



Anthracnose of Avocado

Scot Nelson

Department of Plant and Environmental Protection Sciences

Anthrachnose of avocado (*Persea americana*) is a common fruit disease in Hawai'i causing severe losses during marketing and in storage. Avocado fruits may appear free of blemishes before they ripen, but latent fungal infections quickly result in symptoms when the inhibitory, anti-fungal compounds present in unripe fruit skins diminish during fruit ripening.

Infections, caused by the fungus *Colletotrichum gloeosporioides*, create rounded, dark-colored, sunken lesions that expand rapidly on the fruit skin and into the pulp, causing rot. The lesions may develop salmon-colored, sticky spore masses typical of anthracnose diseases of this and many other plant species.

Anthracnose is the most severe postharvest disease of avocado in Hawai'i and most commonly occurs in areas with high rainfall. In some avocado cultivars, this disease can cause severe problems throughout the fruiting season. The pathogen also may infect the leaves and stems of avocado and a wide range of other host species. It also colonizes dead avocado plant parts suspended in the tree canopy or lying on the ground.

In 2006, approximately 880,000 pounds of locally grown avocados were marketed in Hawai'i. This was only a 27 percent market share,

because over 2.3 million pounds of avocados were imported to Hawai'i that year. Growers in Hawai'i could supply more avocado fruits for local consumption by more effectively managing anthracnose disease and other important problems limiting production.

This publication discusses anthracnose as it affects avocado in Hawai'i and suggests integrated methods for managing it with a combination of cultural practices and fungicide applications, if needed.



Avocado anthracnose lesions may appear just after ripening on green fruits that previously had no visible blemishes. The brown areas develop from latent infections on the avocado skin that were inhibited by anti-fungal chemical compounds in the unripe fruit skin. These anti-fungal compounds diminish as the fruit ripens and the lesions begin to expand rapidly, within days after ripening begins. Photo: S. Nelson

The host

Persea americana Mill. belongs to the family Lauracea. The genus *Persea* is a terminal group of plants, from which no other plant taxa have evolved and its members are among the oldest recorded flowering plants.

Leaves of this medium-sized, soft-wooded, evergreen tree are oval, feather-veined, and downy when young, and they vary considerably in size, from 3–16 inches long by 2–10 inches wide at maturity. The single-seeded fruits, classified by botanists as berries, vary among cultivars in the size of the seed in proportion to the overall fruit size, and in shape from round to oblong or pear-shaped. The skin of the fruit ranges in color from green to purplish-black; it may be thin, smooth, and pliable (as with



Anthracnose lesions on ripening avocado fruits in a farmer's roadside fruit stand near Kailua-Kona on Hawai'i. Plant-pathogenic fungi other than *C. gloeosporioides* can cause the stem-end rot symptoms shown here. Photos: S. Nelson

West Indian types) or thick, warty, and hard (Guatemalan types). The edible fruit flesh varies in fibrousness, color (greenish to yellowish), oil content, and flavor (mild and watery to rich and nutty). The avocado center of origin is Meso-America. Archaeological evidence indicates that humans have cultivated the avocado for at least 10,000 years. However, commercial development of avocado as a crop did not begin until the 20th century, following introduction of avocado plants to California.

Avocado fruits infected by anthracnose are safe for animals and humans to consume, although the infection may create an unpleasant, sour taste in portions of the flesh that are near rotted areas. Anthracnose reduces avocado fruit shelf life and negatively affects fruit quality, taste, and marketability.

