

## 2006 Florida Plant Disease Management Guide: Avocado (*Persea americana*)<sup>1</sup>

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### Avocado Diseases Caused by Fungi and Stramenopiles

#### Phytophthora root rot

Phytophthora root rot is the most important disease of avocado and the limiting factor for production in many regions throughout the world.

#### Symptoms and Causal Organism

*Phytophthora cinnamomi*, the causal agent, forms several different spore stages that are involved in disease development or survival: sporangia (which produce motile zoospores), chlamydospores, and oospores. Sporangia are broadly ellipsoid to ovoid, do not have a rounded protuberance (are nonpapillate) and are persistent (noncaducous). Sporangia are not produced in sterile media, but are produced in non-sterile soil extract or in sterile salt solution.

Chlamydospores are common when growing *P. cinnamomi* on agar media and are abundant on V8

juice agar or in V8 juice broth cultures. Chlamydospores are thin-walled, globose to pyriform, and range from 31-50 µm in diameter. They are borne terminally or on short, lateral branches, frequently in grape-like clusters of 3 to 10 spores.

*Phytophthora cinnamomi* is heterothallic having A1 and A2 mating types, but the A2 type may form oospores in the presence of root extract, some species of the soil borne fungus *Trichoderma viride*, and in the presence of oleic acid.

The pathogen primarily causes a rot of the fine feeder roots that blacken, become brittle and eventually die (Figure 1). As the disease progresses, feeder roots are reduced resulting in reduced; soil beneath the trees remains wet. Severely infected trees show sparse foliage with pale green, often wilted leaves and dieback occurs in advanced stages (Figure 2).

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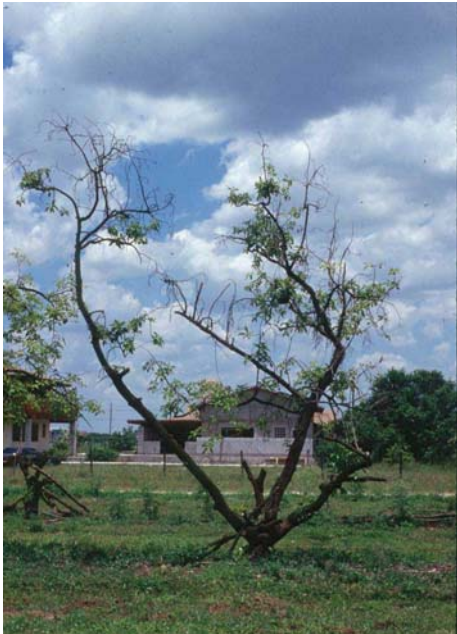
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**Figure 1.** Blackened and brittle feeder roots infected with *P. cinnamomi*.



**Figure 2.** Severely infected trees with sparse foliage, wilted leaves and dieback caused by *Phytophthora cinnamomi*.

### **Disease Cycle and Epidemiology**

An avocado planting in poorly drained soil will develop *Phytophthora* root rot if the pathogen is present. Areas with over irrigation and excessive rainfall can be problematic.

The pathogen can be disseminated by several means including soil movement, nursery stock, infested seeds, equipment and especially water. Infection by *P. cinnamomi* is optimum at soil temperatures of 70-86°F (21-30°C), and increases as soil moisture rises due to favorable conditions for

sporangia formation and zoospore release, motility, and infection.

### **Management**

Only disease-free nursery stock should be used. Do not plant in areas that are subject to flooding. Avoid the introduction of soil or water from infested areas to clean fields on equipment or plant stock. For chemical control use one of the following labeled pesticides according to the manufacturer (Table 1).

### **Anthracnose**

Anthracnose is a serious disease of avocado fruit, causing drop and rot and reducing shelf life during storage and transport. Anthracnose is the most common rot of mature fruit, but also affects leaves, twigs and young fruit under favorable conditions.

### **Symptoms and Causal Organism**

The causal fungus, *Colletotrichum gloeosporioides*, occurs on a large number of hosts. Colonies on potato dextrose agar are grayish white to dark gray. Production of aerial mycelia by isolates varies, ranging from a dense white mat to a few tufts associated with fruiting bodies (Figure 3).



