SOUTHERN LEAF BLIGHT OF CORN IN SOUTHWESTERN ONTARIO IN 1971

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Abstract

In laboratory tests, Helminthosporium maydis race T in naturally infected corn debris survived 11 weekly cycles of thawing and freezing, the total tested. In the field the funqus survived much better in corn residues above the ground surface than in residues partly or wholly buried. The fungus overwintered from 1970 to 1971 in most corn fields. Infected seeds were present in 22% of samples of commercial seed from the 1970 seed crop. Because about 70% of seed for the 1971 corn crop contained the Texas (T) factor for male sterility that is associated with susceptibility to H. maydis race T, early and severe blight seemed possible in 1971.

Leaf lesions were first seen in late June 1971 in fields near elevators, and eight such fields were sprayed. Infection was occasionally heavy near corn cribs. The disease became qeneral in late July, but remained light in most fields through August and September.

In growth cabinet tests at spring temperatures, few seedlings emerged from severely infected seed and the funqus took 4 weeks to appear above ground on the bases of the seedlinqs. These factors may have reduced disease from infected seed in the field. Dry weather and cool nights probably restricted field spread from infected debris. During the summer, day temperatures were ideal for the fungus, but rainfall was abnormally low for much of the season. At night, when leaves would be wet from dew, temperatures were average but were too low for maximum fungus growth. In southwestern Ontario, unusually wet days or unusually warm nights would be needed for the disease to develop at its full potential rate.

Introduction

Southern leaf blight of corn (Zea mays L.) caused by Helminthosporium maydis Nisikado and Miyake (Bipolaris maydis (Nisikado) Shoem., stat perf. Cocbliobolus heterostrophus Drechs.), occurred in Ontario in 1970 from Essex and Kent counties, where most plants were infected, narthward to Bruce and Grey counties and eastward to the Ottawa Valley (3). The race of H. maydis involved (race T) is especially able— to attack corn plants that contain the Texas (T) factor for male sterility, as did most corn hybrids grown in this area in 1970. It was unavoidable that again in 1971 some 70% of corn seed contained this factor. In 1970 the pathogen reached Ontario late in the season from areas to the south, and caused little damage. For 1971, however, the possibility of its overwintering locally posed the threat of early outbreaks and more severe damage. Overwintering of the fungus on corn residues in the field and on seed from the 1970 seed crop was studied, together with the possibility of spore production on seedlings from infected seed. The incidence of the disease in southwestern Ontario in 1971 is summarized.

Methods

To determine survival of H. maydis on corn debris, the debris was placed on and between 20 corn seedlings containing T cytoplasm. Pots of seedlings about 15 cm tall were enclosed in plastic bags closed by cotton wool plugs and kept in a greenhouse at about 24 C. The bags were rumpled daily to spread any spores to the leaves. After 8–9 days, lesions were counted.

To indentify race T of the pathogen, seedlings of single crosses 29N and 29T with normal and T cytoplasm respectively (kindly supplied by Dr. G. Scheifele, P-A-G Seeds, W. R. .Grace 6 Co., Champaign Research Station, R. R. 1, Champaign, Illinois 61820) were used as described above.

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Table 1. Survival of Helminthosporium maydis in field residues of corn subjected to weekly cycles of freezing and thawing[a]

Material and conditions while thawed	Number of weekly cycles[b] 1–4	5–8	9–11
2°C, kept wet			
leaves & husks	78	62	29
stalks	17	12	6
kernels	50	17	1
21°C, kept wet			
leaves & husks	100+	100+	100+
stalks	41	36	5
kernels	19	32	55
21°C, allowed to dry to about 15%moisture', rewetted before freezing			
leaves & husks	100+	100+	100+
stalks	39	28	10
kernels	100+	100+	42

[a] Average numbers of lesions per set of corn seedlings in plastic bag in test described under Methods.

[b] Weekly cycle: freeze 1 day, thaw 6 days.