The pathogen

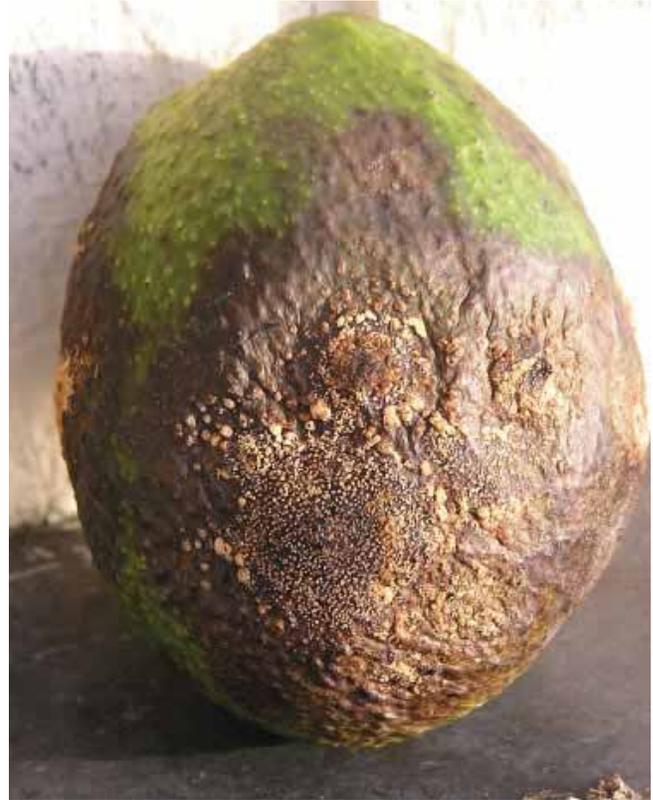
In Hawai'i, *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. in Penz is the anamorph, or asexual stage, of

the fungus. *Glomerella cingulata* (Stoneman) Spauld. & Schrenk is the teleomorph, or sexual stage.

In New Zealand, another fungal species, *Colletotrichum acutatum* (the teleomorph is *Glomerella acutata*) causes avocado anthracnose and also affects citrus, mango, and papaya; these forms of the pathogen have not been reported to occur in Hawai'i.

C. gloeosporioides causes anthracnose diseases on a range of tropical plants. Some important hosts of this pathogen in Hawai'i include banana, avocado, papaya, passionfruit, and other fruit crops. There may be host specialization among strains of the pathogen. For example, strains of *C. gloeosporioides* that attack hosts such as mango may predominate on that host genus and not pose a significant threat to other plant genera.

In Hawai'i, the disease may occur wherever avocados are grown, although it occurs predominantly in high-rainfall regions or in wet seasons and is much less common or severe in low-rainfall areas or during dry periods.



Large avocado anthracnose lesions; the fruit at right has masses of salmon-colored spores typical of the pathogen, *C. gloeosporioides* Photos: S. Nelson

The site of infection is primarily the fruits, but infections may also appear on leaves and stems. Unlike the form of anthracnose that infects mango, *C. gloeosporioides* does not attack avocado flowers.

Disease symptoms

Lesions of various sizes can occur anywhere on avocado fruits. They are dark in color and expand rapidly in size, affecting the skin and pulp. Symptoms may appear rapidly, within 1 or 2 days, on fruits that appeared to have no blemishes at the time of harvest.

Rounded, darkly colored lesions usually appear in latent infections on fruit skins after fruit harvest and during ripening. In some cases, symptoms may form on the unripe fruits while they are still on the trees. Skin symptoms are more difficult to detect on avocado cultivars with dark colored skins. Symptoms may be related to fruit injury or openings created during harvesting. Fruits developing symptoms before ripening may drop prematurely. Lesions range in size from millimeters in diameter to centimeters in diameter and may differ

among avocado cultivars. The lesions on the fruit skin are initially small, light brown, and circular, later enlarging and becoming slightly sunken in their centers, while their color turns to dark brown or black. Leaf and stem symptoms (spots or blight) rarely appear except under very humid conditions. Typically, distinctive salmon-colored spore masses of the pathogen appear in centers of larger or older fruit lesions.

Pathogen infection and survival

The fungal conidia (spores) are mainly spread by splashing caused by raindrop impact, which moves spores from infected or colonized avocado twigs (alive or dead), or infected leaves, to avocado fruits. The conidia germinate within 7 hours when the fruits are wet. The optimum temperature for infection is approximately 82°F (28°C). Fruits of all stages (from fruit set to harvest) are susceptible to infection during periods of extended rainfall and/or high relative humidity.

