CONTROL OF BASAL STEM AND ROOT ROT OF CHRISTMAS CACTUS CAUSED BY PYTHIUM APHANIDERMATUM AND PHYTOPHTHORA PARASITICA[1]

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Abstract. **Several pathogens are capable of causing a severe basal stem and root rot of Christmas cactus. Soil fungicides were evaluated under greenhouse conditions for efficacy in control of 2 of these pathogens,** Phytophthora parasitica **and** Pythium aphanidermatum, **the latter a new pathogen to Christmas cactus reported here for the first time. Attacks by either pathogen produce a root and basal stem rot causing affected plants to turn gray-green in color. Disease development was more rapid in attacks by** P. aphanidermatum, **and phylloclade abscission more prevalent with** P. parasitica. **Of the fungicides tested, Nurelle (pyroxychlor) appeared to provide good control of both pathogens. Truban (ethazole) provided control of** P. aphanidermatum **equal to that achieved with Nurelle.**

Basal stem and root rot of Christmas cactus, *Zygocactus truncatus* Schum., caused by *Phytophthora parasitica* Dast. was first described in 1970 (1). Affected stems were noted to appear wilted and dull, gray-green in color. Basal portions of affected stems reveal at or near the soil line water-soaked but rather firm necrotic areas with faded reddish borders. Phylloclade abscission is common and often a reliable indication of the presence of *P. parasitica.*

Recently, a similar-appearing basal stem and root rot was found to be caused by *Pythium aphanidermatum* (Edson) Fitzp. The symptoms on Christmas cactus caused by *P. aphanidermatum* are similar to those caused by *P. parasitica* except phylloclade abscission is not common, and the stem rot is more rapid and lacking the faded reddish border. Under optimum conditions for disease development, the white, fluffy mycelium of *P. aphanidermatum* is often evident on diseased tissue and around the basal stem of affected plants.

These studies were undertaken to evaluate the efficacy and potential phytotoxicity of various soil fungicides for control of *P. parasitica* and *P. aphanidermatum on Z. truncatus.*

Materials and Methods

In all tests, the experimental unit consisted of 2 rooted cuttings of *Z. truncatus* 'Christmas Cheer' placed at opposite corners of 4 inch sq (Tests 1 and 3) or sides of 5 inch round (Tests 2, 4 and 5) new plastic pots. The sterilized media in Tests 1, 3 and 4 consisted of 1 part German peat and 1 part coarse builders' sand plus 7 lb dolomite, 4 oz chlordane (5%), and 1 lb Perk (minor element supplement, Kerr-Magee Chemical Company, Jacksonville, FL)/yd^3. In Tests 2 and 5, the mix was the same as previously described except the ratio of German peat to coarse builders' sand was 4:1. Five pots comprised each treatment in all tests. Pots were watered 3 times/wk, and soluble fertilizer (1 lb 20-20-20/100 gal) was included in 1 of these waterings.

Fungicides tested as drenches were: Banrot (ethazole + methyl thiophanate 15-25 WP); Dexon (diazoben 35 WP); Dithane M-45 (zinc + maneb 80 WP); Nurelle (pyroxychlor M-3858 7.2 EC, M-3860 12.4 EC, M-3994 7.2 EC, M-4109 7.2 EC); Truban (ethazole 30 WP and 25 EC); and combinations of Truban + Benlate (ethazole 30 WP + benomyl 50 WP), and Nurelle + Benlate (pyroxychlor M-4109 7.2 EC + benomyl 50 WP).

The culture of *P. parasitica* employed was isolate No. DPI-FTCC 518, obtained from the Florida type culture collection (Division of Plant Industry, Gainesville, 32602) and originally isolated from a diseased Christmas cactus stem. Inoculum consisted of a thoroughly chopped and mixed 2-wk-old oatmeal sand culture (1.4 oz Quaker Oats + 7.0 oz washed coarse builders' sand + 3-3.4 fl oz deionized water, autoclaved at 250F for 60 min and grown at 77-80F). The culture of *P. aphanidermatum* employed was isolated by the author in 1973 from a diseased Christmas cactus stem. Inoculum consisted of a thoroughly chopped and mixed 2-wk-old millet seed culture (3.5 oz millet seed + 4.4 fl oz deionized water, autoclaved at 250F for 60 min and grown at 77-80F). Each pot was infested with either 0.3 in^3 (Tests 1, 3 and 4) or

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Table 1. Efficacy of soil fungicide drenches applied to Zygocactus truncatus for control of basal stem and root rot caused by Phytophthora parasitica. Test 1, 119 days.