Results

Overwintering of the fungus on corn debris

In laboratory tests on infected corn debris, the fungus survived 11 weekly cycles (the total tested) of freezing for 1 day and thawing for 6 days (Table 1). It survived better when kept at 21° C for each 6-day period than at 2°C, and its survival was not affected when the debris was allowed to dry during each 6 days at 21" C to about 15% moisture. In a test after the 8th cycle, the funaus gave more and larger lesions on plants with T cytoplasm than on plants with N cytoplasm.

Table 2. Overwinter survival[a] outdoors in Essex county of Helminthosporium *maydis* in field residues of corn wrapped in open-weave terylene cloth, 1970–71

Overwintering site	Sampling dates Dec. 9	Jan. 13	Feb. 25	Apr. 14
45 cm above ground	100+	71	100+	78
At ground level	90	57	34	34
10 cm below ground	70	[c]	20	12
Check[b]	100+	100+	100+	100+

[a] Avg number of lesions on corn seedlings, see Methods for description of test; avg of 3 locations.

[b] Dried infected residues sealed in plastic bags kept outdoors 45 cm above ground.

[c] Not sampled - ground frozen.

Survival in the field

Infected leaves, stalks, and ears were wrapped separately in open textured terylene cloth and overwintered outdoors 45 cm above ground, half-buried in soil, and 10 cm below ground at each of three locations near Harrow (Table 2). The fungus survived equally well on the three types of plant material. Samples which were sealed dry in plastic bags 45 cm above ground survived without evident deterioration. The fungus survived much better in debris wrapped in cloth at 45 cm above ground than when the debris was half-buried or buried 10 cm deep.

Naturally overwintering debris collected

Table 3. Occurrence of Helminthosporium maydis in residues in growers' fields in Essex and Kent counties, 1971

	Period Late March - early April	Late April - early May	Mid May - early June	Mid June - early August
Essex County				
No. of fields in which H. maydis was detected[a]	25/30	23/31	12/38	22/35
Avg no. lesions per positive test[b]	46	14	24	10
Tests in which T cytoplasm was attacked more than N cytoplasm	8/8	14/14	5/6	6/7
Kent County				
No. of fields in which H. *maydis* was detected[a]	15/18	10/15		
Avg no. of lesions per positive test[b]	34	18	No survey in this period	
Tests in which T cytoplasm was attacked more than N cytoplasm	5/6	1/2		

[a] No. positive/no. tested.

[b] Tested on corn seedlings as described under Methods.

each month from December to June at and above the soil surface in six fields near Harrow gave the following average numbers of lesions when tested on corn seedlings as described: Dec., 24; Jan., 33; Feb., 37; March, 19; April, 4; May, 28; June, 14.

Overwintering occurred in most fields in Essex and Kent counties (Table 3), and in nearly all cases that were checked the fungus attacked plants with T cytoplasm more readily than plants with N cytoplasm.

Seed infection

In 1970 the fungus invaded the tip kernels of many ears in seed fields. Seeds from fields with badly infected ears, graded as for commercial use, were examined for infection. Untreated or surface-sterilized seeds were germinated at 21-27° C in paper towels, sand, or soil (details in Table 4).

All commercial grades contained infected seeds, though less than rejected grades. Smaller "flat" grades, which would come from nearer the ear tips, contained more infected seeds than larger "flat" or "round" grades.

Southern leaf blight of corn in southwestern Ontario in 1971

Corn seedlings emerged mainly in the middle two weeks of May in Essex County. No seedlings infected with H. maydis were seen until June 3, when 1 of 30 unthrifty seedlings collected from several fields where corn was graving after corn was infected below ground.

