630 US ISSN 0271-9916 August 1991 RESEARCH EXTENSION SERIES 129

PHYTOPHTHORA DISEASES OF ORCHIDS IN HAWAII

J. Y. Uchida and M. Aragaki

HITAHR • COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES • UNIVERSITY OF HAWAII

Library of Congress Cataloging-in-Publication Data

The Library of Congress has catalogued this serial publication as follows:

Research extension series / Hawaii Institute of Tropical Agriculture and Human Resources.—001—[Honolulu, Hawaii]: The Institute, [1980–
v. : ill. ; 22 cm.
Irregular.
Title from cover.
Separately catalogued and classified in LC before and including No. 044.
ISSN 0271-9916 = Research extension series - Hawaii Institute of Tropical Agriculture and Human Resources.
1. Agriculture—Hawaii—Collected works. 2. Agriculture—Research—Hawaii—Collected works. I. Hawaii Institute of Tropical Agriculture and Human Resources. II. Title: Research extension series - Hawaii Institute of Tropical Agriculture and Human Resources.
S52.5R47 630'.5—dc19
85-645281

AACR 2 MARC-S
Library of Congress [8506]

THE AUTHORS

J. Y. Uchida is assistant professor of plant pathology in the Plant Pathology Department, University of Hawaii at Manoa, Honolulu.

M. Aragaki is a plant pathologist in the same department.

The authors thank the Governor's Agricultural Coordinating Committee and the Dendrobium Orchid Growers Association of Hawaii for supporting research programs making this work possible.

CONTENTS

Figures

PHYTOPHTHORA DISEASES OF ORCHIDS IN HAWAII

J. Y. Uchida and M. Aragaki

INTRODUCTION

Species of *Phytophthora* cause major plant diseases throughout the world. Tropical and subtropical *Phytophthora* species cause well known diseases of vegetable crops such as tomato, pepper, eggplant, and taro; of fruits such as papaya, avocado, pineapple, and cacao; and of ornamentals such as ti, african violet, philodendron, ivy, and spathiphyllum.

In Hawaii, *Phytophthora palmivora* is a major fungal pathogen of orchids, causing large black foliar rots, root losses, and seedling damping-off of *Dendrobium*, *Cattleya*, *Epidendrum*, *Vanda*, *Paphiopedilum*, *Laeliocattleya*, and a few other intergeneric hybrids. Recently, it has also been associated with blossom spots and rots of *Dendrobium* and *Vanda*.

Phytophthora nicotianae (commonly known as *P. parasitica*) also occurs on most of the above orchids. *Phytophthora cinnamomi* is an occasionally important pathogen of cymbidium roots, and *P. cactorum* has also been observed on cymbidium, but only infrequently.

DISEASE AND SYMPTOMS

Disease symptoms caused by *P. palmivora* and *P. nicotianae* are very similar. Microscopic examinations of fungal cultures are required to distinguish and identify each species. Accurate identification of the *Phytophthora* species involved in disease outbreaks is important in preventing cross-contamination with non-orchid host plants. In other aspects of disease management, such as fungicide control or sanitation practices, recommended practices are the same, irrespective of the species of *Phytophthora* involved.

Young orchid seedlings of many genera are highly susceptible to damping-off caused by *Phytophthora* species (Figure 1). Seedlings infected with *Phytophthora* typically have water-soaked leaf lesions, pseudobulb or stem rots, and root loss. Many young plants are eventually killed. Root rots of seedlings also cause chronically weakened plants that grow slowly and fail to thrive as they mature.

Small, young dendrobium plants infected with *Phytophthora* have leaf spots, which begin as small, water-soaked areas. These rapidly expand into scalded or blistered spots with irregular, dark green water-soaked borders and greenish-tan centers (Figure 2). Under moist conditions, these blisters expand and become brown to brownish black or gray, and the leaf quickly yellows and dies. If conditions become dry, scald spots and rots become sunken and brown (Figure 3). Fungal sporulation occurs in the field during prolonged wet periods. Hyphae and sporangial masses of *P. nicotianae* will appear cottony, loose, and white and may even glisten with tiny water droplets (Figure 4), while *P. palmivora* produces a flat, compact, crusty mass of off-white to creamy spores. Overlapping leaves on plants arranged in flats provide easy movement of the pathogen, and many plants are lost (Figure 5). On large plants, lesions are usually sunken, dry, and brown to dark brown with pale centers (Figure 6). The leaves eventually turn yellow and fall off.

