Helminthosporium turcicum Lesion Numbers Related to Numbers of Trapped Spores and Fungicide Sprays

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ABSTRACT

Helminthosporium turcicum lesion numbers were directly related to numbers of trap-monitored spores collected 7 days previously. Aerial sprays of maneb (manganese ethylenebisdithiocarbamate) effectively controlled northern leaf blight on sweet corn, when applied on days of peak spore occurrences. Sprays applied the day before significant spore deposition were largely ineffective because infection took place on unprotected leaf tissue emerging from the whorl. Sprays applied 24 hr after spore deposition were ineffective in control. There were few new infections after tasseling on the sprayed corn despite high spore numbers and most disease increase then came from enlarging lesions. An understanding of corn plant growth characteristics was valuable in determining the importance of whorl infection, new lesion appearance, disease progress, and control.

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Additional key words: northern corn leaf blight, epidemiology.

The air-borne nature of spores of *Helminthosporium turcicum* Pass. (*Trichometasphaeria turcica* Luttrell) is well documented (1, 2, 4, 6, 7, 8). Berger (1) and Meredith (7) have shown that this fungus has a well defined diurnal period of spore release with most spores occurring in the air between 1000-1200 hr. Meredith (7) considered most increases of *H. turcicum* spore concentration in the air were associated with rain on the previous day. However, Berger (1) has provided evidence that sporulation of *H. turcicum* on sweet corn [*Zea mays* L. var. *saccharata* (Sturtev.) Bailey] was influenced more by the length of high humidity periods than by rain per se. Monitoring of air-borne spores by trapping has provided estimates of the daily mean concentration of *H. turcicum* conidia.

A satisfactory forecasting system for *H. turcicum* (northern leaf blight) on Florida sweet corn has been developed by using daily mean spore concentrations and meteorological data (1, 2, 3). This paper describes the relation of the numbers of trapped *H. turcicum* spores to subsequent numbers of corn blight lesions as influenced by weather and aerial spraying of fungicide.

MATERIALS AND METHODS.—The air-borne *H. turcicum* spores were monitored by a continuously sampling spore trap (4) with its orifice 1 m above the ground. The trap sampled approximately 8.75 liters/min (15 cubic ft/hr). The trap was stationed in an 80-acre field of 'Iobelle' sweet corn about 200 m from the northern edge of the crop area. The trap location assured that air coming from any direction would most likely have passed over many corn plants before reaching the trap. Trapped spore deposits occurred in distinct hourly bands. Methods for determining conidia of *H. turcicum* were those described by Drechsler (5) and Meredith (7). Meteorological instrumentation located near the trap area included hygrothermograph, recording anemometer, rain gauge, and maximum-minimum thermometers.

Average corn leaf areas were obtained by selecting 10 representative plants at random from the monitored field on each sampling date. The leaf areas (one surface only) were calculated by average width × length measurements for various linear portions of the leaves with the triangular leaf apices calculated separately. Only the leaf areas were measured; stalks, leaf sheaths, ears and ear flag leaves, tassels and all sucker growth were not included.

Lesion counts and measurements of lesion areas were recorded for 100 plants selected at random on each sampling date. Mean percent disease was calculated by lesion numbers times average lesion area divided by total leaf area. Coalescence of enlarging lesions near the season's end made lesion counting difficult; thus, estimates of lesion numbers and areas were necessary.

Aerial sprays of maneb (manganese ethylenebisdithiocarbamate) fungicide were applied with a fixed-wing aircraft operating with a swath width of approximately 20 m. The material was applied at 454-610 g in 22.7 liters water per 0.4 hectare (1-1.5 lb in 6 gal water per acre). Application dates are given in Fig. 4-B.

RESULTS.—*Leaf area.*—The average total leaf area and progressive stages of plant development for the sweet corn are shown in Fig. 1. The largest weekly increment of growth was observed between 15 and 22 April 1970 when average plant leaf area increased from 1,085 cm^2 to 2,590 cm^2. This large increase came despite the removal of the 3-4 lowest leaves of each plant when the crop was laid-by (final cultivation) on 18 April. Once the tassel was fully emerged from the whorl (about 8 May), little further increase in leaf area was recorded. The seven lowest leaves of each plant accounted for only 17% of the total leaf area (Table 1). Most plants at maturity had 14 or 15 leaves with a total leaf area of 3,450-4,600 cm^2.