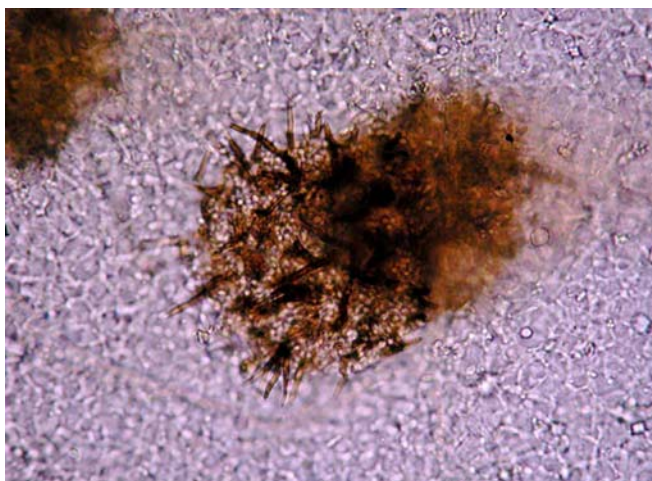
**Figure 3.** Culture of *C. gloeosporioides* growing on potato dextrose agar.

Conidia (7-20 X 2.5 µm) are hyaline, unicellular, and either cylindrical with obtuse ends or ellipsoidal with a rounded apex and a narrow, truncate base. They form on hyaline to lightly brown conidiophores in acervuli that are irregular in shape and approximately 500 µm in diameter. Characteristic setae (4-8 X 200 µm) are one to four

septate, brown, slightly swollen at the base, and tapered at the apex (Figure 4). The teleomorph, *Glomerella cingulata*, is not known to play a role in the disease cycle.

When the foliage remains damp, especially over night, the fungus enters weakened and wounded tissues, causing small, irregular, black spots that eventually coalesce to cover a large areas (Figure 5). Often, one can observe the pink to salmon-colored spores oozing from the lesions.

Fruit lesions start as circular, slightly sunken, brown to black spots. These lesions enlarge rapidly, under favorable conditions, very often becoming conspicuously sunken, and very often develop cracks radiating from the lesion center (Figure 6). The most serious aspect of this disease can be observed on maturing fruit. The fungus can progress into the flesh of the avocado fruit, producing a greenish-black decay, which eventually may involve a large portion of the fruit.



**Figure 4.** Characteristic setae of *C. gloeosporioides*.

### **Disease Cycle and Epidemiology**

This fungus is considered to be a “weak” pathogen of avocado; i.e., its damage is enhanced by wounds created by wind, insects, and other pathogens that assist penetration subsequent disease development. Scab and *Pseudocercospora* spot (blotch) lesions are common entry sites for the anthracnose fungus. Since all varieties of avocado are susceptible, good anthracnose control depends on adequate control of other diseases and avoidance of cuts and bruises to the fruit in handling. Fruits



**Figure 5.** Anthracnose symptoms on foliage.



**Figure 6.** Anthracnose symptoms on fruit.

showing any sign of anthracnose should not be packed in cartons with healthy fruit. Harvesting fruits in an immature condition may substantially contribute to anthracnose appearance at the market place, because the fungus may be carried on the immature fruit and will subsequently invade the flesh through small cracks made during post-harvest handling procedures.

### **Management**

It is recommended that wind and insect damaged trees be treated with a fungicide such as azoxystrobin or copper to prevent infection by the fungus. On late maturing varieties in south Florida such as Nabal, Taylor and Choquette, a fall application of fungicide is recommended. Refer to Table 1 for a list of fungicides currently labeled for use on avocado.

## Pseudocercospora Spot (Blotch)

Pseudocercospora (*Cercospora*) spot or blotch is one of the most common diseases of avocado in Florida. This pathogen thrives when warm, humid, and rainy conditions persist.

