in 935 liters/ha (100 gal/A) was applied with a knapsack sprayer to 20-plant plots at weekly intervals.

RESULTS.—*Disease development and weather.*—Traces of SCLB were first observed at all three locations a few days after a period of warm, moist weather (April 23-30) when several days occurred with minimal temp of 20 C and 6 h or more of 100% RH (Fig. 1 and 2). During this same period, conidia of *H. maydis* were collected in a spore trap at Gainesville. Conidia of *H. maydis* were collected intermittently in a spore trap up to June 11 and were collected daily thereafter (Fig. 1).

Although SCLB first occurred at all locations in early May, mean disease ratings remained relatively low until after 4 June, at which time a more rapid increase in disease ratings occurred. In the 42 days preceding 4 June, only 12 days at Lakeland and 4 days at Gainesville had 20 C minimal temp and 6 h (or more) of 100% RH. However, in the 42 days after 4 June, 35 days at Lakeland and 27 days at Gainesville had 20 C minimal temp and 6 h (or more) of 100% RH (Fig. 1 and 2). Mean SCLB disease ratings reached 3.0 or more on nonsprayed plants with Tms cytoplasm 11 days earlier at Lakeland (19 June) than at Gainesville (30 June). Mean disease rates on Tms cytoplasm corn for 15 to 29 June at Lakeland (0.256) and Newberry (0.257) were similar, but much higher than, that at Gainesville (0.095) for this same period. At Lakeland, a relatively uniform distribution of SCLB occurred over the entire test site. At Newberry and Gainesville, SCLB developed more severely in one area and spread gradually and unevenly through the plot resulting in significant differences among replications.

Disease rates from 15 June to 29 June at Newberry, Florida are shown in Table 1. Disease was more severe and developed more rapidly on Tms cytoplasm plants than on N cytoplasm plants. This indicated that race T of *H. maydis* was predominant. The disease rate on Tms cytoplasm corn for the late hybrid (G-4949) was considerably higher than the early (G-4444) and midseason (G-4697) hybrids.

