

Overwintering and Aerobiology of *Cercospora asparagi* in North Carolina

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ABSTRACT

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Survival of *Cercospora asparagi* was studied in two asparagus fields at two locations in Sampson County, North Carolina, over the winters of 1984 and 1985. *C. asparagi* survived well from December to May in naturally infected stems of asparagus held 75 cm above the ground and at the soil surface; however, only trace amounts of the fungus could be found after February in samples buried 15 cm below the surface. Sanitation by plowing under debris will help reduce inoculum levels and improve disease control. The presence and quantity of airborne conidia of *C. asparagi* were monitored from April to November at both locations with a Burkard spore trap. Conidia were first collected in April, but the number of conidia trapped from April through late July remained low. The greatest concentration of airborne conidia occurred from 29 August to 5 September at the time of maximum disease. Incidence of trapped conidia followed a diurnal pattern with greatest detection between 1000 and 1300 hours. Lesions of *Cercospora* blight on the asparagus plantings first appeared in mid-June or July, but rapid disease progression, associated with the development of the asparagus canopy, did not occur until August and September.

Additional key words: *Asparagus officinalis*

Cercospora blight of asparagus (*Asparagus officinalis* L.) caused by *Cercospora asparagi* Sacc. occurs throughout regions of the world where asparagus is grown but does not cause appreciable damage in cool or dry climates (3). The disease has appeared yearly in North Carolina since 1981 and has caused significant damage to the ferns. In North Carolina, asparagus shoots are generally harvested from 25 March to 5 May, then shoots are allowed to go to fern growth. Lesions first appear on stems and needles in late spring and early summer, usually 6-7 wk after the last harvest, when plants are about 1.5 m tall. Lesions become progressively severe throughout the season. Blighted ferns have small, oval, grayish tan lesions with purple borders, then they turn yellow to brown and eventually die prematurely. Premature death of ferns can reduce photosynthate and subsequent food storage in the crowns. Occurrence of disease is associated with premature

budbreak; stored nutrients are unseasonally depleted, causing yield reductions in the following year (C. W. Averre, unpublished).

The fungus is believed to overwinter in plant debris (10); however, this has not been confirmed. In North Carolina, the cultural practice of allowing the asparagus ferns to remain standing until late February may favor survival of *C. asparagi*. Other *Cercospora* spp. survive the winter on crop residues (6,8).

The aerobiology of several *Cercospora* spp. has been investigated (1,5,7,9). Limited information is available concerning the seasonal and diurnal dispersal of conidia of *C. asparagi* (4).

This study was done to determine if the fungus survives over the winter in asparagus tissue, thus providing a possible source of primary inoculum in the spring, and to monitor the release of conidia contributing to secondary inoculum during the growing season.

MATERIALS AND METHODS

Overwintering. Asparagus stems with *Cercospora* blight lesions were collected on 12 December 1983 and 13 October 1984 from a field in Sampson County, North Carolina. Stems were cut into segments 7-8 cm long and placed in one of four categories based on stem diameter: <2, 2-3, 4-5, and >5 mm. Several stems from each category were placed in bags 15 × 15 cm made of fiberglass netting. Bags were closed with undulated staples and placed in asparagus fields at two locations near Clinton and Turkey, NC, with two sites at each location. Each site consisted of three treatments: bags suspended 75 cm above the

soil surface, bags placed on the soil surface, and bags buried 15 cm below the soil surface. In 1984, an additional treatment consisting of stems sampled from intact plants was added. Samples of diseased tissue stored at 4 C served as a check.

Samples from each treatment and site were collected monthly from November until June and examined for conidia of *C. asparagi*. Stem tissue was removed from the bags, surface-disinfested in 1:5 (v/v) 5.25% sodium hypochlorite-distilled water solution for 5 min, and blotted dry on paper towels. Stems were then incubated in petri dish moist chambers for 4 days at room temperature with incident light from a window. Stems were examined individually under a dissecting microscope, and survival was determined by the ability of the fungus to produce stroma with conidiophores and conidia on asparagus stems and debris. Ten stems for each treatment/site were examined and rated by the amount of sporulation, which was visually estimated on a scale of 0-4, where 0 = no sporulation, 1 = few conidia in only one lesion, 2 = two or more lesions with sparse conidia, 3 = several lesions with abundant conidia, and 4 = dense conidia in several lesions. The width of the stem piece was also noted.