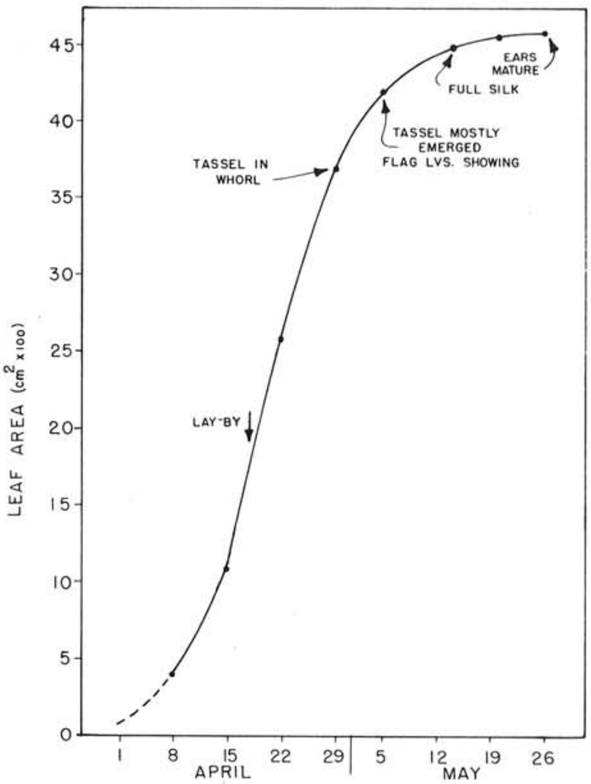

Fig. 1. Average leaf area increase and development stages of 'Iobelle' sweet corn plants in 1970.

Disease was present when observations began on 8 April 1970. Adjacent corn fields were lightly infected with the northern leaf blight fungus at this time.

Lesion numbers.—An average of 0.11 lesions per plant were observed on 8 April (Table 2). The lesion number increased 5-fold to 0.56 lesions per plant 1 week later. At harvest (7 weeks after initial observation) 40 lesions per plant were recorded. The heaviest spore concentrations of the season occurred during the 2 weeks prior to harvest (after tasseling). Observations were made for several weeks after harvest and no appreciable increase in number of lesions occurred.

Lesion size.—The average area of individual lesions increased steadily with time (Fig. 2). The three oldest leaves with the largest lesions on 18 April were covered by the lay-by operation; this lesion removal was reflected in the measurements made on 22 April. Average lesion size increased steadily after lay-by, except for the measurements made on 12 May. Although the average per lesion at harvest was 618 mm^2, many lesions were more than twice that size.

TABLE 1. Mature 'Iobelle' sweet corn leaf areas

Leaf position	Area (cm^2)	% of total area
1 (Bottom)	7	0.2
2	10 - 12.5	0.3
3	12 - 25	0.5
4	35 - 70	1.2
5	82 - 130	2.6
6	150 - 220	4.6
7	250 - 350	7.5
8	400 - 500	11.4
9	500 - 600	14.0
10	550 - 650	15.2
11	500 - 650	14.0
12	400 - 625	12.4
13	400 - 525	11.4
14 (Top)	150 - 220	4.6
(15)[a]	(10)	(0.2)
Total	3,450 - 4,600	b

[a] Fifteenth leaf in topmost position was not present on all plants.
[b] Percentage does not add up to 100% due to rounding.

TABLE 2. Sweet corn leaf areas, *Helminthosporium turcicum* lesion numbers and percent leaf blight during 1970

Date	Total leaf area (cm^2)[a]	Lesion number/plant[b]	% Disease[c]
8 April	400	0.11	0.014
15 April	1,085	0.6	0.049
22 April	2,590	1.5	0.041[d]
29 April	3,675	8.4	0.31
5 May	4,220	10.3	1.50
12 May	4,500	17.0	3.00
19 May	4,600	37.0	7.61
26 May	4,600	40.0	10.64

[a] Average of 10 plants selected at random.
[b] Average of 100 plants.
[c] Percent disease calculated from lesion numbers, times average lesion area, divided by average total leaf area.
[d] Three oldest leaves with largest lesions covered by lay-by (final cultivation) on 18 April.