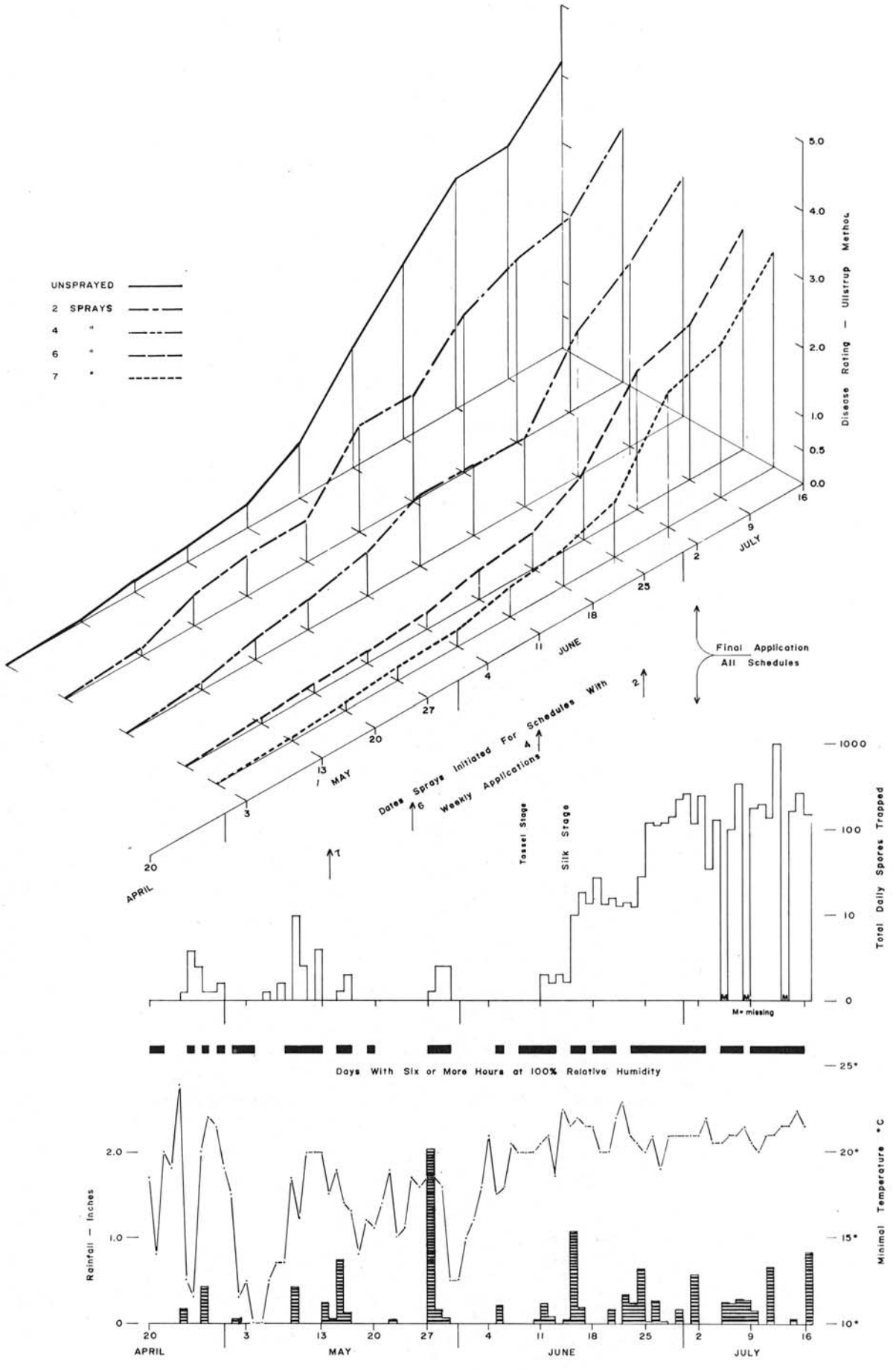
Disease development and fungicidal spray applications.—Mancozeb at 1.7 kg/ha applied by airplane in 28.9 and 23.4 liters/ha and applied from the ground in 935 liters/ha significantly reduced SCLB (Table 2). The degree of disease control obtained was related to the number of spray applications, and when they were initiated. Those plants sprayed earliest (hence the greatest number of times) had less disease than those plants on which sprays were initiated later. However,

TABLE 1. Southern corn leaf blight severity and rates of development on three corn hybrids [Texas male sterile (Tms) and normal (N) cytoplasm] at Newberry, Florida

Hybrids	Cytoplasm	Mean disease[a] rating, June 29	Disease rate "r" after van der Plank 6/15 to 6/29
G-4444	Tms	3.12	0.257
G-4444	N	0.42	0.254
G-4697	Tms	2.54	0.258
G-4697	N	0.12	0.209
G-4949	Tms	2.15	0.428
G-4949	N	0.27	0.195

[a]Ullstrup's scale: 0.5 = very slight disease; 5.0 = very heavy infection.

Fig. 1. Meteorological data, daily incidence of *Helminthosporium maydis* conidia, and southern corn leaf blight (SCLB) development on maize hybrid Florida 200A [Texas male-sterile (Tms) cytoplasm] with and without applications of mancozeb at Gainesville, Florida for the period 20 April to 16 July 1971.


UNSPRAYED
2 SPRAYS
4 "
6 "
7 "
Disease Rating — Ullstrup Method
5.0
4.0
3.0
2.0
1.0
0.5
0.0
16
9
JULY
2
25
18
11
JUNE
4
27
20
13
MAY
3
20
APRIL
Final Application
All Schedules
Dates Sprays Initiated For Schedules With
2
4
6
Weekly Applications
1
Tassel Stage
Silk Stage
1000
100
10
0
Total Daily Spores Trapped
M= missing
Days With Six or More Hours at 100% Relative Humidity
25°
Rainfall — Inches
2.0
1.0
0
20°
15°
10°
Minimal Temperature °C
20
APRIL
3
13
20
27
MAY
4
11
18
25
JUNE
2
9
16
JULY