Cane rots generally begin on sheaths but can also start as independent lesions on the cane. Alternatively, the fungus enters the cane through infected leaves or the apical tip, and the disease progresses down the cane. Apical tip infections can resemble bacterial infections (Figure 7). Infected canes are yellow-brown to brown externally, brown to black internally (Figure 8), and in general do not emit the foul odors associated with bacterial cane rot. The significance of foul odors for distinguishing diseases caused by *Phytophthora* as opposed to bacterial diseases is greatly reduced by the fact that secondary invasion by saprophytic bacteria can also generate unpleasant odors. Severely diseased canes are prone to breakage and frequently fall over in the pot or field (Figure 9).

Pathogenicity tests in our laboratory showed that in cultivar UH 232 ('Uniwai Supreme'), all tissues were susceptible to *P. palmivora*, although young leaves, new shoots, and flowers succumbed more rapidly than the mature, hardy leaves of older canes.

On cattleya, *Laeliocattleya*, and related hybrids, leaf and pseudobulb rots caused by

Figure 1. Leaf spots, root rots, and stunting of seedlings caused by *Phytophthora*.

Figure 2 (right). Leaf spot and severe rot of dendrobium caused by *P. palmivora*. Note blisters and water-soaking.

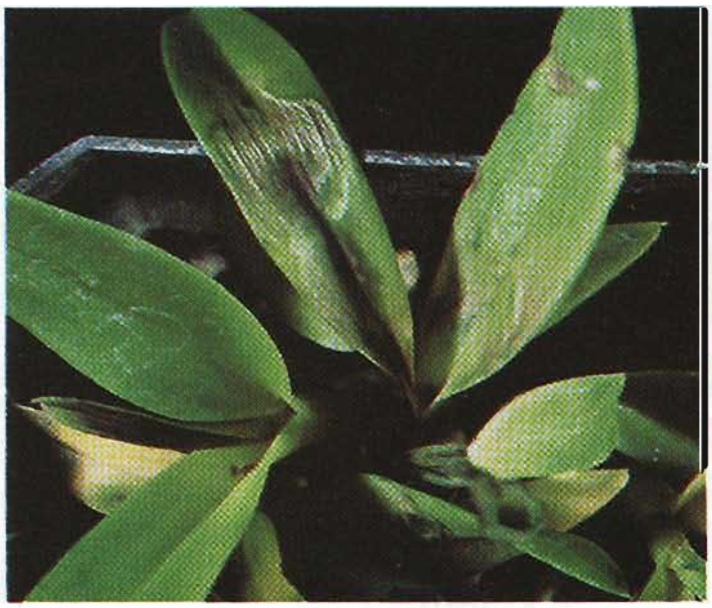

Figure 3. Young dendrobium plants with dried, sunken, brown leaf lesions, apical leaf rot, and yellowing of infected leaves.

Figure 4. Sporangial mass and hyphal strands of *P. nicotianae*.

P. palmivora are usually dark brown to black (Figures 10, 11). After leaf infection, the organism moves rapidly through the leaf and pseudobulb. Large leaves may blacken in a few weeks and then fall off. The fungus usually infects and initiates a gradual rot of the pseudobulb shortly before leaf abscission, and infected pseudobulbs harbor the pathogen for long periods. While young plants are killed quickly, large, mature plants decline gradually and may not die for many years.

Leaf spots and rots of vanda are similar to those on dendrobium and cattleya. They begin as water-soaked spots and progress rapidly to large,

Figure 5. A *Phytophthora* outbreak on dendrobium seedlings.

Figure 6. Sunken, dark lesions on mature dendrobium cane.

Figure 7. Apical tip rot caused by *Phytophthora*. Note water-soaking.

Figure 8. Longitudinal section of dendrobium shoot showing internal rot caused by *Phytophthora*.

Figure 9. Leaf spot, leaf yellowing, advanced stalk rot, and toppling of infected canes of dendrobium.

Figure 10 (right). Black rot of cattleya pseudobulb caused by *P. palmivora*.

