Etiology and Control of Phytophthora Leaf Blight of Golden-Fruited Palm

N. M. NAGATA and M. ARAGAKI, Department of Plant Pathology, University of Hawaii, Honolulu 96822

ABSTRACT

Nagata, N. M., and Aragaki, M. 1989. Etiology and control of Phytophthora leaf blight of golden-fruited palm. Plant Disease 73:661-663.

Necrotic brown flecks and rapidly forming, large, angular to irregularly shaped leaf spots of *Chrysalidocarpus lutescens* (golden-fruited palm) were shown to be caused by *Phytophthora nicotianae*. The disease was confined to single outbreaks on the Hawaiian islands of Oahu and Kauai. Among Palmae tested, *Pritchardia thurstonii, Ptychosperma macarthurii, Areca* sp., *Pinanga* sp., and *Thrinax* sp. were susceptible to *P. nicotianae*. Metalaxyl and fosetyl-Al applied as either foliar sprays or drenches provided effective control of this disease in greenhouse tests.

Additional keywords: areca palm, *Phytophthora parasitica*

Chrysalidocarpus lutescens (Bory) H. Wendl. (= *C. lutescens* Bory), commonly known as golden-fruited palm or areca palm, has been used in the tropics and subtropics for landscaping as well as interior decorating. Diseases reported on golden-fruited palm include leaf spots caused by *Bipolaris setariae* (Saw.) Shoemaker, *Exserohilum rostratum* (Drechs.) Leonard & Suggs, *Phaeotrichoconis crotalariae* (Salam & Rao) Subram. (4), and *Phytophthora palmivora* (Butl.) Butl. (13).

Journal Series No. 3296, Hawaii Institute of Tropical Agriculture and Human Resources.

Accepted for publication 27 February 1989.

In 1980, a severe seedling blight of golden-fruited palm was observed at nurseries on the Hawaiian islands of Oahu and Kauai. The disease was characterized by elongate, irregularly shaped, blackish gray to brown necrotic leaf spots, which frequently expanded into the terminal bud and killed plants. The causal organism was identified as *Phytophthora nicotianae* B. de Haan (10,16,17), on the basis of sporangial and gametangial characteristics.

This study was undertaken to investigate the etiology of Phytophthora blight of golden-fruited palm and the pathogenicity of *P. nicotianae* to other hosts and to evaluate fungicidal control measures. A preliminary report of this research has been published (9).

MATERIAL AND METHODS

A single-zoospore isolate was obtained from each of four cultures of *P. nicotianae* from diseased leaves of

golden-fruited palm from the islands of Oahu (isolates H489 and H490) and Kauai (isolates H491 and H492). Inoculum for pathogenicity and control studies was first grown on 9 ml of 5% V-8 juice agar (5% V-8 juice, 0.2% $CaCo_3$, and 1.8% agar in deionized water) in 50-mm-diameter petri plates for 3 days at 22–24 C under continuous fluorescent light (2,700 lux); then 10 ml of sterile distilled water was added, and incubation was resumed for 3 additional days. Mycelial mats with sporangia were harvested by scraping the agar surface, then suspended in distilled water, and incubated at 16 C for 20–30 min for zoospore release. The suspension was passed through tissue paper to separate zoospores from mycelial fragments. Inoculum levels for pathogenicity studies were adjusted to 1×10^5 zoospores per milliliter.

The following palm species were tested for susceptibility to isolates of *P. nicotianae*: *Areca catechu* L., *Areca* sp., *Chrysalidocarpus lutescens, C. madagascariensis* Becc. var. *lucubensis* Jumelle & Perr., *Caryota mitis* Lour., *Chamaedorea cataractarum* Mart., *C. elegans* Mart., *C. seifrizii* Burret, *Cocos nucifera* L., *Phoenix* sp., *Pritchardia thurstonii* F. J. Muell. & Drude, *Pinanga* sp., *Ptychosperma macarthurii* (H. Wendl.) Nicholas., *Roystonea regia* (HBK) O. F. Cook, *Thrinax* sp., and *Veitchia merrillii* (Becc.) H. E. Moore. Coconut seedlings were collected and planted directly in potting soil in 25-cm-diameter pots. Seeds of other palms were germinated in vermiculite and then transplanted into 7.5-cm-square pots.

