Overwintering and Spore Release of *Cercospora zeae-maydis* in Corn Debris in North Carolina

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ABSTRACT

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Cercospora zeae-maydis survived from November 1979 until May 1980 in corn (*Zea mays*) debris in fields located in the piedmont region (Raleigh) and mountains (Fletcher) of North Carolina. The fungus survived at Raleigh when positioned 100 cm above the soil surface, on the soil surface, or buried 15 cm below the surface. At Fletcher, the fungus did not survive beyond January in leaf tissue buried 15 cm below the surface. Conidia of *C. zeae-maydis* were collected in the air above corn debris as early as 19 June 1979. The concentration of airborne conidia was greatest during the week of 27 September–2 October, when the corn kernels were in dough to late dent stage of development. Lesions with *C. zeae-maydis* did not appear until 19 July (corn in late whorl stage), and rapid disease progression did not occur until September when corn kernels were in milk stage. *C. zeae-maydis* can overwinter in corn debris and produce conidia early in the season. Failure of the disease to develop early in the season may be related to unfavorable microclimate within the corn canopy.

Gray leaf spot of corn (*Zea mays* L.) caused by *Cercospora zeae-maydis* Tehon and Daniels occurs predominantly in the mountainous regions of Virginia, Tennessee, Kentucky, North Carolina, and South Carolina. The disease, however, is not restricted to these areas and can occur in the piedmont region (P. M. Beckman and G. A. Payne, *unpublished*) and coastal plain (3). The microclimate in the plant canopy appears to be extremely important in the development of this disease (1) and may explain why it is commonly found in mountain valleys with poor air movement. Losses as great as 20% from gray leaf spot have been reported (2).

The recent increase in prevalence of this disease has been associated with minimum-tillage farming practices, implying that high inoculum levels may be important in disease development. The disease, however, usually does not develop until late in the season, although plants are susceptible to infection by *C. zeae-maydis* at all stages (1,2). Whether late-season development of the disease is caused by environmental conditions, high inoculum levels, or both, is not known. Both of these observations, however, suggest that overwintering of the fungus and time of conidia release may be important in the epidemiology of *C. zeae-maydis*. The objective of this study was to examine the overwintering of *C. zeae-maydis* in corn debris and to monitor the release of conidia from debris during the growing season.

MATERIALS AND METHODS

Overwintering. Corn debris collected on 29 November 1979 from a field of corn infected with *C. zeae-maydis* was

Table 1. Relative recovery of *Cercospora zeae-maydis* from infected corn leaf and leaf sheath tissue stored above the ground, on the ground, or buried, at Fletcher and Raleigh, NC, from November 1979 until May 1980

		Treatment and location[a]						
			Air		Ground surface		Buried	
Recovery date	Days after treatment	Check	Fletcher	Raleigh	Fletcher	Raleigh	Fletcher	Raleigh
26 November 1979	0	+++[b]	+++	+++	+++	+++	+++	+++
11 December 1979	16	+++	++	++	++	−	++	−
8 January 1980	44	+++	++	+	++	+	−	+
7 February 1980	74	+++	++	++	++	++	−	++
14 March 1980	109	+++	+	+	++	++	−	+
10 April 1980	136	+++	−	+	+	+	−	+
15 May 1980	171	++	+	+	+	++	−	++

[a] Check = samples stored in the laboratory; air = samples placed 100 cm above soil surface; ground surface = samples placed on soil surface; buried = samples buried 15 cm below soil surface.
[b] Relative recovery of *C. zeae-maydis*: − = no conidiophores observed, + = 1–5 conidiophores, ++ = five to 15 conidiophores, +++ = more than 15 conidiophores observed per sample plate. Data represent observations from three plates per treatment with approximately 30 cm^2 of tissue per plate.