### Symptoms

Symptoms may occur on leaves, stems and fruit. Small lesions (2 – 5 mm) appear first on the abaxial leaf surface and appear brown to purplish brown in color. Spots eventually develop on both leaf surfaces as irregular, dark smokey patches on the lower leaf. Under high humidity, sporulation of the causal fungus may be seen in lesion centers as gray, felty growths. Individual lesions may coalesce to form large areas of necrotic tissue. The fungus can infect fruit and cause lesions and fruit cracking which may lead to secondary anthracnose infection (Figure 7).



**Figure 7.** Symptoms of *Pseudocercospora* spot on avocado fruit.

### Causal Organism

*Pseudocercospora purpurea* causes Pseudocercospora spot. Conidia (2-4.5 X 20-100 µm) are obclavate cylindrical, pale olive, indistinctly one to nine septate, and straight to curved. Conidiophores (3-4.5 X 20-200 µm) are pale to medium olive brown, multiseptate, straight or rarely branched, and slightly bent at a sharp angle (geniculate). The pathogen can be difficult to isolate, but grows readily on nutrient agar. In culture, the fungus produces tufts of gray mycelium that turn brown to blackish brown with age.

## Disease Cycle and Epidemiology

Infected leaves are sources of inoculum. The pathogen may penetrate host tissue directly or via wounds. Once infected, the fungus reproduces abundantly from the lower leaf surfaces.

Sporulation is greatest during warm, rainy weather and most abundant from May to September. Spores are disseminated via wind, rain splash, insects and irrigation.

Very small fruit and those at or near maturity are less susceptible than those fruit which are one-fourth to three-fourths of full size.

### Management

Due to the favorable environment for disease development in south Florida, strategic chemical control is deemed necessary for successful avocado production. The disease can be controlled readily by timely applications of copper or azoxystrobin sprays (Table 1). Be careful to cover both foliage and fruit. Application in early May and June gives effective control on varieties maturing in summer and fall. A third application is recommended in mid July for winter maturing varieties.

## Stem-End Rot

Stem-end rot is a post harvest disease that occasionally causes losses under suboptimal storage conditions.

### Symptoms

Fruit rot starts on the stem end and generally initiates as the fruit ripens or after harvest. Small, purplish-brown spots appear and can enlarge to involve the entire fruit surface. The pathogen invades the flesh causing tissue discoloration, degradation, and offensive odors, thus compromising the quality of the fruit.

### Causal Organism

In the United States stem-end rot is caused by *Botryosphaeria* spp. and their anamorphs, but *Colletotrichum gloeosporioides* is also capable of causing stem-end anthracnose. Literature indicates

that the anamorphs of *Botryosphaeria* spp. are *Fusicoccum luteum* and *Dothiorella aromatica*.

Colonies of *D. aromatica* on potato-dextrose agar (PDA) produce aerial mycelia with dark, dendritic growth patterns on the undersides and radially aligned, immersed conidiomata. Conidia (17-25 X 4-6 µm) are narrowly fusiform to clavate, hyaline, and granular. Other fungi have been reported to cause stem-end rot either alone, or as a complex.

### **Disease Cycle and Epidemiology**

The anamorph stages of *Botryosphaeria* spp. occur as endophytes in avocado stems. They can infect fruit from endophytically colonized inflorescence and stem-end tissue (pedicle and adjacent peduncles). Symptoms of endophytic infections are not apparent in the stem-end tissue until fruit development is well advanced.

Spores of *Fusicoccum* spp., are produced on dead leaves, twigs, and branches in the canopy and spread by wind and water. In addition to endophytic colonization, preharvest infections of the stem end and associated fruit tissue can occur through wounds and direct penetration by some fungi. Preharvest infections remain quiescent until the fruit ripen after harvest.

Environmental conditions influence which pathogens are present and subsequently cause stem-end rot. Water stress is reported to promote endophytic infection. Cool storage conditions promote infection of *C. gloeosporioides* and *Phomopsis perseae* over *L. theobromae*.

### **Management**

The causal fungi survive on dead host debris. Avoid buildup of this material in groves. Use low sprinklers to avoid movement of the fungi up to the fruit. Avoid water stress to reduce endophytic infection. Mulching under the trees to promote tree litter decomposition should be practiced.

Further, do not harvest fruit when it is raining. Copper fungicide sprays and other management practices used for anthracnose control will reduce inocula of stem-end rot pathogens.