Chrysalidocarpus lutescens was inoculated with isolates H489, H490, H491, and H492; the other palm species were inoculated with cultures H490 and H492. Five plants from each palm species were inoculated at the two- to four-leaf stage by being sprayed to runoff, incubated in moisture-saturated plastic bags in the laboratory for 24 hr, and then taken to the greenhouse. The plants were evaluated 3 wk later for disease incidence and severity by the following index: 0 = no disease; 1 = flecks or lesions expanding to 5 mm; 2 = lesions 6 mm long to one-third the length of the leaflet blade; 3 = more than one-third of the leaflet blade diseased; 4 = plant dead.

Carica papaya L. (papaya), *Ananas comosus* (L.) Merr. (pineapple), *Lycopersicon esculentum* Mill. (tomato), *Cordyline terminalis* (L.) Kunth (ti), *Solanum melongena* L. (eggplant), *Anthurium scherzeranum* Schott (pigtail anthurium), *Euphorbia pulcherrima* Willd. ex Klotzsch (poinsettia), and *Dendrobium* sp., all previously reported to be susceptible to *P. nicotianae* in Hawaii, were inoculated with isolates H490 and H492. *Ricinus communis* L. (castor bean) and *Nicotiana tabacum* L. (tobacco) plants were inoculated with all four isolates.

Fruits of papaya, tomato, and eggplant were harvested from field-grown plants at the color break stage. Pineapple, ti, poinsettia, anthurium, dendrobium, castor bean, and tobacco plants were grown in potting soil in 7.5-cm-square pots. For each species, five plants or fruits were inoculated and incubated as previously described. The plants were placed in the greenhouse for 3 wk, and the fruit was left in the laboratory for 5 days for disease development. All inoculations were repeated once.

Four fungicides selected for control studies were diluted in aqueous Tween 20 (1:2,000) to the following concentrations: metalaxyl, 80 ppm a.i.; fosetyl-Al, 9,600 ppm a.i.; propamocarb HCl, 2,888 ppm a.i.; and ethazol, 268 ppm a.i. These were applied to five golden-fruited palms as a foliar spray to runoff or as a drench of 20.6 ml per 7.5-cm-square pot (100 gal./800 sq. ft). The palms were inoculated 7 days later with isolate H490 at 5×10^5 zoospores per milliliter and then incubated and evaluated as previously described. Inoculated and uninoculated untreated plants served as controls. These tests were performed four times.

RESULTS

All four isolates of *P. nicotianae* were pathogenic to golden-fruited palm seedlings (Table 1). Symptoms of the disease ranged from necrotic brown flecks to angular to irregularly shaped leaf spots, to severe blighting, occasionally with a yellow border around lesions (Fig. 1). Diseased tissue was blackish gray in the first few days of infection and turned tan to brown as the blight progressed. Disease development was very rapid, with lateral spread somewhat restricted by the larger parallel veins. Leaf lesions were typically 5–40 mm long, or up to one-third the length of the leaflet, with the infection confined to the lamina. When an emerging leaf became infected, the blight occasionally spread into the unfurled leaflets, killing the terminal bud and the plant. Palms were rarely killed following artificial inoculations, although dead plants were commonly observed in field infections.

Other palms found susceptible to these isolates included *Areca* sp., *Pinanga* sp., *Pritchardia thurstonii, Ptychosperma macarthurii*, and *Thrinax* sp. Foliar symptoms appeared as necrotic flecks or angular to irregularly shaped leaf spots, several centimeters in length. Eggplant, tomato, and papaya fruits and dendrobium, pigtail anthurium, and castor bean plants were highly susceptible to these isolates, with inoculation resulting in severe fruit rots, blight, or plant death. Other plants tested were not infected by these isolates.

Metalaxyl at 80 ppm a.i. and fosetyl-Al at 9,600 ppm a.i. provided significant control of Phytophthora leaf blight of golden-fruited palm in both spray and drench applications (Table 2). Metalaxyl was more effective as a drench; fosetyl-Al gave better protection as a spray.

Ethazol and propamocarb HCl were ineffective in controlling this disease at the rates used. None of the four fungicides were phytotoxic to golden-fruited palm.

Table 1. Pathogenicity of four *Phytophthora* isolates on golden-fruited palm

Isolate[w]	Plants infected (%)[x]	Leaves infected (%)[y]	Disease index[z]
H489	100	50	2.2
H490	100	87	2.3
H491	90	47	1.9
H492	80	40	2.3
Control	0	0	0.0

[w] Isolates from golden-fruited palm.
[x] Based on 10 plants per isolate (five plants per test).
[y] Based on 30 leaves (three leaves per plant).
[z] Disease severity on leaves: 0 = no disease; 1 = flecks or lesions expanding to 5 mm; 2 = lesions 6 mm long to one-third the length of the leaflet; 3 = more than one-third of the leaflet blade diseased; 4 = plant dead.