Table 2. Climatological data for 26 November 1979 to 15 May 1980 for Raleigh and Fletcher, NC

		Temperature (C)					
Location	Date	Lowest	Highest	Avg. min.	Avg. max.	Avg.	Precip. (mm)
Fletcher[a]	November 1979	−7.2	18.9	−1.1	10.7	5.0	2.54
	December 1979	−11.7	20.6	−1.3	12.3	5.6	26.67
	January 1980	−9.4	17.2	0.0	9.4	4.7	72.39
	February 1980	−12.8	23.3	−5.1	8.4	1.7	13.46
	March 1980	−12.8	22.3	2.5	13.3	7.9	209.80
	April 1980	−0.6	30.0	7.1	20.1	13.6	121.16
	May 1980	2.8	31.1	10.1	24.2	17.2	1.02
Raleigh[b]	November 1979	−7.8	22.2	1.9	16.2	9.1	24.89
	December 1979	−9.4	22.2	0.1	12.5	6.3	23.88
	January 1980	−7.2	16.7	0.1	9.4	4.8	111.51
	February 1980	−13.9	26.1	−3.9	8.9	2.5	48.51
	March 1980	−11.7	21.7	2.3	13.8	8.1	149.10
	April 1980	0.6	35.0	9.0	24.3	16.7	50.04
	May 1980	3.3	27.2	11.3	27.0	19.4	5.33

[a] Weather data obtained from Asheville Airport Weather Station, approximately 1.6 km from the field.
[b] Weather data obtained from Raleigh-Durham Airport Weather Station, approximately 8 km from the field.

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enclosed in packets (10 × 10 cm) made of fiberglass screening. Each packet contained approximately 30 g of leaf blade and sheath tissue. Half of the packets were placed at a location in the mountains (Fletcher, NC) and half were placed at a location in the piedmont region (Raleigh, NC). At each location there were two sites (separated by approximately 50 m), each consisting of three positions: 100 cm above the soil surface, on the surface, and buried 15 cm below the surface. Once a month from December to May, one packet from each position at each of the two sites at both locations was brought to the laboratory, rinsed 20 min in running water and approximately 30 cm^2 of leaf tissue was placed on moist filter paper in each of three petri dishes. The tissue was incubated at room temperature and observed for conidiophores and conidia of *C. zeae-maydis*. Survival was determined by the ability of the fungus to sporulate on the corn debris. Infected tissue stored at room temperature for the duration of the experiment served as a check.

Disease evaluation and spore trapping. Development of gray leaf spot was monitored in the mountains at Fletcher and Waynesville in 1979. Conidial trapping of *C. zeae-maydis* was done at Fletcher only. Experimental plots consisted of four rows, 12 m long, replicated six times. Two corn cultivars, Pioneer Brand 3147 and DeKalb XL72B, were planted on 7 May and 8 June in Waynesville and on 8 May and 15 June in Fletcher. Corn debris infected with *C. zeae-maydis* in 1978 and collected at Waynesville was used as a source of inoculum. The debris was baled and stored in a barn after the grain was harvested. Two weeks after planting, debris (approximately 50 kg) was spread evenly throughout each plot. Plants were examined periodically for lesion development, and disease ratings were taken on 4 August, 9 September, and 3 October. Disease was rated on a scale of 0–5, as described by Roane et al (3).

Airborne dispersal of conidia was studied at Fletcher with a Burkard spore trap (Burkard Scientific Sales Ltd., Rickmansworth, Hertfordshire, England). The spore trap was placed 10 m from the edge of the plot on 19 June. The trap orifice was located 45 cm above the ground and the trap was adjusted to sample 10 L of air per minute (= 14.4 m^3 of air per day). Daily spore counts were made with the aid of a microscope at a magnification of ×250. The Melinex tape taken from the trap was cut into segments representing 24-hr periods and the conidia on it were stained with cotton blue. Because of a malfunction in equipment, conidia were not collected from 6 to 20 August. Rainfall was recorded at the Asheville Airport, approximately 1.6 km away.