The experimental design was a randomized complete block design with the treatments as main effects and the sampling dates as split plots. The data were analyzed by analysis of variance and Fisher's LSD.

Aerobiology. Airborne dispersal of conidia was studied at both sites with a Burkard spore trap operated at a flow rate of 10 L of air per minute through an orifice 45 cm above the soil level. The fields were sprayed with maneb-zinc (4 L/ha) four times throughout the growing season. Melinex tapes collected weekly from the trap were cut in 48-mm strips representing 24-hr periods, mounted on glass slides, stained with 1% trypan blue in lactophenol, and examined under a compound microscope. The number of conidia of *C. asparagi* trapped during each 1-hr period was recorded. A period of seven successive days from 21 to 28 August 1984 was selected to illustrate the average count of spores of *C. asparagi* in relation to the time of day, average hourly temperature, and relative humidity. Temperature and relative humidity were recorded in the plots with a hygrothermograph (Belfort Instrument Company, Baltimore, MD), and rainfall data were obtained with a recording rain gauge

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(Belfort). Maneb-zinc sprays were applied at 4.7 L/ha four times between 21 June and 10 August 1984.

RESULTS

Overwintering. *C. asparagi* survived in asparagus debris from December until May at both locations and during both years in the two aboveground treatments. *C. asparagi* did not survive in buried stems collected after 17 February 1983 or 10 December 1984 (Table 1). Few conidiophores and conidia ($P = 0.05$) developed on asparagus debris buried 15 cm deep than on residues that overwintered on the soil surface or were suspended above the soil surface. The number of sporulating stroma on the soil-surface samples was significantly smaller than that on those suspended in the air or from intact plants ($P = 0.05$). The width of the stem piece did not appear to significantly affect the ability of *C. asparagi* to survive. Sample stems stored at 4 C contained viable *C. asparagi* throughout the study and were not included in analysis.

Aerobiology (seasonal periodicity). Patterns of the seasonal occurrence of airborne conidia of *C. asparagi* for 1984 are presented in Figure 1. Similar patterns were observed in 1983, except fewer spores were trapped. Conidia were first detected in April. Few airborne conidia were collected through June; most were collected August to September. Daily totals during this period varied from 28 to 1,389 conidia per cubic meter of air. Although *C. asparagi* conidia were apparently present as early as April, lesions were not detected until 1 July 1983 or 19 June 1984. Rapid disease progression occurred during late August and September and was associated with the development of the asparagus canopy. Fungicide sprays did not appear to have a direct effect on the numbers of spores trapped.

Aerobiology (diurnal periodicity). The incidence of airborne conidia generally followed a diurnal pattern (Fig. 2). Conidia were trapped beginning at 0700-0800 hours; when temperature increased and humidity dropped below 90%, the number of spores trapped increased sharply. Numbers remained high until 1600 hours, then fell off toward evening. The occurrence of airborne conidia was highest between 1000 and 1300 hours; 99% of spores were trapped between 0800 and 2100 hours. Fewer conidia were observed during a rainy period than during a period immediately following a rain. After a rain, the peak catch of conidia occurred later in the day (Fig. 3). This apparent shift in spore release, however, was still related to a decrease in relative humidity.

Under conditions of drought and high temperature, low concentrations of *C. asparagi* conidia were usually observed. Rainfall amount did not correlate consistently with increased numbers of

conidia. Simple diurnal fluctuations in humidity appeared to be the major factor in spore releases.

DISCUSSION

C. asparagi overwintered in infected asparagus stems and asparagus debris in

Sampson County, North Carolina. Survival of *C. asparagi* was reduced dramatically when asparagus debris was buried in the soil and to a somewhat lesser extent when the debris was left on the soil surface. *C. asparagi* survived well on intact plants and in debris suspended above the sur-