DISCUSSION

This is the first report of *P. nicotianae* parasitizing golden-fruited palm. Five *Phytophthora* spp. have been recorded on palms. *P. palmivora* has been found on *Cocos nucifera* and *Borassus flabellifer* L. (2), *Elaeis guineensis* Jacq. (7), *Washingtonia robusta* H. Wendl. (1), *Chrysalidocarpus lutescens* (13), *Chamaedorea elegans*, and *C. seifrizii* (Nagata, 1984, *unpublished*). *P. nicotianae* has been observed on *Howea forsterana* (C. Moore & F. J. Muell.) Becc. (3) and *W. filifera* (Linden) H. Wendl. (5). *P. arecae* (Coleman) Pethyb. has been known to infect areca-nut palm and coconut (6). Recently, two other species, *P. katsurae* Ko & Chang and *P. heveae* Thompson, have been reported to cause fruit rots (11,12) and bud rots (12) of coconut. In 1979, Keim et al found an unidentified *Phytophthora* sp. causing a collar rot on *W. robusta* (8).

In 1896 J. van Breda de Haan first described *P. nicotianae* on tobacco, and in 1913 J. F. Dastur reported *P. parasitica* on castor bean. In an extensive treatment of the genus *Phytophthora*, Tucker (16) noted that de Haan's

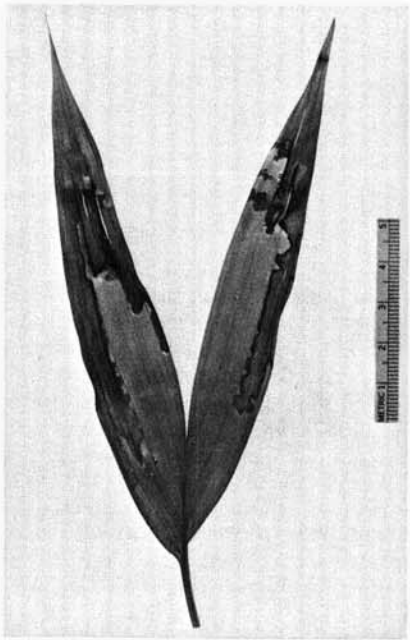

Fig. 1. Phytophthora leaf blight of golden-fruited palm, with lateral spread restricted by parallel veins.

Table 2. Fungicidal control of seedling blight of golden-fruited palm caused by *Phytophthora nicotianae*[w]

Treatment[x]	Concentration (a.i., ppm)	Sprayed		Drenched	
		Infected leaves (%)[y]	Disease index[z]	Infected leaves (%)[y]	Disease index[z]
Metalaxyl	80	50	0.6 b	25	0.2 a
	5	80	1.0 c	85	1.0 bc
Fosetyl-Al	9,600	10	0.2 a	75	0.7 b
	1,200	60	0.9 bc	75	1.0 bc
Ethazol	268	82	1.2 c	80	1.1 c
	67	88	0.9 bc	85	0.9 bc
Propamocarb HCl	2,888	95	1.3 c	85	1.0 bc
	1,444	90	1.3 c	85	1.2 c
Inoculated control	—	95	1.3 c	95	1.2 c
Uninoculated control	—	0	0.0	0	0.0

[w] Isolate H490 from palm.
[x] Fungicides applied 7 days prior to inoculation.
[y] Based on 40 leaves from four tests (five plants per test, two leaves per plant).
[z] Disease severity on leaves: 0 = no infection; 1 = flecks or lesions expanding to 5 mm; 2 = lesions 6 mm long to one-third the length of the leaflet; 3 = more than one-third of the leaflet diseased; 4 = plant dead. Means in same column followed by same letter do not differ significantly at the 5% level, according to Duncan's multiple range test.

description of *P. nicotianae* was incomplete and was a source of confusion to later workers. He observed that apart from pathogenicity, tobacco black shank isolates were identical to *P. parasitica*. Tucker supported the binomial *P. parasitica* for the fungus but also considered *P. p.* var. *nicotianae* to be appropriate for isolates pathogenic to tobacco. Similarly, Waterhouse (17) found no difference between the groups but retained *P. nicotianae* on the basis of priority. Tsao and Sisemore (15) also found no difference between the two groups. In a recent study, Cacciola and Magnano di San Lio found that morphological characteristics of several isolates fit both groups and elected to apply the name *P. nicotianae* to a root rot organism of prickly pear cactus (3).

