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Phytophthora Blight of Papaya

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Papaya (*Carica papaya* L.) is a large, herbaceous plant native to tropical America. In Hawai'i, commercial cultivation of papaya is mainly for production of fresh fruit for export to the U.S. mainland and Japan. Most of Hawai'i's papaya is grown on approximately 3000 acres of lava rock land in the southeastern corner of the island of Hawai'i.

Fungi cause most of the problematic plant diseases of papaya in Hawai'i, including diseases of leaves and fruits. There is also a severe viral disease (papaya ringspot virus), spread by aphids. In high-rainfall areas, a disease known as Phytophthora blight is perhaps the most important disease affecting papaya. It is caused by a fungus-like organism and occurs most severely during periods of windy, wet weather. When it affects fruits, it may initially be mistaken for another disease, powdery mildew, due to the mass of whitish spores and mycelium on the fruit surface. But mildew does not rot papayas as does the blight disease. This publication discusses Phytophthora blight of papaya in Hawai'i and summarizes methods for managing the disease.

The pathogen

Phytophthora blight has also been called soft foot rot, stem canker, soft fruit rot, and root rot. The pathogen, *Phytophthora palmivora* (E. J. Butler) E. J. Butler, was named in 1919. It was once classified as a fungus, but now it is regarded as a pseudofungus in the stramenopiles. Several strains of *P. palmivora* have been described due to considerable morphological and pathogenic variation in the species.

Blighted papaya fruit infected with *Phytophthora palmivora*, showing the typical white mycelium and sporangia on the fruit surface Photo: Scot Nelson

The host

Papaya is just one of many plants affected by this pathogen worldwide. Other hosts include breadfruit (*Artocarpus altilis*), palms including the coconut (*Cocos nucifera*), *Catteleya* orchids, English ivy (*Hedera helix*), and cocoa (*Cacao* sp.). The disease occurs on papaya in the Philippines, Sri Lanka, Santo Domingo, India, Indonesia, Malaysia, Hawai'i, Mauritius, Mexico, Australia, Brazil, Spain, Taiwan, and perhaps elsewhere.

Symptoms on papaya

Young fruits. Water-soaked lesions exude milky latex. Fruits may eventually mummify and fall.

Mature fruits. Fruit rot initially appears as small, circular, water-soaked lesions about 3/16–3/8 inch (5–10 mm) in diameter. Large lesions, often forming first where the fruit contacts the stem of the plant, are covered with whitish mycelium and masses of *Phytophthora* spo-

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rangia. Fruits can rot, turn soft, and fall prematurely.

Stems and foliage. The top portion of the fruit-bearing region of the stem is susceptible to infection during rainy periods. This can cause stem cankers to appear. The infected plant may become more susceptible to wind damage. Older portions of stems are susceptible when wet after extended rainfall, or after injury. As lesions enlarge, infected areas of the stems way weaken, causing stem damage or breaking. Foliage on affected stems may collapse.

Roots. Lateral roots of young plants (less than 3 months old) are most susceptible in poorly drained soils. Roots may become dark and rotten, causing stunting of plant growth and yellow, collapsed leaves. Severely infected plants may die. Plants with a heavy load of fruit may topple. Papaya plants with rotten roots are susceptible to drought stress.

Morphology and life cycle of *P. palmivora*

The most important developmental factor in *P. palmivora* is its ability to produce zoosporangia on diseased plant tissue when free water is present. The organism produces hyphae, zoosporangia containing zoospores, chlamydospores, and oospores. Two separate mating types (called A1 and A2) are required for the production of oospores. Oospores do not play a significant role in the disease cycle because the chance of both mating types occurring together naturally is low. Zoospores are motile and infective after their release from the zoosporangia. Chlamydospores are the principal long-term survival structures in soils. Chlamydospores may germinate in water to produce sporangia and release zoospores, which may be transported by wind-blown or splashing rain to susceptible plant tissues. Chlamydospores formed in fallen fruit can survive in soils and infect roots of papaya seedlings in subsequent plantings.

