Root Rot of *Ficus benjamina*

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ABSTRACT

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Chlorosis, defoliation, and dieback of weeping fig (*Ficus benjamina*) were found to be partially attributable to root infection by several fungi. *Rhizoctonia solani* caused death of young plants within a few weeks after the roots or root medium were inoculated with mycelial suspensions. *Fusarium oxysporum* isolated from *F. benjamina* caused severe symptoms and subsequent death of plants inoculated 6 wk after transplanting rooted cuttings to soil mixture. *Pythium aphanidermatum* and *Cylindrocarpon* sp. isolated from *F. benjamina* caused severe infection in newly rooted cuttings but did not affect those inoculated 6 wk after transplanting. Control of the disease in early stages of development was achieved by drenching the root medium with benomyl or PCNB.

Leaf drop and subsequent deterioration of *Ficus benjamina* is a problem in public buildings, shopping malls, and greenhouses. Large plants may defoliate rapidly but may live for several months in varying stages of deterioration. Factors of light intensity, temperature, and moisture have been described as contributing to this condition (2). This paper reports research during 1980–1982 on root diseases of *F. benjamina*.

MATERIALS AND METHODS

Thirty-eight plants of *F. benjamina* showing various degrees of defoliation, chlorosis, and dieback were collected from office buildings, homes, and greenhouses at 12 locations in Ontario and Quebec. One healthy-appearing plant was also collected from each location. Root tissue from these plants was sectioned and placed on potato-dextrose agar (PDA) after immersion for 1 min in 2% sodium hypochlorite solution. Mycelium growing out into the PDA was transferred to PDA in test tubes. The resulting colonies were tentatively identified and representatives tested for pathogenicity on *F. benjamina*.

In preliminary tests, *Rhizoctonia solani* Kühn, *Pythium aphanidermatum* (Edson) Fitzp., *Fusarium oxysporum* Schlecht, and *Cylindrocarpon* sp. showed some degree of pathogenicity and were used for further testing. All fungi were propagated from single conidia, or in the case of *R. solani*, from hyphal tips.

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In initial inoculations, 20 single-conidium or hyphal-tip cultures of each fungus were mixed to produce a mass inoculum. In subsequent inoculations, single-conidium cultures were used separately.

Inoculum was prepared by scraping mycelium or mycelium plus spores or sporangia from the surface of PDA in petri dishes and diluting with sterile distilled water to the following concentrations: *P. aphanidermatum*, 60,000 sporangia per milliliter; *R. solani*, 10^5 propagules per milliliter; *F. oxysporum*, 10^6 conidia per milliliter; and *Cylindrocarpon* sp., 10^5 conidia per milliliter. Cuttings of *F. benjamina* were rooted under mist in sterile Turface (calcined montmorillonite clay chips; International Minerals & Chemical Corp., Des Plaines, IL). Ten cuttings were taken directly from the rooting medium, dipped in a spore-mycelium suspension of each fungus, and planted in soil-sand-peat moss (2:1:1) in 12-cm pots. To test pathogenicity on established plants, 10 cuttings were planted singly in 12-cm pots and allowed to grow for 6 wk. At the end of this time, spore-mycleium suspensions were placed in a syringe and introduced into the rooting medium at a rate of 200 ml/pot.

Crowns and roots of all plants were sectioned and planted on PDA in petri dishes using surface-disinfection procedures described earlier, either when a plant was considered dead or 12 wk after inoculation

To determine if the diseases could be controlled by fungicides, cuttings were rooted, planted in the soil-sand-peat mixture in 12-cm pots, and allowed to grow for 6 wk. The rooting medium was then infested in the manner described earlier with a combination of the four fungi in equal proportions. The pots were drenched with 200 ml/pot of ethazol (Truban) at 0.25 g a.i./L, fenaminosulf (Dexon) at 0.25 g a.i./L, benomyl (Benlate) at 0.35 g a.i./L, PCNB (Terraclor) at 0.75 g a.i./L, ethazol plus benomyl, or fenaminosulf plus PCNB at 14-day intervals. Two intervals between inoculation and first application were investigated 2 days after inoculation and 12 days later when necrotic symptoms began to show on the leaves. Ten plants per treatment were used and final observations made 12 wk after inoculation.