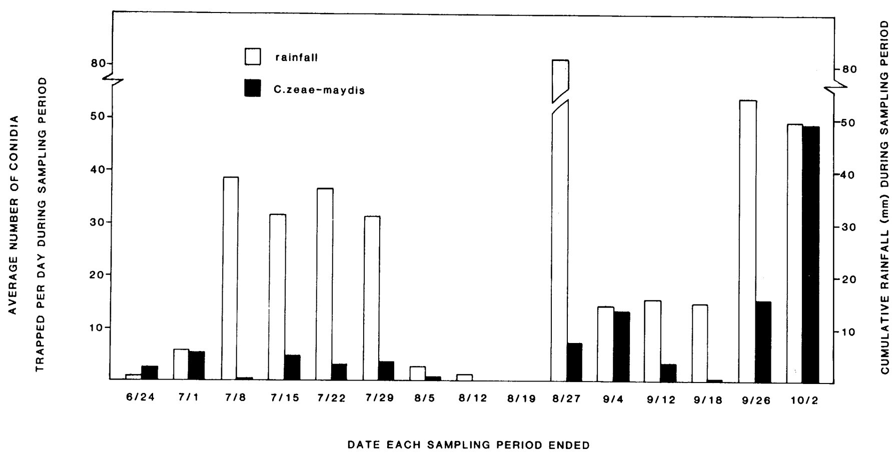

Fig. 1. Average number of conidia of *Cercospora zeae-maydis* trapped daily and weekly rainfall totals. Conidia were collected with a Burkard spore trap sampling 14.4 m^3 of air per day. Spores were not collected from 6 to 20 August because of a malfunction of the spore trap.

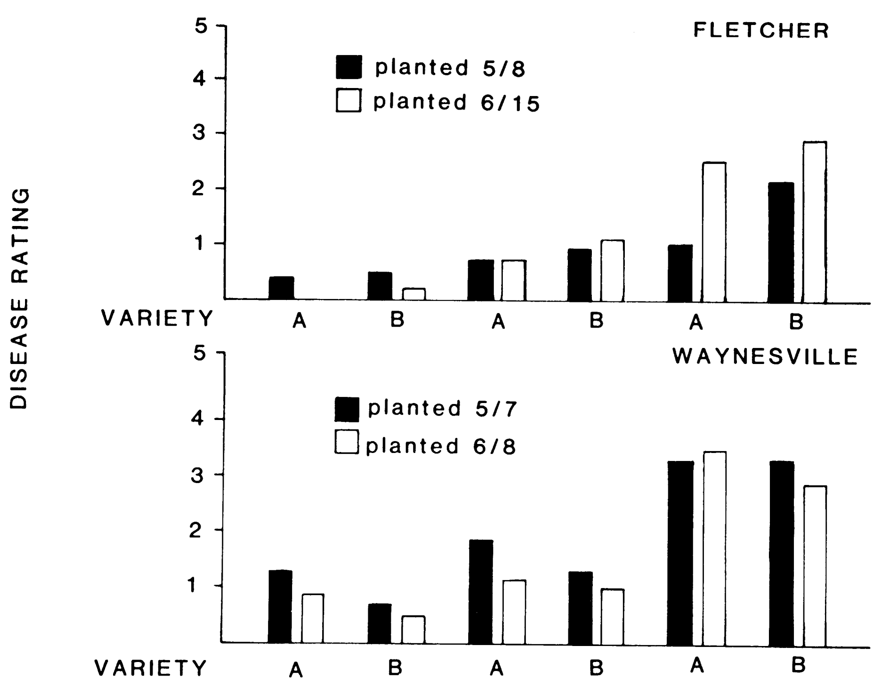

Fig. 2. Development of gray leaf spot of corn on two cultivars planted at two dates at Fletcher and Waynesville, NC. Hybrid A = DeKalb 72B, Hybrid B = Pioneer Brand 3147. Leaf disease ratings: 0 = no symptoms; 1 = few (<2/leaf) lesions below the ear, none above; 2 = many lesions below the ear, trace above; 3 = severe lesion development below ear, all leaves above ear with lesions; 4 = all leaves with severe lesion development, but green tissue visible; 5 = all leaves dry and dead.