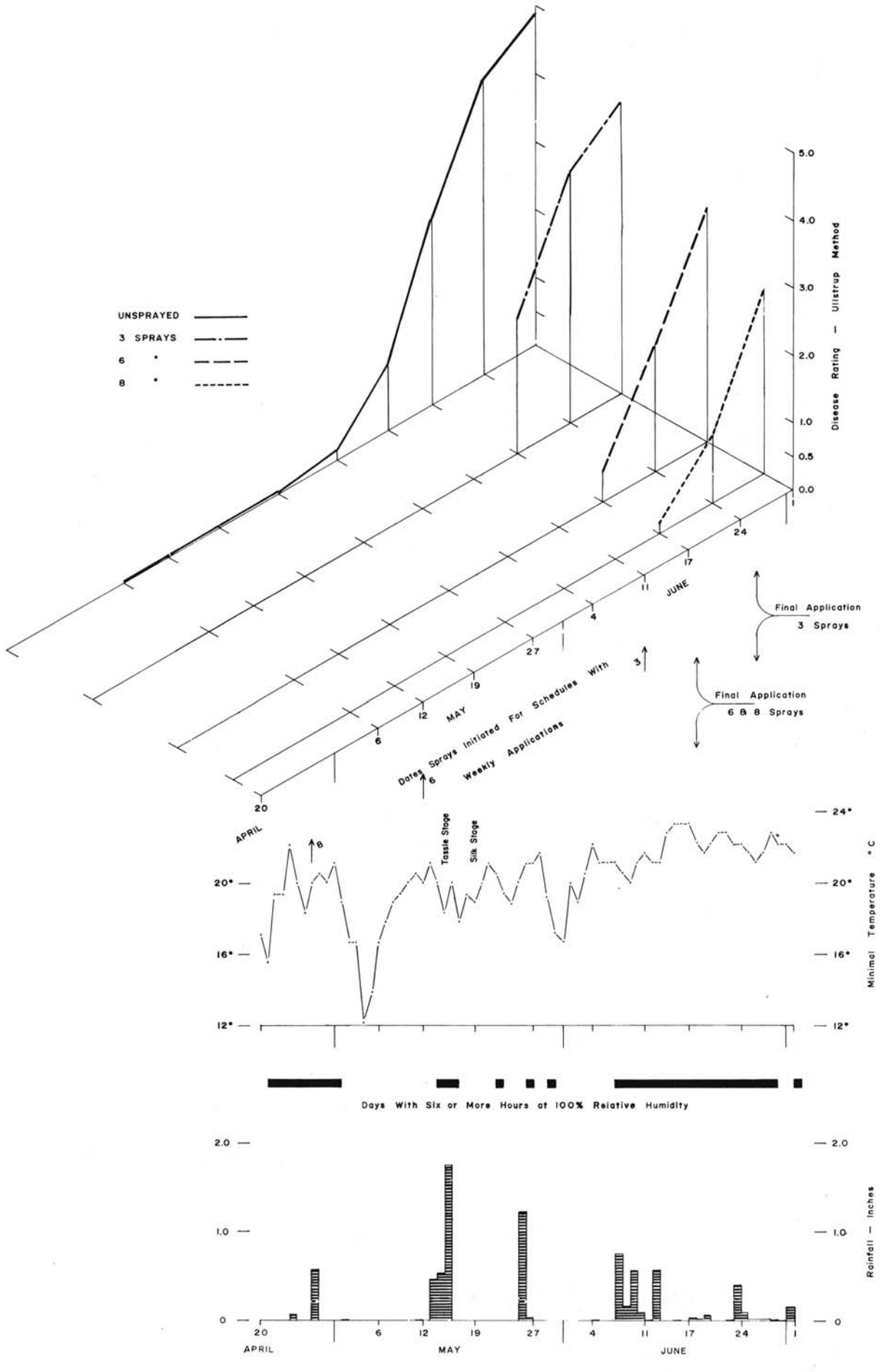

UNSPRAYED
3 SPRAYS
6 "
8 "
5.0
4.0
3.0
2.0
1.0
0.5
0.0
Disease Rating — Ullstrup Method
1
24
17
11
JUNE
4
27
19
12
MAY
6
20
APRIL
Dates Sprays Initiated For Schedules With
6 Weekly Applications
3
Final Application
3 Sprays
Final Application
6 & 8 Sprays
8
Tassle Stage
Silk Stage
24°
20°
16°
12°
Minimal Temperature °C
Days With Six or More Hours at 100% Relative Humidity
2.0
1.0
0
Rainfall — Inches
APRIL
MAY
JUNE