The minimum temperature for growth of *P. palmivora* in culture is 52°F (11°C). The optimum temperature is 81.5–86°F (27.5–30°C), and the maximum growth temperature is near 95°F (35°C).

Propagules of this pathogen are dispersed principally by wind-blown rain, splashing rain, slugs, ants, knives, clippers, rodents, soil, or plant growth media.

Disease management techniques

- Improve drainage in problematic papaya fields; well-drained soil is important to prevent damping off of seedlings.
- Pick up, remove and destroy fallen fruits, especially those with disease symptoms.
- Spray pesticides, sometimes as often as weekly to bi-weekly, to control Phytophthora diseases on papaya, especially before and during rainy periods.
- Select a low-rainfall site for cultivation of papaya.
- Intercrop papaya with non-susceptible host plants.
- Do not grow papaya crops successively in the same field.
- Use non-infested soil or media for new transplant holes in fields with Phytophthora root rot (this is known as the "virgin soil" technique).
- Seedbeds in nurseries should be steamed or fumigated prior to planting.
- Control incipient rots (less than 24 hours old) of harvested fruit by dipping fruits in hot water held at 120°F (48°C) for 20 minutes.
- Avoid damage or injury to papaya stems during cultivation.
- Control African snails; they can vector the pathogen.

Variety selection

No papaya varieties are known to be resistant to Phytophthora blight, yet they vary somewhat in their reaction to infection. The main commercial papaya cultivars grown in Hawai'i are 'Rainbow', 'Kapoho Solo', 'Sunrise', and 'Kamiya'. All of these cultivars are susceptible to *P. palmivora*. However, 'Sunrise' is probably the most susceptible to the disease, and 'Kapoho Solo' is the least sensitive.

Chemical control

In high-rainfall areas, or during wet seasons in lower-rainfall areas, growers often use preventive sprays of mancozeb and copper-based fungicides to control various fungal diseases of papaya, including Phytophthora blight, anthracnose, black spot, powdery mildew, and others.

Preventive spraying against these diseases is done about every 2 weeks in wet locations or seasons. In drier locations, the preventive sprays such as mancozeb or copper may be applied every 3 weeks, or less often. Once Phytophthora blight appears in a field, the disease can become a major concern due to its ability to spread among plants and destroy fruits rapidly during windy, rainy periods. In that case, curative, systemic metalaxyl fungicides may be used, such as Ridomil Gold Copper.

Phytophthora blight of papaya fruits is a "backside of the fruit" problem. When spraying fungicides to manage

Table 1. Some fungicides registered in Hawai'i for management of Phytophthora blight of papaya.*

Example product name(s)	*Active ingredient(s)*	*Formulation*
Applause 720, Initiate 720	Chlorothalonil (54%)	Emulsifiable concentrate
Axle 2E	Metalaxyl-M (25.1%)	Emulsifiable concentrate
Dithane 75DF Rainshield DuPont Manzate Pro-Stick Griffin Manzate 75DF	Mancozeb (75%)	Water dispersible granules
DuPont Kocide 101	Copper hydroxide (77%)	Wettable powder
DuPont Manex, Griffin Pentathlon	Maneb (37%)	Flowable concentrate
DuPont Mankocide Fungicide/Bactericide	Mancozeb (15%) and copper hydroxide (46.1%)	Water dispersible granules
DuPont Manzate Flowable Lesco 4 Flowable	Mancozeb (37%)	Flowable concentrate
Fosphite, Rampart	Mono- and di-potassium salts of phosphorous acid (53%)	Emulsifiable concentrate
Fungi-phite	Mono- and di-potassium salts of phosphorous acid (45.5%)	Soluble concentrate
Maxide Concentrate	Chlorothalonil (12.5%)	Soluble concentrate
Nu-Cop 3L	Copper hydroxide (37.5%)	Flowable concentrate
Quali-Pro Chlorothalonil 500 ZN	Chlorothalonil (38.5%)	Flowable concentrate
Ridomil Gold Copper	Copper hydroxide (60%) and metalaxyl (5%)	Wettable powder
Ridomil Gold	Metalaxyl (49%)	Emulsifiable concentrate
Serenade	QST strain of *Bacillus subtilis* (16.6%)	Wettable powder
Sonata	*Bacillus pumilis* strain QST 2808 (1.38%)	Emulsifiable concentrate
Twist	Metalaxyl (25.1%)	Emulsifiable concentrate