Treatment[y]	Oz active /100 gal	Plants remaining	Avg disease rating[z]	Top wt (% of control)
Banrot	1.8 + 3.0	6	2.2	58.1
Dexon	5.6	7	1.9	43.0
Truban EC	2.0	6	2.2	70.7
Truban WP	3.6	6	2.2	64.9
Nu 3858[x]	2.7	10	1.0	92.8
Nu 3858	5.4	10	1.0	80.0
Control	---	10	1.0	100.0
Control, infested	---	4	2.8	41.8

[z]Rooted cuttings, 2/4 inch sq pot, 5 pots/treatment. Plants obtained as rooted cuttings, selected for uniformity of size, potted 4 days prior to infestation with P. parasitica. Disease rating: 1 = none; 2 = slight; 3 = definite; and 4 = total stem rot.
[y]Drench at 6.7 fl oz/pot, 1 day after infestation.
[x]Nu = Nurelle

0.6 in³ (Tests 2 and 5) of inoculum 1 day prior to fungicide drench application. Inoculum was placed in a hole made in the soil surface in the center of each pot. Non-infested, control pots were handled similarly but received identical amounts of either sterile oatmeal sand (Tests 1, 2) or sterile millet seed (Tests 3, 4, 5).

Fungicide drenches were applied at the rate of 6.7 fl oz/4 inch sq pot (Tests 1, 3) and either 4.3 or 2.15 fl oz/5 inch round pot (Tests 2, 4, 5). Control pots received similar quantities of tap water.

Data were taken on disease severity according

Table 2. Efficacy of soil fungicide drenches applied to Zygocactus truncatus for control of basal stem and root rot caused by Phytophthora parasitica. Test 2, 101 days.

Treatment	Oz active /100 gal	Drench[y] volume (fl oz)	Plants remaining	Avg disease rating[z]	Top wt (% of control)
Dithane M-45	25.6	4.3	6	2.2	62.9
Dithane M-45	25.6	2.15	5	2.5	50.0
Truban WP	3.6	4.3	8	1.6	65.1
Truban WP	3.6	2.15	9	1.3	81.7
Nu 4109[x]	2.0	4.3	10	1.0	81.7
Nu 4109	2.0	2.15	10	1.0	94.3
Nu 4109	1.0	4.3	10	1.0	92.1
Nu 4109	1.0	2.15	9	1.3	65.7
Nu 4109 + Benlate	2.0 + 4.0	4.3	10	1.0	95.6
Control	---	---	10	1.0	100.0
Control, infested	---	---	8	1.6	69.9

[z]Two cuttings/5 inch round pot, 5 pots/treatment, cuttings selected for uniformity in size and age and rooted directly in pot 1 month prior to infestation with P. parasitica. Disease rating: 1 = none; 2 = slight; 3 = definite; and 4 = total stem rot.
[y]Applied 1 day after infestation with P. parasitica.
[x]Nu = Nurelle

Table 3. Efficacy of soil fungicide drenches applied to Zygocactus truncatus for control of basal stem and root rot caused by Pythium aphanidermatum. Test 3, 124 days.

Treatment[y]	Oz active /100 gal	Plants remaining	Avg disease rating[z] 49 days	Avg disease rating[z] 117 days	Top wt (% of control)	Root wt (% of control)	Total no. new leaves
Truban WP	3.6	5	1.0	3.1	31.3	11.9	54
Banrot WP	1.8 + 3.0	2	1.0	3.4	16.9	7.6	27
Truban EC	2.0	2	1.0	3.4	12.2	2.6	18
Dexon WP	5.6	5	1.7	2.6	39.4	11.7	56
Nu (M-3858)[x]	1.35	9	1.1	1.3	66.3	33.1	89
Nu (M-3858)	2.7	10	1.0	1.0	66.9	51.5	103
Nu (M-3860)	1.35	10	1.0	1.0	82.3	57.2	120
Nu (M-3860)	2.7	10	1.0	1.0	66.4	49.8	100
Control	---	10	1.0	1.0	100.0	100.0	120
Control, infested	---	2	2.3	3.5	10.3	7.3	10

[z]Rooted cuttings, 2/4 inch sq pot, 5 pots/treatment. Plants obtained as rooted cuttings, selected for uniformity of size, potted 3 days prior to infestation with P. aphanidermatum. Disease rating: 1 = no symptoms; 2 = slight, 3 = definite; and 4 = total stem rot.
[y]Drench at rate of 6.7 fl oz/pot, 1 day after infestation.
[x]Nu = Nurelle.

to the following scale: 1 = none; 2 = slight; 3 = definite; and 4 = total stem rot. At the conclusion of experimentation additional data were recorded on no. plants remaining, total fresh top and root wt, and total no. of new leaves produced.