Leaf lesions were found in Essex County on June 24-25 on lower leaves of plants in 9 fields adjacent to elevators. In 3 of these, only single lesions were found. In areas of the other fields up to 10% of plants had 1-5 lesions on lower leaves. One of these fields was ploughed and 5 were sprayed, as described later. By mid-July, occasional lesions (up to 2% of plants with 1-3 lesions) were found in 5 other fields close to elevators, in 9 of 23 fields where corn had been grown the previous year, along the edges of 2 fields where the adjacent field had been planted with corn the year before, and in 2 of 8 fieldn which had not grown corn in the previous year. In the last week of July and the first week of August, 26 out of 34 fields surveyed had blight. In 16 fields, lesions occurred only on 3-15% of the leaves below the ear. Eight fields had occasional lesions on a few upper leaves. and in 2 fields lesions occurred on many upper leaves, In late September, the disease had become more general on upper leaves. In 9 of 23 fields surveyed the disease was not seen, but in 12 fields the upper leaves had up to 50 lesions per leaf and in 2 fields 200-300 lesions per leaf. Infection of the ear husks was occasional and usually penetrated only one or two husk layers.

Table 4. Infection with *Helminthosporium maydis* in seeds from fields with badly infected ears, graded as for commercial use

Seed source and treatment	% infected seeds
Seed sources[a]	
Sample A - rejected seed	41
- commercial grades:	
medium flats (18-20)	17
medium flats (22-24)	10
large flats	6
medium rounds (18-20)	8
medium rounds (22-24)	7
Sample B - rejected seed	28
- commercial seed (ungraded)	8
Sample C - ears sorted before shelling	13
Sample D - ears sorted before shelling	2
Seed treatments[b]	
Javex	21
Mercuric chloride	10
Captan dust	12
None	14
Germination *methods*[c]	
Paper towels	16
Trays steamed sand	9
Trays steamed soil	16

[a] Means for all seed treatment and germination methods. Sieve sizes in brackets in 1/64 inch (0.40 mm).

[b] Means for all samples and germination methods. Javex: soak 1 minute in Javex (5.25% active Cl), rinse twice. Mercuric chloride: soak 3 minutes in 95% ethanol, then in 0.1% mercuric chloride for 15 minutes, 5 rinses.

[c] Means for all samples and seed treatments. Paper towels were folded around seed and enclosed in plastic bags closed with cotton wool plugs. Trays had glass covers sealed with cotton wool between cover and tray.

Blight was identified in Kent County on June 26 at the Ridgetown College of Agricultural Technology in plots in which quantities of dried infected leaves were spread on the soil as a source of Phyllosticta maydis Arny and Nelson. Apparently the inoculum source also contained H. maydis. These plots were ploughed on June 28 to reduce the chance of early spread into other corn plots at the College.

A survey of corn fields near grain elevators in Kent County on June 28-29 revealed 7 fields with blight infections on

the lower leaves of plants growing close to the elevators. On July 3, 12 fields in Kent County were found to contain southern leaf blight, 10 next to elevators and 2 near cob dumps.

Surface-sterilized seed had about the same percentage of infection as untreated seed, suggesting that the fungus usually penetrates the seed. The fungus was most readily detected by germinating seeds in moistened paper towels. In tests in sand or soil the fungus showed at the bases of the seedling stems, but was often obscured by other fungi.

These samples, though from unusually severely affected fields, indicated that commercial seed from other fields would probably contain infected kernels. Of 1129 samples of commercial seed examined from January to March 1972 by the Plant Products Seed Testing Laboratory in Toronto, 22% contained infected seeds (Mr. P. Grainger, personal communication). The infection level was generally 0.5-2%, though occasional samples contained 10-20% infected seed.

Seedling infection and appearance of the fungus above ground

To determine how often infected seeds gave rise to infected seedlings, and how readily the fungus appeared above ground to produce spores for further spread, infected seeds were planted 5 cm deep in steamed field soil in the greenhouse or in a growth cabinet. Temperatures were 20°C by day and 13° C at night, to approximate day air temperatures and night soil temperatures in May in Essex County.