After the fungus penetrates the fruit skin, it remains inactive until the fruit ripens. Anti-fungal chemical com-



Spots and stem-end rots typical of anthracnose in a farmer's market near Kailua-Kona

pounds present in unripe skin usually inhibit pathogen growth. During and after fruit ripening, the pathogen grows rapidly through the peel and into the pulp of fruits.

Symptom development can occur rapidly after harvest, especially under warm, humid storage conditions. The pathogen can cause significant damage to fruit appearance, quality, and taste in just 2 days after ripening.

The fungus survives between fruiting cycles on dead avocado leaves and twigs, either in the plant canopy or on the ground. It may also survive as a pathogen on other fruiting host plants, such as banana (*Musa* spp.) or coffee (*Coffea arabica*), or saprophytically as a colonizer of dead organic matter.

Integrated disease management practices

Tactics for managing anthracnose disease of avocado in Hawai'i include selection of avocado cultivar and planting location, cultural practices within orchards, fungicides (applied pre- and/or postharvest), care in fruit handling, and control of fruit storage conditions and marketing.

Choice of cultivar. Avocado types and cultivars differ in fruit susceptibility to anthracnose and in the season

when their fruits mature (see Chia and Evans 1997, Evans and Hamilton 1999). If avocado plants are grown in a high-rainfall location, select cultivars that produce mature fruits in the summer or during traditionally drier periods of the year. Select a cultivar that is suited to your cultivation environment, because there is much variation among hybrid avocado cultivars in their adaptation to elevation and air temperature.

Choice of planting location. Avoid planting avocado in areas that are prone to strong winds, as branches broken or moved by windstorms can damage avocado fruits, creating openings in the skins for avocado diseases to infect.

Cropping system. Planting avocado trees at least 25 feet apart allows good aeration of the canopies of mature trees, so wet fruits and foliage dry quickly after rainfall, which helps to inhibit infections after *C. gloeosporioides* conidia inoculate the fruits.

Fungicides. Sprays of fungicide may be required at 14-day intervals from fruit set to fruit harvest.

Sanitation in the field. Pick up fallen plant debris and remove it from the field. Prune avocado plants to improve the movement of air within the tree canopy. Remove dead



Anthracnose lesions on avocado Photo: Wayne Nishijima

twigs and leaves within the canopy.

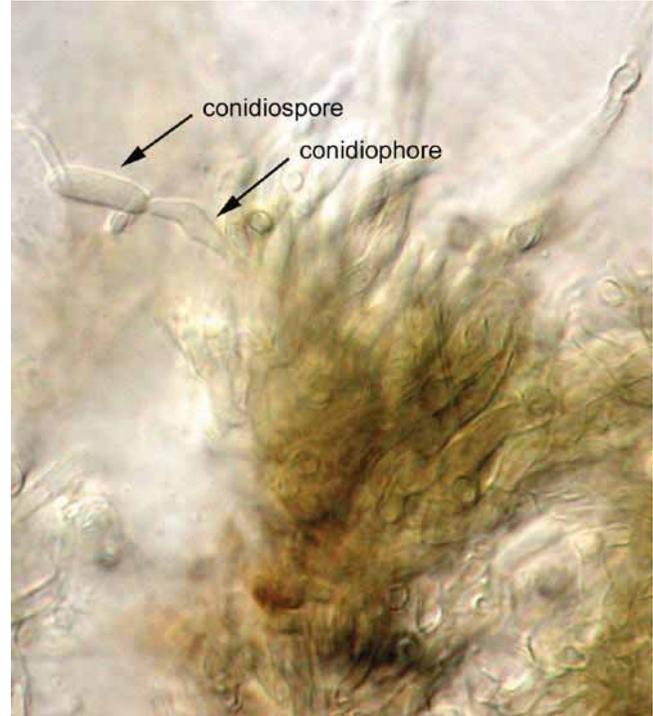
Insects. Control fruit-injuring insect pests such as fruit flies.