Results and Discussion

In Test 1, Nurelle (M-3858) provided the best control of *P. parasitica* (Table 1). The higher concn employed appeared to be phytotoxic as is indicated by the reduced top wt of the resultant plants. At the concns and rate tested, Banrot, Truban WP and EC, and Dexon provided fair to moderate control based on no. of plants remaining and average disease rating. In Test 2 (Table 2), both Nurelle (M-4109) and Truban WP applied at their suggested concns at the rate of 2.15 fl oz/5 inch round pot (equivalent to 1 pt/sq ft of soil surface) provided control of *P. parasitica*. Similar drenches at twice the rate (4.3 fl oz/5 inch pot) were effective in control but the resultant plants weighed less (Table 2) indicating possible phytotoxicity. Nurelle was somewhat more effective in control and the differences might have been greater had the disease pressure been equal to that achieved in Test 1 (compare infested controls, Table 1 and 2). Dithane M-45 did not provide control of *P. parasitica* as it did in an earlier study (2), although the concn applied in this test at the lower rate was similar. In this study, however, drenches were made 1 day after infestation with *P. parasitica* while in the earlier study (2) drenches were applied 1 day prior to infestation. The difference noted with Dithane M-45 in the 2 studies suggest that host protection and/or fungus eradication may have taken place in the earlier study where application of Dithane M-45 occurred prior to soil infestation.

In Test 3 (Table 3) for control of *P. aphanider-*

Table 4. Efficacy of soil fungicide drenches applied to Zygocactus truncatus for control of basal stem and root rot caused by Pythium aphanidermatum. Test 4, 112 days.

Treatment	Oz active /100 gal	Drench[y] volume (fl oz)	Plants remaining	Avg disease[z] rating	Top wt (% of control)	Total no. new leaves
Truban WP	3.6	4.3	10	1.0	81.7	91
Truban WP	3.6	2.15	10	1.0	99.3	84
Truban WP + Benlate WP	3.6 + 4.0	4.3	10	1.0	86.3	85
Truban WP + Benlate WP	3.6 + 4.0	2.15	10	1.0	94.2	96
Nu (M-3994)[x]	2.0	4.3	9	1.3	97.4	85
Nu (M-3994)	2.0	2.15	10	1.0	111.0	84
Nu (M-3994)	1.0	4.3	10	1.0	117.6	93
Nu (M-3994)	1.0	2.15	9	1.3	88.5	85
Control	---	---	10	1.0	100.0	103
Control, infested	---	---	5	2.5	48.1	42

[z]Two cuttings/5 inch round pot, 5 pots/treatment, cuttings selected for uniformity in size and age and rooted for 1 month prior to potting. Infestation with P. aphanidermatum 1 day after potting. Disease rating: 1 = no symptoms; 2 = slight; 3 = definite; and 4 = total stem rot.

[y]Applied 1 day after infestation with P. aphanidermatum.

[x]Nu = Nurelle.

matum, all fungicides and concns tested appeared to be effective 49 days after infestation. After 117 days, however, only Nurelle (M-3858 and M-3860) provided good control. At the concns and rate tested, drenches of Truban WP and Dexon provided little control while Banrot and Truban EC proved ineffective. Although no plant loss occurred with several treatments, no fungicide treatment (Table 3) produced plants as good as the non-infested control. This is evidenced by fresh top wt reductions ranging from 87.8% (Truban EC) to 17.7% (Nurelle M-3860) and root wt reductions of 97.4% (Truban EC) to 42.8% (Nurelle M-3860).

In Tests 4 and 5, all fungicide treatments provided good control of *P. aphanidermatum* (Tables 4, 5). The lower volume drench of 2.15 fl oz/5 inch round pot provided the best control and subsequent plant growth indicating again the possibility of phytotoxicity occurring when either high fungicide concns or rates of applications are used on Christmas cactus. Both Nurelle (M-3994 and M-4109) and Truban WP alone or in combination with Benlate WP provided good control of this pathogen.