RESULTS

Of the 38 plants examined, 18 yielded *R. solani*, 11 yielded *Cylindrocarpon* sp., 8 yielded *F. oxysporum*, and 6 yielded *P. aphanidermatum*. Nine plants showed badly decayed roots, but only bacteria were isolated and these were not tested for pathogenicity

Cylindrocarpon sp. occurred in association with either *R. solani* or *P. aphanidermatum*. *P. aphanidermatum* was not found in association with *R. solani* in any of the plants. *F. oxysporum* alone was isolated from five plants showing severe root rot. Both *F. oxysporum* and *R. solani* were isolated from three dead plants.

The 14 plants from which *R. solani* was isolated were severely defoliated and showed various degrees of dieback. The roots of these plants were badly discolored, and in some cases, the discoloration extended 3–4 cm above the soil line. Plants yielding only *P. aphanidermatum* showed severe chlorosis and defoliation, but dieback of the tips was not evident. In cases where only *F. oxysporum* was isolated, plants were completely defoliated and tips had died. Although some brown lesions were observed on the roots of the 12 healthy-appearing plants, no microorganisms were isolated except a species of *Trichoderma* from two of the 12 samples.

All cuttings inoculated with *R solani* immediately after removal from the rooting medium developed symptoms within 7 days (Table 1). Severe wilting occurred in most plants 3–6 days after inoculation and leaves became chlorotic about 2–3 days later. In most cases, the tips of the branches became necrotic about 10 days after inoculation (Fig. 1), but the leaves adhered for about 3 wk. None of the 30 plants inoculated with *R. solani* recovered. Cuttings inoculated with *P. aphanidermatum* became chlorotic after 7 days. Some defoliation occurred after 10 days, but most leaves remained

on the plants for 4 wk. *P. aphanidermatum* caused death in 17 of the 30 plants inoculated; the remaining 13 were still alive after 12 wk and the pathogen could not be isolated from them. *F. oxysporum* caused chlorosis within 3–5 days, followed by severe dieback (Fig. 1) and death of all plants by the end of 2 wk. *Cylindrocarpon* sp. did not induce severe symptoms on the *F. benjamina* cuttings, but some chlorosis and defoliation occurred during the second week after inoculation. These plants had recovered and new leaves had developed after 12 wk.

Six-week-old plants inoculated with *R. solani* developed symptoms more slowly than the rooted cuttings, but 4 wk after inoculation, 21 of 30 plants showed severe defoliation and dieback. Although 14 of these plants were still alive after 12 wk, the pathogen was reisolated from them. None of the nine plants that were symptomless 4 wk after inoculation showed symptoms after 12 wk and *R. solani* was not reisolated from their roots. Seven of the 6-wk-old plants inoculated with *F. oxysporum* were defoliated after 2 wk and dead after 6 wk, whereas the remaining 23 were unaffected and the roots and crowns did not yield the fungus. Some defoliation was apparent in 18 of 30 plants inoculated with *P. aphanidermatum*, but none were dead after 12 wk. The fungus was reisolated from four plants. None of the established plants inoculated with *Cylindrocarpon* sp. were significantly affected and the fungus was not reisolated from their roots.

Plants inoculated with a combination of the four fungi began to wilt 2 days after inoculation, at the time of the first fungicide application. Within 1 wk, plants treated with benomyl or PCNB, or combinations including these chemicals, had recovered and there were no observable differences between these and the uninoculated checks at the end of the test (Table 2). Ethazol and fenaminosulf did not give control. When the second group of inoculated plants was treated with fungicides (14 days after inoculation), several leaves were chlorotic and necrotic and some defoliation had occurred. The fungicide treatments had no effect on disease development, and 12 wk after inoculation, all plants were dead.

Table 1. Pathogenicity[a] of four fungi isolated from *Ficus benjamina* as indicated by type and severity[b] of symptoms on the host

Treatment	Type and severity of symptoms on *F. benjamina*			
	Chlorosis	Defoliation	Stunting	Dieback
Pythium aphanidermatum	3.1	3.3	3.0	0.0
Rhizoctonia solani	4.4	5.0	4.4	4.0
Cylindrocarpon sp.	2.2	3.0	2.0	0.0
Fusarium oxysporum	2.0	4.2	4.2	4.0
Water	1.0	0.0	0.0	0.0

[a] Average of three tests, 10 plants per treatment.
[b] Chlorosis: 0 = no yellowing, 5 = all leaves yellow. Defoliation: 0 = no leaf drop, 5 = loss of all leaves. Stunting: 0 = no stunting, 5 = plants less than one-half the height of the checks. Dieback: 0 = branch tips intact, 5 = entire branches dead.