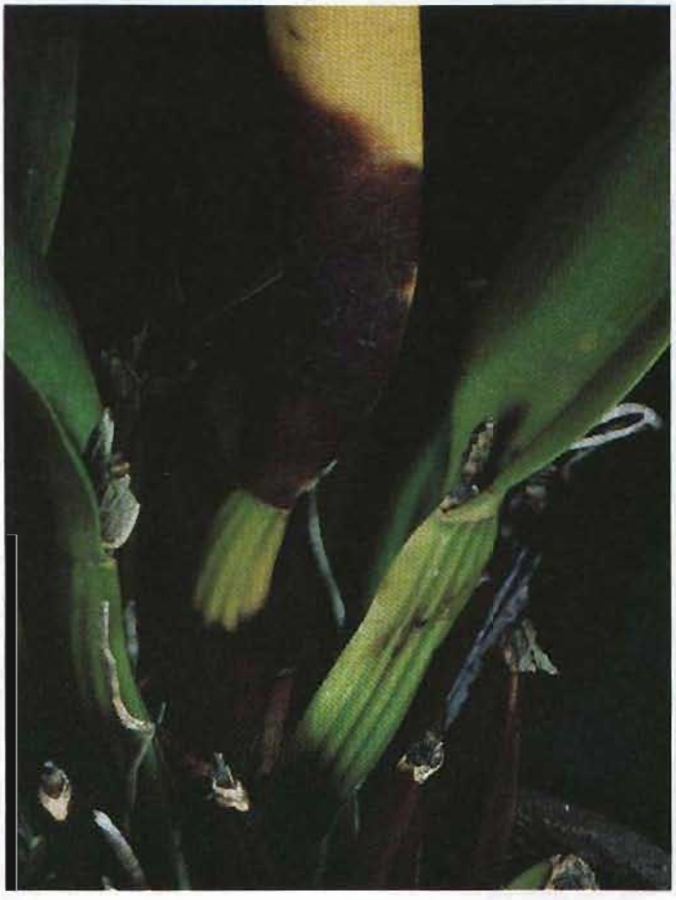

Figure 11. Leaf necrosis, and pseudobulb rot originating at the base.

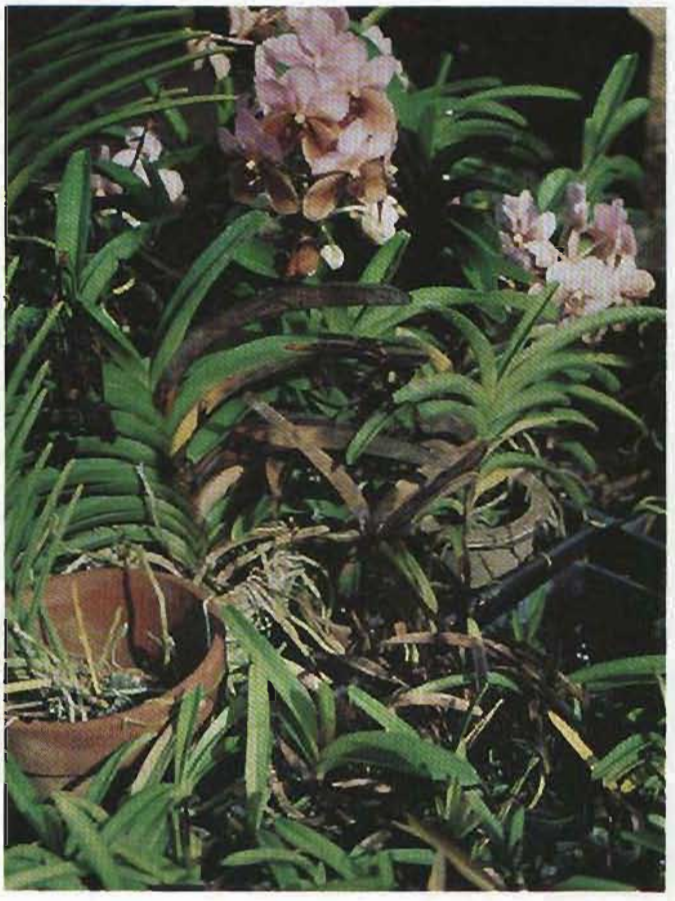

Figure 12. *Phytophthora* blight of vanda.

Figure 13. Dendrobium flower spots and rots caused by *Phytophthora*.

Figure 14 (right). Flower rot of vanda caused by *Phytophthora*.

Figure 15 (below). Spike and blossom rot caused by *Phytophthora*.

dark rots followed by leaf loss (Figure 12). The stem is less readily invaded but will also eventually succumb, resulting in loss of young plants. Basal rots of larger plants can be cut off, and the uninfected top may be salvaged with proper disinfestation.

