

Black Leaf Spot Phase of Strawberry Anthracnose Caused by *Colletotrichum gloeosporioides* (= *C. fragariae*)

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ABSTRACT

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Since the mid-1970s, a new leaf spot of strawberries has been found in summer nurseries in Florida. Isolations from the lesions consistently yielded a *Colletotrichum* sp. identical to the original description of *C. fragariae*. In inoculation tests, an isolate from a leaf lesion and an isolate from the crown of a wilted plant incited leaf spot and typical anthracnose symptoms on stolons and petioles.

Additional key words: *Fragaria* × *ananassa*, *Glomerella cingulata*

Strawberry (*Fragaria* × *ananassa* Duch.) anthracnose was first described in 1931 by Brooks (1), who named the causal organism *Colletotrichum fragariae* Brooks. He considered anthracnose primarily a disease of stolons but reported that the pathogen occasionally attacked petioles of nursery plants. Brooks (2) later reported that the pathogen also caused rhizome rot and wilt in severely diseased nurseries during the summer. Researchers in Louisiana (4-6) reported crown rot in the fruit-production field in addition to the other three phases of the disease. Howard (7) reported a strawberry fruit rot caused by *C. fragariae*. *C. fragariae* has been reported to cause various phases of the anthracnose disease in North Carolina (9), Argentina (12), Brazil (3), India (15), and Mexico (11). All phases of the disease are common in Florida.

Several species of *Colletotrichum* or

Gloeosporium have been reported to cause anthracnose of strawberry fruits or stolons and petioles (10,14,16,17,19). Only Saccardo's report (13) describes a leaf spot, although Simmonds (14) mentions isolates of *C. acutatum* sp. nov. obtained from strawberry leaves. Since the mid-1970s, we have observed a heretofore unidentified leaf spot of strawberries in the summer nursery (8). The spots are round, usually black (sometimes light gray), and 0.5-2 mm in diameter (Fig. 1). They often become numerous on leaflets without killing them and sometimes have a water-soaked appearance during the early stages of development. This leaf spot is often found in association with anthracnose symptoms on stolons and petioles but also occurs before typical anthracnose symptoms can be found in the particular nursery. This report describes experiments to identify the pathogen causing the leaf spot.

MATERIALS AND METHODS

The two isolates used in this study conformed to the description of *C. fragariae*, but because this species may be synonymous with *C. gloeosporioides* (18), they will be referred to as *C. gloeosporioides* (*C. fragariae* type).

Isolates were obtained from leaf lesions

and crowns of wilted plants. We chose one leaf isolate and one crown isolate for this study. They were grown for 7 days on Difco potato-dextrose agar (PDA) in petri dishes. The cultures were flooded with sterilized distilled water and the resulting spore suspensions were used to inoculate strawberry plants. There were 3,200 and 4,100 spores per milliliter from the leaf and crown isolates, respectively.

Potted Tioga strawberry plants with stolons and nonrooted daughter plants were divided into three groups of five plants each. DeVilbiss atomizers were used to spray 25 ml of each spore suspension onto the stolons, leaves, and petioles of the plants in a group. Sterilized distilled water was atomized onto control plants. Each plant was covered with a clear polyethylene bag immediately after inoculation and left on a greenhouse bench. The bags were removed after 3 days. The stolons, petioles, and leaves of each plant were checked for lesions 7 and 14 days after inoculation. The plants were observed for an additional 4 mo. Daily mean

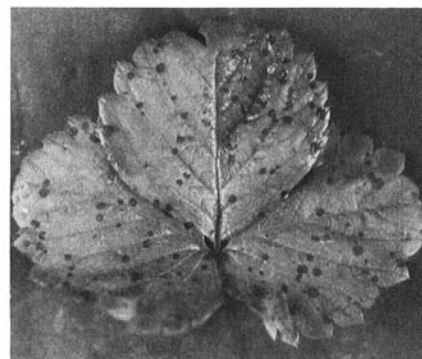


Fig. 1. Black leaf spot phase of strawberry anthracnose caused by *Colletotrichum gloeosporioides* (*C. fragariae* type).

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temperatures in the greenhouse varied from about 19 to 30 C during this period.

Four groups of 25 spores of the leaf spot isolates were measured. The measurements in each group were averaged to obtain a range of average spore size for this isolate. Measurements were made from 7-day-old cultures grown on PDA under constant fluorescent lighting (40W cool-white) and temperatures of about 25 C.