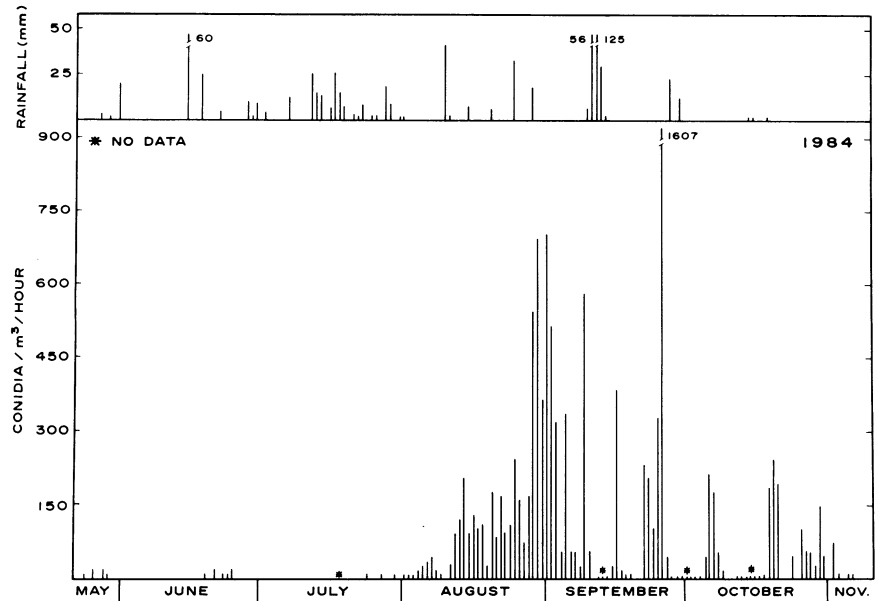


Fig. 1. Daily counts of airborne conidia of *Cercospora asparagi* collected in an asparagus field at Turkey, NC, in 1984 with a Burkard spore trap (22 May-14 November). Maneb-zinc applied at 4.7 L/ha on 21 June, 9 and 24 July, and 10 August 1984. Asterisks indicate missing data because of equipment malfunction on 18 July, 12 and 13 September, 28 September through 4 October, and 12-17 October.

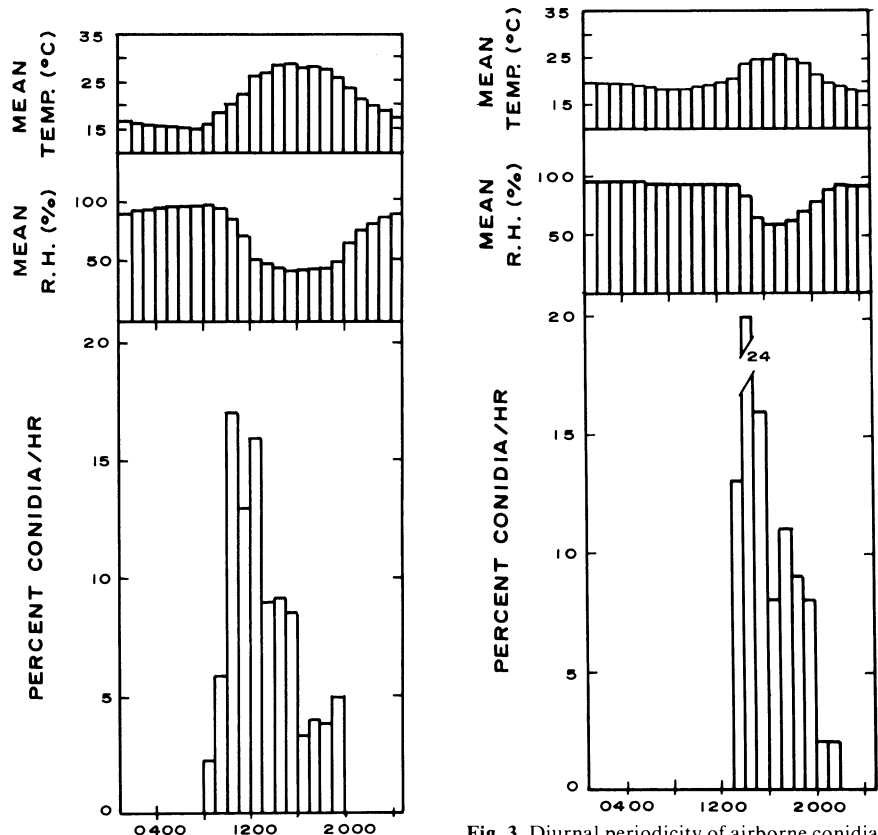


Fig. 2. Diurnal periodicity of airborne conidia of *Cercospora asparagi* in an asparagus field and average hourly temperature and relative humidity for 21-28 August 1984.

Fig. 3. Diurnal periodicity of airborne conidia of *Cercospora asparagi* in an asparagus field after rainfall (0200 hours) and hourly temperature and relative humidity for 24 August 1984.