Field and nursery surveys conducted on the islands of Oahu, Maui, Kauai, and Hawaii did not uncover any further *Phytophthora* outbreaks on golden-fruited palm or other palm species. Absence in the field suggested the disease to be one of potted nursery seedlings.

This disease occurred at nurseries during periods of high moisture, with no preventive fungicidal control practices. Overcrowding of plants and overhead sprinkler systems contributed to high humidity and excessive moisture, favoring infection and disease development. Disease management should include consideration for increased plant spacing, maintaining dry foliage by drench irrigation, and preventive chemical control.

Metalaxyl applied as a drench at 80 ppm a.i. and fosetyl-Al sprayed at 9,600 ppm a.i. were very effective in controlling this disease on golden-fruited palm. Metalaxyl, through root absorption and subsequent protection of leaves, was the best among the systemic fungicides tested, with fosetyl-Al also providing significant control. These results are compatible with other observations for rapid root absorption and acropetal translocation of metalaxyl and fosetyl-Al applied as drenches (14). In spray applications, fosetyl-Al provided better control than metalaxyl. However, the high concentrations of fosetyl-Al as a foliar spray left a visible residue on leaves, requiring removal before marketing.

LITERATURE CITED

1. Atilano, R. A. 1982. Phytophthora bud rot of Washingtonia palm. Plant Dis. 66:517-519.
2. Butler, E. J. 1906. Some diseases of palms. Agric. J. India 1:299-310.
3. Cacciola, S. O., and Magnano di San Lio, G. 1988. Foot rot of prickly pear cactus caused by *Phytophthora nicotianae*. Plant Dis. 72:793-796.
4. Chase, A. R. 1982. Dematiaceous leaf spots of *Chrysalidocarpus lutescens* and other palms in Florida. Plant Dis. 66:697-699.
5. Darley, E. F., and Wilbur, W. D. 1953. Phytophthora trunk rot of Washington palms. (Abstr.) Phytopathology 43:469-470.
6. Gadd, C. H. 1927. The relationship between the Phytophthorae associated with the bud-rot diseases of palms. Ann. Bot. 41:253-280.
7. Joseph, T., and Radha, K. 1975. Role of *Phytophthora palmivora* in bud rot of coconut. Plant Dis. Rep. 59:1014-1017.
8. Keim, R., Klure, L. J., and Zentmyer, G. A. 1979. Collar rot of Washington palms in containers. Plant Dis. Rep. 63:718-720.
9. Nagata, N. M., and Aragaki, M. 1985. Phytophthora blight of golden-fruited palm (*Chrysalidocarpus lutescens*). (Abstr.) Phytopathology 75:1382.
10. Newhook, F. J., Waterhouse, G. M., and Stamps, D. J. 1978. Tabular key to the species of *Phytophthora* de Bary. Mycol. Pap. 143. Commonw. Mycol. Inst., Kew, Surrey, England. 20 pp.
11. Ooka, J. J., and Uchida, J. Y. 1984. *Phytophthora katsurae* fruit rot of coconut in Hawaii. (Abstr.) Phytopathology 74:816.
12. Quillec, G., and Renard, J. L. 1984. La pourriture à *Phytophthora* du cocotier. Oleàgineux 39:143-147.
13. Roldan, E. F., and Luczon, C. U. 1953. Phytophthora blight of ornamental palmera palm seedlings (*Chrysalidocarpus lutescens* Wendl.). Philipp. J. For. 9:43-53.
14. Schwinn, F. J. 1979. Control of Phycomycetes: A changing scene. Pages 791-802 in: Proc. Br. Crop Prot. Conf. Pests Dis.
15. Tsao, P. H., and Sisemore, D. J. 1978. Morphological variability in *Phytophthora parasitica* (*P. nicotianae*) isolates from citrus, tomato, and tobacco. (Abstr.) Phytopathol. News 12:213.
16. Tucker, C. M. 1931. Taxonomy of the genus *Phytophthora* de Bary. Univ. Mo. Agric. Exp. Stn. Res. Bull. 153. 208 pp.
17. Waterhouse, G. M. 1963. Key to the species of *Phytophthora* de Bary. Mycol. Pap. 92. Commonw. Mycol. Inst., Kew, Surrey, England. 22 pp.