Percent disease.—The percent disease for the eight weekly readings is given in Table 2. The disease incidences over the season exhibited the lower part of the sigmoid curve for disease progress described by van der Plank (9) (Fig. 3). Lesion number increased 3-fold from 15 to 22 April but percent disease slightly decreased for the period. The amount of infected leaf tissue at harvest was only about 10% of the total leaf area even though the greater portions of several lower leaves were killed by *H. turcicum*. The infection rate (9) calculated from the formula $r = 2.303/t_2\text{-}t_1 \cdot \log (x_2/1\text{-}x_2)\text{-}\log (x_1/1\text{-}x_1)$, for the period 22 April to 26 May, was 0.14.

Daily spore count.—The numbers of *H. turcicum* spores trapped daily varied (Fig. 4-B). No rain was recorded in the field except for the final week of the season. There were no periods of 100% RH for more than 12 hr recorded between 13 April and 23 May, thus there were few lengthy favorable periods for sporulation (1). As the disease progressed (Fig. 4-A) total leaf area blighted increased and the highest numbers of spores were trapped at the season's end.

Lesion numbers and aerial sprays.—Specific weekly increases in lesion numbers were correlated with spore flights by adding 7 days (incubation period) (3) to those days of peak spore occurrences (Fig. 4-A, B). A low peak of spore numbers occurred on 15 April and the average number of lesions per plant increased from 1.5 on 22 April to 8.4 on 29 April. A higher number of spores were trapped on 27 April, a day on which spray was applied, but lesion numbers increased only slightly to 10.3 per plant by 5 May. Over 50 spores were trapped on 1 May, a day on which no spray was applied, although sprays were applied the preceding and following days. The average number of lesions per plant increased to 17 by 12 May. A three-day peak of spore numbers occurred on 4-6 May with a spray only on 4 May. Lesion numbers increased notably to 37 per plant by 19 May.

DISCUSSION.—Monitoring the air-borne spores of *H. turcicum* with a spore trap, provided an accurate assessment of the threat of northern leaf blight on sweet corn. Spore-trap monitoring, coupled with accurate disease ratings, furnished a very satisfactory method for tracking the progress of *H. turcicum* buildup in the field. These techniques also provided a good evaluation of the effectiveness of specific aerially applied fungicide sprays.

The final cultivation (lay-by) acted as a lesion removal mechanism. That operation covered the 3-4 lowest leaves with soil, which removed the oldest and largest lesions at that time from further participation in the epidemic.

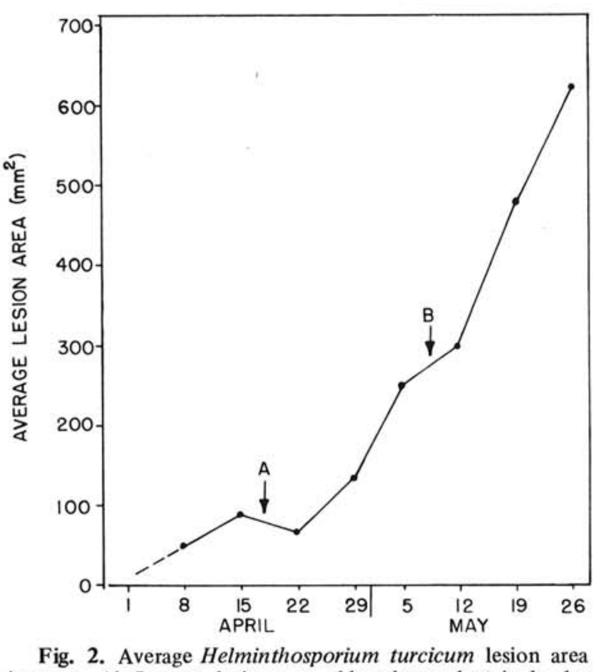

Fig. 2. Average *Helminthosporium turcicum* lesion area increase. **A)** Largest lesions on oldest leaves lost in lay-by operation. **B)** Cool weather (20 hr below 15 C) between 6 and 9 May.