Table 1. Relative recovery of *Cercospora asparagi* from infected asparagus stem tissue stored above the ground, on the ground, or buried at Clinton (CL), and Turkey (TK), NC, from January 1984 to June 1984 and November 1984 until May 1985

Recovery date	Treatment and location ^w								Mean
	Intact		Air		Ground		Buried		
	CL	TK	CL	TK	CL	TK	CL	TK	
	1984								
14 Nov.	2.55 ^x	1.80	1.30	1.30	0.45	0.60	0.05	0.00	1.0
10 Dec.	3.45	2.20	1.15	1.95	0.30	0.55	0.05	0.00	1.2
	1985								
19 Jan.	2.80	2.00	1.60	1.20	1.05	0.65	0.00	0.00	1.2
18 Feb.	2.50	1.55	1.25	1.55	0.65	0.70	0.00	0.00	1.0
14 Mar.	2.60 ^y	1.00 ^y	1.30	1.20	0.85	0.50	0.00	0.00	0.9
1 May	0.50 ^z	0.30 ^z	1.80	1.85	0.65	0.30	0.00	0.00	0.6
Treatment mean ^v	1.9 a		1.5 b		<1.0 c		<0.1 d		

^wIntact = stems from plants in field, air = samples placed 75 cm above soil surface, ground = samples placed on ground surface, and buried = samples buried 15 cm below surface.

^xRelative recovery of *C. asparagi*: 0 = no conidia observed, 1 = 1–5 stroma with conidia in only one lesion, 2 = two or more lesions with sparse conidia, 3 = several lesions with abundant conidia, and 4 = dense conidia in several lesions. Data represent means of observations from 10 stem segments per treatment at each of two sites per location.

^yRecently mowed debris (25 February 1985).

^vFisher's LSD ($P = 0.05$) for treatment means for 1985 is 0.18. Treatment means with different letters denote significantly different values.

face. Differences in survival were probably due to higher moisture at the soil level and below the surface that favored decomposition of the substrate and organisms antagonistic to *C. asparagi*.

In North Carolina, the cultural practice of allowing asparagus ferns to remain standing until late February favors survival of *C. asparagi*. When ferns are mowed, the debris is left on the soil surface and only disked under every 3–4 yr. Thus a substantial amount of debris remains undecomposed or partially decomposed on the ground when the new shoots emerge in April. The high incidence of this disease in the southern regions may also be related to the ability of the fungus to overwinter in the mild winter climate and to produce inoculum in the spring.

Although conidia of *C. asparagi* were trapped in April and May (Fig. 1), *Cercospora* blight lesions were not observed until 19 June. Concentrations of conidia in the air remained low until the disease began to progress rapidly in late August. Because conidia were trapped early in the season, failure of the disease to develop early does not appear to be due to absence of inoculum. Although the fields were sprayed with fungicides, no direct correlation with a decrease in

numbers of spores trapped was observed. The sprays, however, may have reduced the order of magnitude of the numbers of spores trapped throughout the season. The lower numbers of spores trapped in 1983 were probably due to the extremely high temperatures and drought conditions that existed most of the summer.

One factor that appears significant in disease development is the development of the asparagus canopy (4). As the asparagus plants develop, the ferns of adjacent plants overlap to produce a dense canopy that retains moisture and high humidity, creating a more favorable microclimate for spore germination and disease development. The age of the ferns does not appear to greatly influence lesion development, because young plants are susceptible to *C. asparagi* and lesions develop readily under greenhouse conditions. A similar pattern of seasonal periodicity has been observed for *Cercospora* spp. that affect other crops (8,9).

Diurnal periodicity of *Cercospora* spp. has been reported for several species, with maximal catches during the daytime (1,2,7,9,11). We found the greatest numbers of trapped spores of *C. asparagi* with a similar daytime peak.

The concentration of *C. arachidicola* conidia has been observed to increase

rapidly after the termination of leaf wetness (9). *C. asparagi* appears to follow the same pattern. Meredith (7) suggested that a hygroscopic response was involved in the release of *C. beticola* conidia. A decrease in vapor pressure from drying air caused detachment of conidia, which could then be easily carried by gentle air currents. A similar mechanism is likely in *C. asparagi*.

Development of *Cercospora* blight in the field is dependent on inoculum and a suitable microclimate provided by development of the asparagus canopy. In the asparagus-growing regions of North Carolina, the fungus can overwinter in asparagus plants and debris and produce conidia the following season. Because the fungus did not overwinter well in buried debris or on surface debris, earlier mowing of the asparagus ferns and disking under may help reduce initial inoculum levels and disease severity significantly.

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