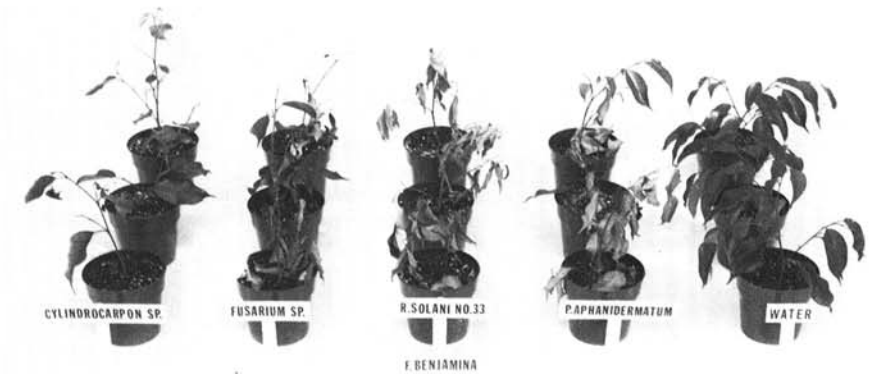

Fig. 1. *Ficus benjamina* inoculated with (left to right) *Cylindrocarpon* sp., *Fusarium oxysporum*, *Rhizoctonia solani*, *Pythium aphanidermatum*, or water. Plants were inoculated 6 wk after transplanting from rooting medium and photographed 6 wk later.

Table 2. Effects of four fungicide drenches on two groups of *Ficus benjamina* plants inoculated with a combination of four fungi

Fungicides	After 4 wk		After 8 wk		After 12 wk	
	Group 1[a]	Group 2	Group 1	Group 2	Group 1	Group 2
Benomyl	0.0[b]	2.5	0.0	4.2	0.0	5.0
PCNB	0.0	2.4	0.0	3.8	0.0	5.0
Fenaminosulf	2.0	2.6	3.5	3.3	5.0	5.0
Ethazol	2.0	2.3	3.5	3.7	5.0	5.0
Benomyl + ethazol	0.0	2.4	0.0	3.8	0.0	5.0
PCNB + fenaminosulf	0.0	2.5	0.0	4.0	0.0	5.0
Water	2.3	2.4	3.8	4.1	5.0	5.0

[a] Group 1 = first application 2 days after inoculation; group 2 = first application 14 days after inoculation.
[b] 0 = No infection, 5 = plant dead. Intermediate ratings based on degree of chlorosis, defoliation, stunting, and dieback of branches.

DISCUSSION

Very little information is available concerning *F. benjamina*, although its popularity as an indoor foliage plant has increased greatly during the last several years. It is quite tolerant of low light conditions but is susceptible to environmental changes. Nevertheless, during the past 6 yr, many plants have been examined that have suddenly defoliated and died after growing in the same location for several months.

Phomopsis cinerescens has been described as causing wilting, defoliation, and dieback of weeping fig (1). The fungus was isolated from dead twigs of *F. benjamina* at Ottawa, but attempts to infect healthy plants of several ages were unsuccessful.

Each of the four fungi I tested was capable of causing considerable damage to *F. benjamina* immediately after rooting, but established plants were somewhat resistant. *R. solani* and *F. oxysporum* were pathogenic on healthy established plants, although several plants escaped infection. *P. aphanidermatum* and *Cylindrocarpon* sp. did not cause sufficient damage to established plants to be considered serious pathogens, although they are probably able to invade plants weakened because of some other factor.

When plants were inoculated with the four fungi simultaneously, good control was achieved with either benomyl or PCNB, known to control *R. solani* and *Fusarium* spp., but not with ethazol and fenaminosulf, which give good control of *Pythium*-caused diseases.

No control was achieved when the first application of fungicide was delayed until severe disease symptoms appeared. It can be assumed that the fungicides are not effective against fungi that are established in the roots; therefore, a control program must be started when plants are transplanted from the rooting medium.

LITERATURE CITED

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