RESULTS

Cercospora zeae-maydis survived in corn debris from November 1979 until May 1980 at both Raleigh and Fletcher (Table 1). The fungus survived at all three treatment positions in Raleigh. At Fletcher, the fungus did not survive beyond January in leaf tissue buried 15 cm below the surface. The weather conditions during this study are presented in Table 2.

Conidia of *C. zeae-maydis* were collected as soon as the spore trap was installed on 19 June (Fig. 1). Airborne conidia of *C. zeae-maydis* were in low concentrations until late August, when the concentration of conidia began to increase rapidly, reaching a peak the week of 27 September–2 October.

Although conidia of *C. zeae-maydis* were present on 19 June, lesions of gray leaf spot were not detected until 19 July when the corn plants were in late whorl stage. On this date there were few lesions at Fletcher (less than one lesion per plant) and numerous lesions at Waynesville (10–15 lesions per plant). The disease developed first on the early planted corn and developed faster at Waynesville than Fletcher (Fig. 2). By 4 August, when the corn plants were tasseling, the fungus was present in all plots at Waynesville but only in the early planted plots at Fletcher (Fig. 2). The disease progressed slowly at both locations for the next month but began to increase rapidly in late September when plants reached dough and dent stages of kernel development. Although lesions first appeared on the early corn at Fletcher, disease severity at the end of the season was greater on the late planted corn. The early planted corn at Fletcher grew poorly because of excessive rain early in the season and never developed a dense canopy as did the late planted corn.

DISCUSSION

Cercospora zeae-maydis overwintered in corn debris in the mountain and piedmont regions of North Carolina. Survival of the fungus, however, was reduced when corn debris was buried in the soil. The increased severity of this disease, associated with the increase in minimum tillage (3), is probably related to overwintering of the fungus. In minimum tillage, much of the previous crop debris is left on the soil surface. Under these conditions, the fungus overwinters well and is able to produce inoculum during the next season.

Conidia of *C. zeae-maydis* were trapped early in the season. The concentration of conidia in the air remained low until sporulating lesions were formed. Even though conidia were present early, gray leaf spot lesions were not observed until 19 July and the disease did not begin to develop rapidly until late September, which agrees with other studies (3). Since conidia were trapped early in the season, failure of the disease to develop early does not appear to be due to absence of inoculum. Other factors that may be responsible are stage of plant development and suitable environmental conditions. Young plants are susceptible to *C. zeae-maydis* (1,2) and, under greenhouse conditions, lesions develop as rapidly as they do on older plants (1). Although plant stage may influence lesion development to some degree, it is more likely that plant canopy is important for creating a favorable microclimate. Infection by *C. zeae-maydis* is greatly influenced by humidity and free water on the leaf surface (1). Failure of *C. zeae-maydis* to develop as well on early planted corn at Fletcher, which had a poor canopy, supports the importance of the plant canopy in disease development.

Development of gray leaf spot in the field is dependent on inoculum, plant age, and a suitable microclimate. In the mountains and piedmont regions of North Carolina, the fungus can overwinter in corn debris and produce conidia the following season. Since the fungus did not overwinter well in buried debris in the mountains, fall plowing may be an effective way to reduce inoculum levels in that area.

LITERATURE CITED

1. Beckman, P. M., and Payne, G. A. 1982. External growth, penetration, and development of *Cercospora zeae-maydis* in corn leaves. Phytopathology 72:810-815.
2. Hilty, J. W., Hadden, C. H., and Garden, F. T. 1979. Response of maize hybrids and inbred lines to gray leaf spot disease and the effects on yield in Tennessee. Plant Dis. Rep. 63:515-518.
3. Roane, C. W., Harrison, R. L., and Genter, C. F. 1974. Observations on gray leaf spot of maize in Virginia. Plant Dis. Rep. 58:456-459.