For six samples of commercial seed with a 20% estimated average infection with *H. maydis* planted in the growth cabinet average seedling emergence was 76%. Under these temperature conditions *H. maydis* appeared on the tips of the coleoptile sheaths, just above the soil surface, on 11% of the plants about 4 weeks after emergence. In the greenhouse, in similar tests under less consistently humid conditions, no *H. maydis* was observed above ground. Seeds infected to the extent that 50% of the surface of each seed was blackened were also planted in the greenhouse. Only 3-4% emerged, and no *H. maydis* was seen on these plants in the next-5 weeks.

At 16-17" C, corn and *H. maydis* grew at about half their rates of growth at 25-28° C, and the fungus took about twice as long to induce the collapse of 10-cm-segments of seedling stalks. At 11" C, both corn and fungus grew very slowly.

In early September the disease was noted as far east as Wellington County. It developed in August and September in the Ottawa Valley (2), Quebec, and Prince Edward Island (W. E. Sackston and H. W. Johnston, respectively, personal communications).

Fields sprayed for blight control

It was decided to spray 5 of the fields in Essex County that had blight on June 24-25 because they might provide an early source of spores for surrounding corn. In the first week of July and in mid July these fields were sprayed with zineb at 3.5 lb active ingredient/acre (3.9 kg/ha) plus Triton B1956 at 1/3 oz formulation/acre (23 g/ha) in 35 gallons (160 liters) water. Rain (up to 2 cm) occurred on July 4-5 and 23-25.

In late June and early July, the number of lesions multiplied 3-5 times per week in these fields. At the second spraying there were up to 20 lesions per leaf at the bottom 45 cm of the plant. On Aug. 9 there were 20-30 lesions per leaf at ear level, and 1-8 on upper leaves, about ten times as many as in Essex County in general. At this time, about 3 weeks after mid-silk, there was a potential for damage, but dry weather and cool nights restricted the disease. The disease increased in early September, and up to 200 lesions per leaf damaged some of the upper leaves, but this was too late to affect yield appreciably. There was no apparent spread of the disease to neighboring fields during the season.

In Kent County, blight did not develop as rapidly as in Essex County. On July 9 a few lesions were noted in the upper leaves in two fields and considerably more in a third field where air movement was reduced by tall weeds. These three fields were sprayed on July 14 and 23 with maneb at 2.5 lb a.i./acre (2.8 kg/ha). By mid-August there was no longer a threat of an epidemic, and spraying was discontinued.

Cribs as sources of infection

Although leaf infection was noted on two occasions in 1971 near cribs in Essex County, no serious infections resulted from this association. In Kent County, two fields near cribs from which corn had been removed in June had severe outbreaks of blight in the dozen or so rows next to the cribs were corn handling equipment had been standing in the new crop. Sections of 20 rows in each field were ploughed down on July 10 and 12. When growers were advised of this development, samples of blight infections came in from widely scattered farms in Kent County.

The widespread overwintering of the fungus on corn residues in southwestern Ontario and its presence in 20% of commercial seed samples made an early outbreak of blight seem very possible in 1971. Growers were advised to plant hybrids with normal (N) cytoplasm, to plough under corn residues, to avoid growing corn after corn, to handle stored corn as little as possible in the growing season, to plant early using a Vitavax-thiram seed dressing, and to minimize stress on the plants by sound cultural practices.

Table 5. Weather records, Harrow (Essex County) and Ridgetown (Kent County)[a], summer 1971