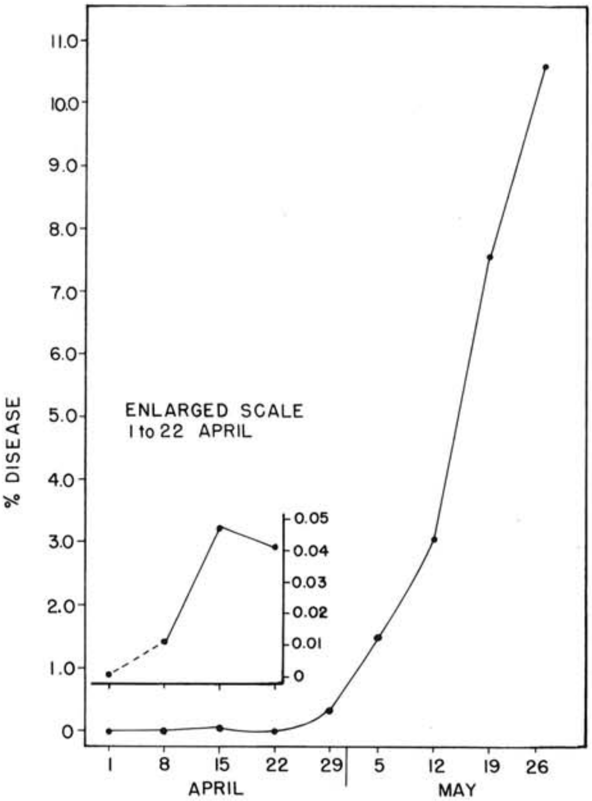

Fig. 3. Progress of *Helminthosporium turcicum* blight on sweet corn in 1970.

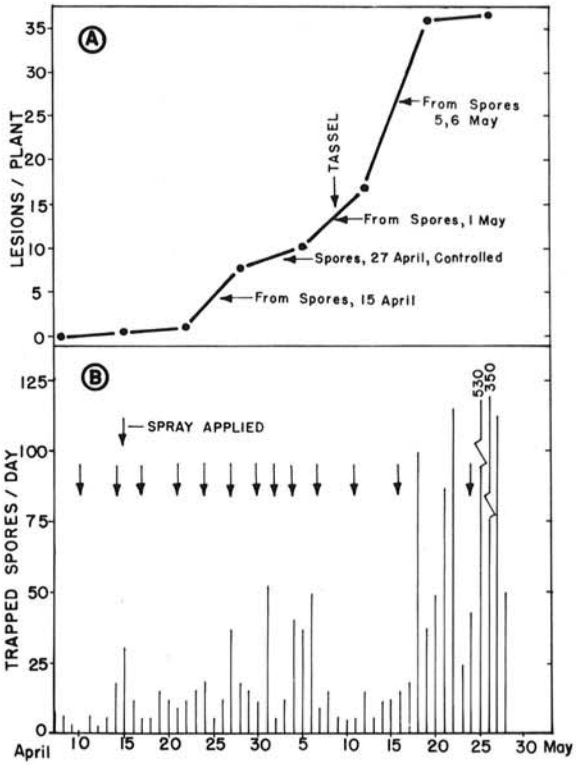

Fig. 4. Relation of *Helminthosporium turcicum* lesion numbers to numbers of trapped spores, aerially applied sprays, and corn plant development.

The disease progress curve based on accurate weekly estimations of percent disease essentially followed the lower part of the disease progress curve described by van der Plank (9). The average number of lesions per plant increased from 0.6 on 15 April to 1.5 on 22 April but the percent disease decreased slightly for the same period. This apparent anomaly resulted from lay-by cultivation covering the largest lesions and a substantial increase in new leaf area.

Average lesion size increased steadily over the season, reflecting the effects of the lay-by operation and temperature. Over 20 hr of below 15 C temperatures occurred between 6 and 9 May which may have slowed lesion enlargement for that period.

The data suggest that aerial fungicide sprays of maneb gave adequate control of spores deposited on the day of spraying, but such sprays gave practically no control if applied 24 hr later. Sprays applied the day before a significant spore flight were also largely ineffective because most infections took place on the new, expanding, unprotected tissue emerging from the whorl. Once the corn plant was in tassel, very little new leaf area developed, and disease control was maintained by infrequent protective sprays even though heavy *H. turcicum* spore deposits occurred.

The accurate leaf area calculations were valuable for the determination of disease incidence and disease progress. The leaf area would understandably depend upon variety, crop nutrition, and weather. Such measurements along with plant development notations provided a better understanding of blight progress than would have been possible otherwise.

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