In these tests on Christmas cactus, Nurelle provided good control of both *P. parasitica* and *P. aphanidermatum* while proving to be relatively non-phytotoxic. The efficacy of control of pythiaceous plant pathogens is supported by previous work employing Nurelle for control of this group of pathogens (3,4,5,6,7,8,9,10). Truban WP also provided good control of *P. aphanidermatum* but the degree of control achieved against *P. parasitica* or other Phytophthoras would probably be less than that achieved with Nurelle (3,4,5,6,7,8).

The results of these tests indicate Christmas cactus may be a rather sensitive plant to soil fungicide concns, a situation similar to that previously noted for peperomia (4). Where soil fungicide drenches are applied to Christmas cactus, the lowest recommended fungicide suspension or solution concn should probably not be applied at a rate greater than 2 pt/sq ft (4.3 fl oz/5 inch round pot) of soil surface area. If the highest suggested fungicide suspension or solution concn

Table 5. Efficacy of soil fungicide drenches applied to Zygocactus truncactus for control of basal stem and root rot caused by Pythium aphanidermatum. Test 5, 101 days.

Treatment	Oz active /100 gal	Drench[y] volume (fl oz)	Plants remaining	Avg disease[z] rating	Top wt (% of control)	Total no. new leaves
Truban WP	3.6	4.3	10	1.0	92.8	52
Truban WP	3.6	2.15	10	1.0	132.6	86
Nu (M-4109)[x]	2.0	4.3	10	1.0	100.5	74
Nu (M-4109)	2.0	2.15	10	1.0	121.5	88
Nu (M-4109)	1.0	4.3	10	1.0	106.2	81
Nu (M-4109)	1.0	2.15	9	1.3	152.4	97
Truban WP + Benlate WP	3.6 + 4.0	4.3	10	1.0	92.2	68
Control	---	---	9	1.4	100.0	59
Control, infested	---	---	5	2.5	73.7	44

[z]Two cuttings/5 inch round pot, 5 pots/treatment, cuttings selected for uniformity in size and age and rooted directly in pot for 1 month prior to infestation with P. aphanidermatum. Disease rating: 1 = no symptoms; 2 = slight; 3 = definite; and 4 = total stem rot.
[y]Applied 1 day after infestation with P. aphanidermatum.
[x]Nu = Nurelle.

is employed, the drench rate should be 1 pt (2.15 fl oz/5 inch round pot) or less/sq ft. Nurelle used as a drench appears to be effective for the control of both *P. parasitica* and *P. aphanidermatum* and relatively non-phytotoxic to Christmas cactus at the concn of 1.0 - 2.0 oz active ingredient/100 gal.

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LEAF SPOT OF BLACK OLIVE CAUSED BY CRISTULARIELLA DEPRAEDANS[1]

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Abstract. **A new leaf spot was found in early summer of 1974 affecting black olive,** Bucida buceras, **growing in a nursery in Ft. Lauderdale. It was later also noticed in a field block of black olives at Goulds. The lesions were orange-tan to brown, circular to oval in shape and ranged from 2 to 10 mm in diam. Severe defoliation resulted from heavy infection under conditions of high temperature and high humidity.** Cristulariella depraedans **was consistently associated with and isolated from the leaf spots. Inoculation of healthy plants by spraying on a suspension of the fungus and keeping the plants under conditions of high humidity and warm temperatures reproduced the disease. The following fungicides provided excellent disease control: MEB 6447 25W; Benlate 50W; Dithane M45 80W; and Bravo 6F when used as protective sprays, and Triforine W524 6.5EC when used both as a protective spray and a soil drench.**

Black olive, *Bucida buceras* L., is native to the upper Florida Keys (1). It has a thick, straight trunk with a densely foliated, rounded crown. It is an excellent street and shade tree for South Florida and has high salt tolerance (2). Black olive is grown by nurserymen in containers or in the ground.

Diseased leaf specimens of black olive were received during the summer and fall of 1974 from Ft. Lauderdale and Goulds, Florida. The younger lesions were orange-tan to brown, 2 to 10 mm in diameter. As the leaf spots enlarged, they became tan to dark brown in color, often causing necrosis over 50% or more of the leaf. The disease caused severe defoliation in the nurseries, especially when the plants were crowded and under conditions of high humidity, high rainfall, and high temperatures.

The fungus was seen fruiting on the necrotic leaf tissue, with the conidiophores, when viewed under the microscope, resembling tiny shade trees. Conidia were not observed either on infected leaves or in culture. The fungus was isolated and identified as *Cristulariella depraedans* (Cke.) Hoehn.[2] It has previously been reported as a pathogen of several species of maple in England, Ger-

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[2]Identified by Dr. J. W. Kimbrough, Mycologist, University of Florida.