*These are examples of existing products; more products may be available with the same active ingredients. Data were compiled from the Hawai'i Pesticide Information Retrieval System (HPIRS). Some products such as Ridomil Gold may be restricted in their use to root applications or to young plants in nurseries. Always follow pesticide label instructions.

the disease, more water is needed, from 75 to 100 gallons per acre, to obtain good coverage of the fruit surface that rests against the stem. Conversely, when spraying to control anthracnose, which is primarily a "front side of the fruit" disease (that portion of the fruit skin the faces away from the plant stem), only 40–50 gallons of water per acre are needed to obtain acceptable disease control.

Older fruits have lesions that are covered with masses of white mycelium and masses of zoosporangia of *Phytophthora palmivora*. Infections may begin often on the surface of the fruit that faces or contacts the stem.

Photos, pages 4–6: Wayne Nishijima

Droplets of papaya latex oozing through gray stem lesions

A brown stem canker

Basal stem rot of a mature papaya plant

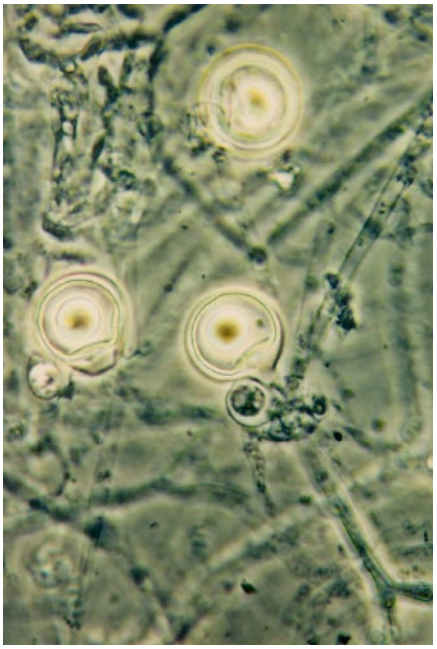
The upper stem of a fruit-bearing papaya plant severely affected by Phytophthora blight

A fallen papaya plant infected near the base of the stem

A papaya field destroyed and abandoned after infection by *Phytophthora palmivora*

Papaya field severely damaged by Phytophthora blight; note the large areas of missing plants (aerial view).

Spraying a papaya fruit column with pesticides to manage Phytophthora blight



Phytophthora palmivora hyphae, antheridia, and oogonia in culture, highly magnified

Phytophthora palmivora mycelium associated with snail or slug feeding and bird feeding injury to papaya near Kainaliu, Hawai'i

Photos (this page): Scot Nelson

Birds and perhaps a snail or slug has fed on this papaya fruit infected with *Phytophthora palmivora*. Note the holes in the pulp (bird damage) and the loss of epidermis (perhaps snail or slug damage).

African snails on papaya and associated *Phytophthora palmivora* hyphae on fruit surfaces; the African snail may vector infective propagules of *P. palmivora*.

References

Erwin, D.C., and O.K. Ribeiro. 1996. Phytophthora diseases worldwide. APS Press, The American Phytopathological Society, St. Paul, Minnesota.

Hunter, J.E., and R.K. Kunimoto, 1974. Dispersal of *Phytophthora palmivora* sporangia by wind-blown rain. Phytopathology. 64:202–206.

Ko, W.H. Phytophthora blight of papaya. University of Hawai'i at Manoa, Crop Knowledge Master. www.extento.hawaii.edu/kbase/Crop/Type/p_palmi.htm.

Ko, W.H. 1982. Biological control of Phytophthora root rot of papaya. Plant Disease 66:446–525. 1982.

Nishijima, W.T. 1999. Diseases of papaya. American Phytopathological Society. www.apsnet.org/online/common/names/papaya.asp.

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