TABLE 2. Control of southern corn leaf blight on normal (N) and Texas male sterile (Tms) cytoplasm hybrids with mancozeb spray applications at three Florida locations, 1971

Lakeland July 1				Mean Disease Ratings[w] Newberry June 29				Gainesville July 9		
Spray applications		Cytoplasm[x]		Spray applications		Cytoplasm[y]		Spray applications		Cytoplasm[z]
Date begun	Number	N	Tms	Date begun	Number	N	Tms	Date begun	Number	Tms
4/27	8	0.30 a	2.22 a	5/23	6	0.18 a	1.79 a	5/25	6	2.78 a
5/12	6	0.52 a	2.87 a	6/17	2	0.29 a	2.37 ab	6/11	4	2.90 a
6/11	3	0.81 a	4.10 b	6/24	1	0.23 a	3.26 bc	6/25	2	3.28 b
--	0	1.97 b	4.51 b	--	0	0.67 a	3.44 c	--	0	3.78 c

[w] Ullstrup's rating scale: 0.5 = very slight disease; 5.0 = very heavy infection. Means followed by the same letter are not significantly different, $P = 0.05$.
[x] Mean of hybrids G-4444 and G-4697.
[y] Mean of hybrids G-4444, G-4949, and G-4697.
[z] Mean of hybrid Florida 200A.

TABLE 3. Hybrid corn seed yields (kg/ha) at three Florida locations as affected by southern corn leaf blight control with mancozeb in 1971[w]

Lakeland July 24			Newberry July 29			Gainesville August 1	
	Cytoplasm[x]			Cytoplasm[y]			Cytoplasm[z]
No. of sprays	N	Tms	No. of sprays	N	Tms	No. of sprays	Tms
8	7,032 b	5,565 a	6	3,002 a	2,184 a	6	2,571 a
6	7,438 a	5,547 ab	2	3,817 a	2,515 a	4	2,714 a
3	7,307 a	5,313 b	1	2,801 a	1,390 a	2	2,416 ab
0	6,579 c	4,359 c	0	2,374 a	1,996 a	0	2,178 b

[w] Weights adjusted to 15% moisture; means with the same letter are not significantly different, $P = 0.05$.
[x] Mean of hybrids G-4444 and G-4697.
[y] Mean of hybrids G-4444, G-4949, and G-4697.
[z] Hybrid Florida 200A.

even late fungicide applications, initiated after disease was well established, were reasonably effective in disease control (Table 2, Fig. 1).

At Gainesville and Lakeland, no significant differences in disease control occurred among treatments initiated while disease incidence was slight and developing slowly, 4 May - 4 June ($r = 0.06$ at Gainesville, $r = 0.14$ at Lakeland). In general, time of application did not significantly influence the effectiveness of fungicidal sprays in controlling SCLB.

Although fungicidal spray applications did not stop SCLB development, they did delay disease development considerably. At Gainesville, and Lakeland, a disease rating of 2.0 on Ullstrup's scale occurred at 12-14 days earlier on nonsprayed plants containing Tms cytoplasm than on similar plants which received fungicidal sprays initiated before tasseling (Fig. 1 and 2).

Disease control and yield.—Although no statistical correlation occurred between yields and disease incidence, yields were highest on plants with good disease control, and lowest on nonsprayed plants (Tables 2 and 3). Yield increases were obtained from both N- and Tms cytoplasm plants, that received a fungicidal spray (Table 3).

DISCUSSION.—Although temp and moisture requirements for *H. maydis* infection are known (6, 7) our report relates temp and moisture to SCLB development in the field. Hyre's preliminary data (2) indicated temp exceeding 15 C with 7 h (or more) of high humidity favored SCLB development. Our data indicate that 20 C minimal temp and 6 h (or more) of 100% RH were necessary for rapid disease development in the field.