Period		Soil temp 10 cm depth[b] (°C)	Air temperature (°C)				Rainfall			
			Average daily maximum		Average daily minimum		Days with rain		Total rain (cm)	
		Harrow	Harrow	Ridgetown	Harrow	Ridgetown	Harrow	Ridyetown	Harrow	Ridgetown
May	1-10	10	17	18	6	5	2	1	1.1	0.1
	11-20	13	22	22	9	8	4	2	0.7	0.1
	21-31	13	18	19	7	7	2	3	2.5	2.8
June	1-10	16	23	24	13	10	4	3	2.0	1.6
	11-20	19	26	26	16	15	4	1	3.0	0.6
	21-30	22	28	29	18	17	3	4	2.7	1.4
July	1-10	23	28	28	18	18	2	1	0.5	0.7
	11-20	22	26	26	15	14	2	1	0.2	0.1
	21-31	22	25	25	16	16	6	4	4.5	3.2
Aug.	1-10	21	26	27	15	15	2	1	2.9	5.5
	11-20	21	26	26	16	16	1	2	0.1	4.6
	21-31	21	26	25	16	14	1	4	1.5	5.6
Sept.	1-10	22	27	27	20	19	2	0	1.3	0.0
	11-20	20	22	22	14	13	4	6	2.7	3.5
	21-30	17	21	21	11	11	3	2	2.4	0.9

[a] Ridgetown is 70 miles east of Harrow.

[b] Average of readings at 8 a.m. and 5 p.m., in soil with sod cover.

Except for one plant, infection of seedlings was not seen even when they grew through corn residues. The low rate of emergence of seedlings from severely infected seeds, and the 4 weeks required at spring temperatures for the fungus to appear above ground at the base of the plant, may have reduced the likelihood of disease originating from infected seed. Dry weather and cool nights probably restricted spread from debris.

Discussion

The disease was first seen near elevators, as it often was in the U.S. corn-growing areas. Growers and elevator operators were asked to avoid or reduce movement and shelling of corn until mid-August and to avoid movement of cobs and corn debris. The eight most affected fields were sprayed as described above.

Although the disease became widespread in late July and early August, infection was very .Light and no spray recommendations were made. At this time a further 2-3 weeks were needed for 70% yield dry matter and 2 more weeks for 90% dry matter to be obtained (1). Experiments at Harrow (unpublished) indicated that loss of leaves below the ear leaf during the first 2-3 week period would decrease yield at the most by 15%. Therefore, unless the weather favored rapid disease spread, spraying was likely to be uneconomic. In fact, dry weather and cool nights delayed the disease, which did not become general on upper leaves until late September.

The weather, as recorded at Harrow and Ridgetown (Table 5), evidently was important in restricting blight development. Rainfall at Harrow in May, July, and August was only about 70% of the long-term averages, while at Ridgetown rainfall in May, June, and July was only about half the long-term averages. Average temperatures were usually within 1-2 C of the long-term averages, except in early September. Because the widespread establishment of new infections would require moisture from rain or dew, night temperatures during periods of dew probably limited the development of the fungus. At Ridgetown, rainfall totalled 15.7 cm in August, but night temperatures were low. The general summer night low temperatures of 15-15 C are those which allowed the fungus only half its maximum growth rate on agar, and this limitation would presumably operate in any normal season in this area. In addition, low soil temperatures and low night air temperatures in May and early June would restrict the development of H. maydis from infected seeds and debris.

Maximum day temperatures of 23-28 C are ideal for the fungus through June-early September, but these days in 1971 were mostly dry.

It would seem therefore that for southwestern Ontario a period of unusually wet days or of unusually warm nights would be needed for the disease to develop at its full

potential rate. It was during unusually hot and humid weather, particularly at night, in August 1970 and early September 1971 that the disease became general in this area.

The fungus overwintered from fall 1970 to spring 1971 in many areas of the United States in addition to the southeastern states (4, 5), and it evidently survives a wide range of winter conditions. It is therefore likely to overwinter again in southwestern Ontario, and the use of hybrids with normal (N) cytoplasm is recommended for the future. Because some lesions occurred in 1971 on plants with normal cytoplasm, efforts to prevent overwintering of inoculum are needed to reduce the chance of development of fungus races able to attack severely plants with normal cytoplasm. It was the general experience that the fungus overwintered best in corn residues above the soil surface (4, 5), and the destruction of such debris by deep ploughing is therefore of great importance.

Literature cited

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