RESULTS

Seven days after inoculation, minor lesions (less than 1 cm long) were abundant on petioles of mother and daughter plants and on stolons of all plants inoculated with either isolate. Data on major lesions (1 cm or longer) and leaf spot 7 days after inoculation are shown in Table 1. Data for 14 days after inoculation are not shown because there were only slight differences between the 7- and 14-day periods. Major lesions were abundant on stolons and petioles of daughter plants. Black leaf spots identical to the black leaf spots in the field were present on leaves of mother and daughter plants inoculated with either isolate. *C. gloeosporioides* (*C. fragariae* type) was reisolated from lesions on stolons, petioles, and leaves of plants inoculated with either isolate.

All plants inoculated with the leaf spot isolate died within 4 mo. The first died from crown rot 78 days after inoculation. Three plants inoculated with the crown isolate developed crown rot and died. The first two of these died 64 days after inoculation. No anthracnose lesions developed on any of the control plants until about 2 mo after the experiment began, when lesions developed on three stolons, apparently from natural infection. None of the control plants developed crown rot. In a repetition of this trial, results were similar, although slightly fewer lesions developed in each series, apparently because lower inoculum levels were used.

The range of average spore measurements for the leaf spot isolate was 17.2–18 × 6.2–6.5 μm. This is slightly larger than the average spore size of 16.4 × 4.8 μm given in the original description of *C. fragariae* (1).

DISCUSSION

This work indicates that black leaf spot of strawberry is another phase of anthracnose and is caused by the *C. fragariae* type of *C. gloeosporioides*. Isolates from leaf spots or rotting crowns were equally capable of causing black leaf spot, crown rot, and typical anthracnose lesions on stolons and petioles.

The annual hill system of strawberry production is used in Florida. Plants are grown in nurseries during the summer and transplanted into fruit-production fields in the fall. Anthracnose is a devastating disease that sometimes

Table 1. Numbers of major lesions on stolons and petioles and number of leaves showing black leaf spot after inoculation with *C. gloeosporioides* (*C. fragariae* type) isolates from black leaf spot lesions and infected strawberry crowns

Isolate source	Mother plants		Stolons		Daughter plants		
	No. of leaves ^a	No. of leaves with spots	No. of stolons ^b	No. of major lesions ^c	No. of leaves ^d	No. of leaves with spots	No. of major lesions on petioles ^c
Check	62	0	27	0	48	0	0
Leaf	50	9	19	57	42	22	18
Crown	45	10	20	55	38	21	15

^aNumber of leaves on five plants in each series.

^bNumber of stolons on five plants in each series.

^cLesions 1 cm or longer.

^dTotal leaves on all daughter plants produced by five mother plants in each series.

destroys entire nurseries. When plants from nurseries that appear to have a moderate incidence of disease are transplanted into the fruit-production field, as many as 80% of the plants sometimes die from crown rot by March. Plants produce fruit from December through April, with peak production occurring in March and early April. Thus, high plant loss in a field results in a very large loss to the grower. The black leaf spot phase of anthracnose often is the first symptom of anthracnose in the strawberry nursery. Observations during the last 6–8 yr indicate that, in Florida, black leaf spot can serve as an early warning that anthracnose is present. Control measures can then be intensified in this early stage of development to control the disease before severe outbreaks occur.

According to von Arx (18), the binomial *C. fragariae* is synonymous with *C. gloeosporioides* Penz., the teleomorph of which is *Glomerella cingulata* (Stonem.) Spauld. & Schrenk. Researchers, however, have retained the name *C. fragariae* in reports dealing with this pathogen on strawberries. We have isolated *Colletotrichum* spp. from strawberry plants 40–75 times each year since 1968. Since 1977, about half the isolations each year have been from crowns of plants grown in Arkansas, North Carolina, or Tennessee (primarily North Carolina and Tennessee) that wilted from crown rot after being transplanted into fruit-production fields in Florida. Isolates from these plants have invariably been *G. cingulata*. Observations for 15 yr indicate there is no spread of the crown rot or foliage phases of anthracnose in fruit-production fields in Florida. Crown rot occurs in these fields only when plants from diseased nurseries are used. Therefore, the out-of-state plants apparently were infected before they were introduced into Florida.

In our laboratory, *G. cingulata* isolates from strawberry always form perithecia in culture; acervulispores are whitish or translucent and aerial conidia are less abundant than those produced by *C. fragariae*. Isolates of *C. fragariae* never form perithecia in our laboratory and acervulispores are always salmon-colored.

G. cingulata was isolated from Florida-grown plants for the first time in December 1982. Before then, all isolates obtained from Florida-grown plants had conformed to the original description of *C. fragariae* except for slight differences in spore size. Thus, if *C. fragariae* is a variant of *C. gloeosporioides* (= *G. cingulata*), the variant characteristics remained stable for many years, and typical *G. cingulata* was not isolated from Florida-grown strawberry plants until after it had been introduced into the state many times over a period of 5 yr or more in plants from other areas.

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