Nelson and Tung's results (6) substantiate our arbitrary selection of 20 C and 6 h of 100% RH as criteria for severe

Fig. 2. Meteorological data and southern corn leaf blight (SCLB) development on maize hybrid G-4444 [Texas male-sterile (Tms) cytoplasm] with and without applications of mancozeb at Lakeland, Florida for the period 20 April to 1 July 1971.

SCLB development in the field. With a postdew temp of 20 C, Nelson and Tung (6) observed little disease development with dew temp of 12-16 C. A substantial increase in SCLB occurred when dew temp was increased to 20 C. SCLB lesion numbers increased 3- to 4-fold when the dew period was extended from 4 to 6 h. Larsen et al. (3) also reported a large increase in lesions per leaf with an increase of dew periods from 4 to 6 h.

Differences in the rate and amount of SCLB development at Lakeland and Gainesville (Fig. 1 and 2) were probably due to several factors. There were more days at Lakeland than Gainesville with 20 C minimal temp and 6 h (or more) of 100% RH, and disease rates were higher on Tms cytoplasm corn hybrids at Lakeland than at Gainesville. Also, there was an even distribution of SCLB at Lakeland resulting from the additional inoculum provided by overwintering corn debris from a 1970 planting which had been infected with SCLB. Lakeland was the only site with a corn-corn rotation. At Newberry and Gainesville peanuts had preceded the corn planting.

SCLB developed slowly until June because of unfavorable weather. This resulted in only slight differences in disease control among fungicidal treatments initiated before tasseling. A similar result was obtained by Harrison, et al. (1) for potato early blight, caused by *Alternaria solani,* where early disease development was slow ($r = 0.02$). This was not the case for watermelon downy mildew, caused by *Pseudoperonospora cubensis,* where early disease development in the field was more rapid ($r = 0.30$) (9).

LITERATURE CITED

1. HARRISON, M. D., C. H. LIVINGSTON, and N. OSHIMA. 1965. Control of potato early blight in Colorado. I. Fungicidal spray schedules in relation to the epidemiology of the disease. Am. Potato J. 42:319-327.
2. HYRE, R. A. 1970. Epidemiology of southern corn leaf blight-exploratory experiments. Plant Dis. Rep. 54:1131-1133.
3. LARSEN, P. O., J. P. SLEESMAN, and D. G. WHITE. 1973. Effect of duration of high humidity on lesion production by Helminthosporium maydis (races T and O) on corn (Zea mays) seedlings. Plant Dis. Rep. 57:76-78.
4. MILLER, P. R., J. R. WALLIN, and R. A. HYRE. 1970. Plans for forecasting corn blight epidemics. Plant Dis. Rep. 54:1134-1136.
5. MULLIN, J. E. 1971. Florida agricultural statistics. Field crops summary 1970. Florida Crop and Livestock Reporting Service. 7 p.
6. NELSON, R. R., and G. TUNG. 1972. Effect of dew temperature, dew period, and post-dew temperature on infection of male-sterile corn hybrid by race T of Helminthosporium maydis. Plant Dis. Rep. 56:767-769.
7. PEET, C. E., and M. A. MARCHETTI. 1972. Effects of temperature and duration of dew period, under controlled conditions, on infection of corn by Helminthosporium maydis. Phytopathology 62:771 (Abstr.).
8. SCHENCK, N. C. 1964. A portable, inexpensive and continuously sampling spore trap. Phytopathology 54:613-614.
9. SCHENCK, N. C. 1968. Fungicidal control of watermelon downy mildew and its relationship to first infection in the field. Plant Dis. Rep. 52:979-981.
10. SCHENCK, N. C., and T. J. STELTER. 1971. Fungicidal control of corn leaf blights in Florida with fixed-wing aircraft. Proc. Fla. Soil Crop Sci. Soc. 31:61-64.
11. VAN DER PLANK, J. E. 1963. Plant disease: epidemics and control. Academic Press. New York. 394 p.