Phytophthora causes serious diseases of dendrobium blossoms (Figure 13), buds, and spikes. Lesions on flowers begin as small, water-soaked spots that rapidly expand into large, wet, translucent rots, which may resemble the gray mold disease caused by *Botrytis* spp. Gray mold is characterized by soft rot and is usually accompanied by powdery masses of gray-brown *Botrytis* spores, not present in *Phytophthora* blights, unless both diseases occur simultaneously. Infected blossoms may also become brown or brownish black due to colonization of dead tissue by secondary fungi producing dark mycelia or spores.

Figure 16. Dendrobium root rot, three weeks after inoculation with zoospores of *P. palmivora*.

Figure 17. Sporangia and zoospores of *P. palmivora*. Zoospore emerging through a sporangial pore; other zoospores swimming.

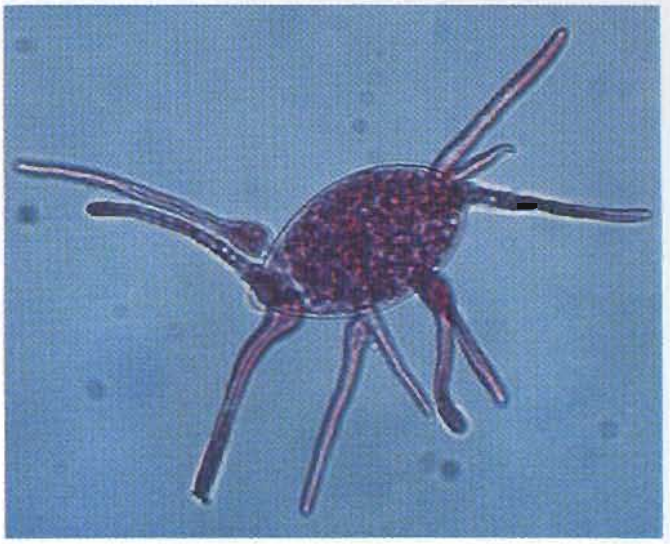

Figure 18. Sporangium germinating by producing germ tubes (stained red for contrast).

On vanda blossoms, spots and large rots are brown to dark brown, and spikes are also infected (Figures 14, 15). Flowers and petals in contact with each other enable the fungal mycelium simply to grow from one flower to the next, rapidly spreading the disease.

Root rots generally accompany foliar symptoms, as fungal spores produced on diseased leaves and flowers continually fall into the pot or field and infect roots. Plants in well drained potting media will have less severe root rots that develop slowly, as compared to plants in heavy, compact media.

In general, root rots of orchids tend to be severe, and many plants are left with very few functional roots. Commonly, only the darkened cores of larger roots are left on diseased plants. In cattleya, severe root rots result in slow-growing plants that lack vigor and are small compared with uninfected plants of the same age.

With dendrobium, plants also exhibit poor vigor and leaf yellowing, followed by premature leaf loss. Infected roots are first translucent, then turn brown (Figure 16). The fungus also moves from roots into canes and causes basal stalk rot.

CAUSAL ORGANISMS AND DISEASE SPREAD

The primary causal organisms, *Phytophthora palmivora* and *P. nicotianae*, are tropical species favored by high moisture and temperatures of 24–30°C (75–86°F). These fungi produce spherical to lemon-shaped sporangia that release smaller motile spores (zoospores), which swim in water (Figure 17).

Attracted to roots or other host tissue, zoospores migrate, encyst, and germinate by producing hyphal threads, which in turn penetrate the plants, proliferate internally, and cause disease symptoms a few days later. Young plants subjected to high levels of zoospores may be killed in a week. Sporangia also germinate directly by producing germ tubes and hyphae, which can infect the host (Figure 18).

Sporangia are usually dislodged by splashing water (e.g., rain, overhead irrigation, and mist systems) and are subsequently disseminated by air movement. These spores are also spread by careless handling of diseased plants, reusing contaminated potting media, or reusing pots or tools without disinfestation.

The placing of mature blooming plants near clean young seedlings to promote sales or for display should be avoided, as this provides a means for inoculum to splash from a symptomless but infected mature plant onto young seedlings. Even if no dead tissue, such as blackened leaves or pseudobulbs, is evident, roots may be diseased and could provide contaminating inoculum. Likewise, diseased plants hanging on racks or baskets will contaminate plants below, by the movement of fungal propagules in draining water.

Both *Phytophthora* species also produce thick-walled chlamydospores, which enable the fungus to survive long periods of desiccation. Chlamydospores are generally formed in the later stages of disease and are frequently embedded in dead or decomposing orchid tissue. In addition to resisting desiccation, chlamydospores are known to

tolerate other adverse conditions and antagonistic microorganisms.