Harvesting. Minimize wounds to fruit skins during and after harvest to reduce postharvest disease development. During harvest, allow some of the plant stem to remain attached to harvested fruits by cutting the fruits from trees with stems attached, rather than by pulling fruits from the branches. This practice reduces stem-end rots of avocado fruits. Use clean, sanitized harvesting tools and fruit-carrying baskets. Wash fruits and dry them promptly.

Postharvest temperature management. Cool avocado fruits after harvest to inhibit anthracnose lesion development. Some avocado cultivars may be refrigerated after harvest without damage to fruits. High storage temperatures enhance disease severity.

Marketing and consumption. Sell avocados before they turn soft and develop anthracnose symptoms. Consume them promptly (within 1 day) after ripening or else refrigerate or cool them after ripening until they are ready to be eaten.

Several other plant-pathogenic fungi can cause diseases of avocado fruits in Hawai'i and may initially create similar disease symptoms. *Colletotrichum gloeosporioides* may enter the stem end of harvested fruits, creating stem-end rots in the fruits that resemble stem-end rots caused by other plant-pathogenic fungi. But anthracnose is the most common disease of avocado fruits statewide,



Conidiogenesis in *C. gloeosporioides* (highly magnified) on mango in American Samoa. A conidium (pl. conidia) is an asexual, nonmotile fungal spore that develops or is liberated from the cell that formed it. Conidiogenesis is the formation of these asexual spores (conidia or conidiospores). A conidiophore is simple or branched hypha upon which conidia are produced. Photo: Fred Brooks

and fungicides and management practices used to manage anthracnose may have a similar controlling effect on the other diseases.

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Table 1. Some fungicides registered in Hawai'i for management of anthracnose disease of avocado.*

<i>Product names (examples)</i>	<i>Active ingredient(s)</i>	<i>Formulation</i>
70% Neem oil	Clarified hydrophobic neem oil (70%)	Oils, no added pesticide
Abacide 2	Mono- and di- potassium salts of phosphorous acid (45.8%)	Pelleted/tabletletted
Armicarb	Carbonic acid, monopotassium salt (85%)	Soluble concentrate
Avalon WDG	Fosetyl-AI (80%)	Emulsifiable concentrate
Basic Copper 53	Basic copper sulfate (98%)	Emulsifiable concentrate
Champ Formula 2 Flowable Agricultural Fungicide/Bactericide	Copper hydroxide (37.5%)	Flowable concentrate
Champ WG	Copper hydroxide (77%)	Wettable powder
DuPont Kocide 101 Fungicide/Bactericide	Copper hydroxide (77%)	Wettable powder
Griffin Kocide 2000 Fungicide/Bactericide	Copper hydroxide (53.8%)	Water dispersible granules
Metastar 2E	Metalaxyl (32%)	Emulsifiable concentrate
Nu-Cop 3L	Copper hydroxide (37.5%)	Flowable concentrate
Serenade Max	QST 713 strain of <i>Bacillus subtilis</i> (14.6%)	Wettable powder
Sonata	<i>Bacillus pumilus</i> strain QST (1.38%)	Emulsifiable concentrate
Tennocop 5E Fungicide/Bactericide (delayed dormant application)	Copper salts of fatty and rosin acids (58%)	Emulsifiable concentrate

*Table 1 contains examples of product names and specific active ingredients and/or formulations. There are similar products on the Hawaii Pesticide Information Retrieval System (HPIRS). You can also contact the CTAHR Cooperative Extension Service. Always read the pesticide label before applying the products and follow the label instructions exactly. Most of these products are intended as foliar sprays. Fungicide registrations periodically expire.

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Acknowledgments

Wayne Nishijima (UH-CTAHR) for a photograph; Mike Kawate (UH-CTAHR) for pesticide information; Fred Brooks (UH-CTAHR) for a photograph and review.