Sexual spores, called oospores, are also thick-walled and may function as survival structures. Numerous oospores are produced when A1 and A2 types of *P. palmivora* grow together in infected plants. These oospores have been rare under natural conditions in Hawaii, probably because the A2 mating type is rare. Of 18 *P. palmivora* isolates examined, only two were A2; all the others were A1.

In a typical disease cycle, *Phytophthora* spores land near or on host tissue, germinate, and infect the host as hyphae, and the fungus proliferates in living plant tissue. Symptoms of the disease occur within a few days, and new crops of spores are produced to continue the cycle. High moisture favors abundant sporangial and chlamydospore formation on the external surface of diseased plants. Moisture reduction will decrease sporangial formation, but chlamydospore production may continue until the diseased tissue dries out. Large spore masses may be visible in the field, but in many cases, there are insufficient numbers of sporangia to form masses large enough to be seen with the unaided eye, so microscopic examinations are needed. Thousands of sporangia may be distributed on the host tissue with the potential to spread the disease.

CONTROL

Both the disease and fungal life cycles are accelerated by high moisture. Diseases that develop from "too much water" are usually the result of pathogen growth and development rather than the direct effects of water on the plant. Evidence of disease spread will develop when these wet periods exceed one week or more. Intermittent wet periods allow the fungus to grow, sporulate, spread, and infect, although serious disease symptoms may not develop until the next period of extended high moisture. Reduction of high humidity and avoidance of excess water are essential to disease control and can be attained by having solid covered greenhouses or glass houses, good ventilation, and well drained potting media.

Fungicides such as ethazol (e.g., Truban 30WP) or metalaxyl (e.g., Subdue 2E) are effective against *Phytophthora*. These chemicals should be used in conjunction with sanitation and moisture control practices to attain maximum benefits for reducing *Phytophthora* blights.

Standard sanitation procedures, such as the removal of dead and diseased plant parts, greatly reduce inoculum or spore levels and will increase the effectiveness of fungicides. Glass, plastic, cloth, or other nonmetallic tools, pots, and equipment can be disinfested with a solution of household bleach (e.g., 10 percent freshly prepared Clorox) or by the use of quatenary ammonium compounds such as Physan or Consan.

Plant cuttings from diseased stock plants should be treated with metalaxyl or other fungicides before transplanting. Diseased plants of common cultivars should be destroyed, since such plants serve as a continuous source of the pathogen. Rare, valuable plants that are infected should be kept isolated, and strict care should be taken to keep the fungus controlled and contained, to prevent contamination of other plants.

Slugs and snails are potential agents for pathogen spread. These animals may transport pathogen spores on their bodies or by ingesting spores in diseased plant tissue and later excreting viable spores.

Pathogenicity studies in our laboratory of isolates from several orchid genera, as well as from papaya, palms, ornamentals, and macadamia, reveal that there are several host-related strains of *P. palmivora*. For example, while *P. palmivora* from papaya or cacao (*Theobroma cacao*) rarely infects dendrobium, isolates of *P. palmivora* collected from cattleya, vanda, epidendrum, dendrobium, and other orchids are highly pathogenic to dendrobium but not to cacao and very rarely to papaya.

In contrast, isolates of *P. palmivora* collected from diseases of *Chamaedorea* palm, macadamia, and English ivy (*Hedera*) were also able to infect dendrobium. Orchids, *Chamaedorea*, macadamia, or English ivy infected with *P. palmivora* are thus sources of inoculum and should be destroyed or moved away from healthy orchids. Diseased papaya or cacao trees are less likely to be a source of *P. palmivora* spores capable of infecting orchids.

For *P. nicotianae*, specific cross-inoculation results involving dendrobium are not available, but other studies have shown that isolates of this fungus have broad host ranges; thus, it is quite possible that *P. nicotianae* from diseased eggplant, tomato, ti, or spathiphyllum could infect orchids and cause serious disease.

DISCLAIMER

Reference to a company or product name does not imply approval or recommendation of the product by the College of Tropical Agriculture and Human Resources, University of Hawaii, or the United States Department of Agriculture to the exclusion of others that may be suitable.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Noel P. Kefford, Director and Dean, Cooperative Extension Service, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, Honolulu, Hawaii 96822. An Equal Opportunity Employer providing programs and services to the citizens of Hawaii without regard to race, color, national origin, or sex.

RESEARCH EXTENSION SERIES 129—8/91 (3M)