## **Scab**

Scab is a serious problem in humid areas such as the tropics and subtropics.

### **Symptoms and causal agent**

Avocado scab is caused by the fungus *Sphaceloma perseae*. Acervuli are formed, and conidia (2-30 X 2-5 µm) are hyaline, one-celled, and ovoid. They may be produced acrogenously or pleurogenously on conidiophores and conidia are continuous to several septate. Growth of the fungus appears as olive to brownish olive in color.

The disease is most prominent and most easily diagnosed on the fruit of very susceptible varieties. Spots are first oval, slightly raised, and brown to purplish-brown (Figure 8). As the fruit mature, spots coalesce and the centers of these spots become sunken and a large portion of the fruit may become rough in appearance.

The lesions on the leaves are less well known and less readily observed, because they most often occur in the upper part of the tree canopy. Scab starts on leaves as discrete, small spots less than 1/8 inch (3.5 mm) in diameter.

The spots are especially common on veins on the underside of leaves. As leaf spots develop, they very often take on a star-like pattern, with the center eventually dropping out to give a "shot-hole" effect.

Symptoms on petioles and twigs include oval to elongate spots that may, on initial inspection, be confused with scale insects. Eating quality is not impacted, but severely affected fruit are very unattractive. Varieties vary in susceptibility to scab. Lula is the most susceptible commercial variety. Fuschsia, Pollock, Booth 1 and Waldin are quite resistant.

### **Disease cycle and Epidemiology**

*Sphaceloma perseae*, is carried over one season to the next on leaf and stem lesions. With abundant moisture and cool temperature, the fungus readily infects young succulent tissues of avocado leaves, twigs, and fruits, forming the characteristic scab



**Figure 8.** Symptoms of scab on avocado fruit.

lesions in which spores are produced. These spores are readily spread through the grove by wind, rain, dew, and most likely insects. Young leaves are susceptible, but become resistant once they mature and the tissues become more hardened. Fruits are extremely susceptible just after the petals fall and become more resistant as they develop. One of the most important economic aspects of scab fruit infection is the creation of portals for entry by many fruit-rotting organisms.

### **Management**

Efficacy trials indicate that copper fungicides seem to give good control and Folpet is also labeled for controlling avocado scab (Table 1). The *Pseudocercospora* spray program works for scab, but if you're growing Lula it requires 3 additional sprays. Timed as follows: just as the bloom bud opens (late January), near the end of the main bloom period (mid February-March), and 3-4 weeks after all the fruit have set in a normal season.

### **Powdery Mildew**

Powdery mildew is usually a minor disease problem, but may become serious enough to warrant chemical sprays.

### **Symptoms and Causal Agent**

*Oidium* sp. frequently occur on avocado foliage. Powdery mildew can become serious on untreated trees if favorable conditions persist. Infections on young leaves appear as dark green areas with a powdery, white, spore-bearing growth on the

undersides. Undersides of infected areas on mature leaves are generally purplish brown and covered with white powdery growth. The upper sides of leaves have a yellowish-green discoloration (Figure 9).



**Figure 9.** Symptoms of powdery mildew on the upper and lower leaf surface.

The disease is caused by an *Oidium* sp. Barrel-shaped conidia are formed in chains on the underside of the leaves.

### **Disease Cycle and Epidemiology**

Spores of the fungus are dispersed mostly by wind and rain to young leaves in the spring. Spores from these primary infections attack subsequent flushes. Powdery mildew is most severe in damp, shaded areas, especially in nurseries.

### **Management**

Be certain to scout trees for symptoms when conditions are cool and humid especially during early spring in south Florida. Adequate pruning to reduce humidity and increase transmission of sunlight may reduce the disease. For chemical control apply sulfur fungicides according to the manufacturer's label (Table 1).

## **Avocado Diseases Caused by Nonfungal Agents**

### **Alga Leaf Spot**

This is a relatively minor disease that occurs most frequently in tropical avocado production areas; it is fairly common on avocado in south Florida.

### **Symptoms and Causal Agent**

Alga leaf spot is caused by *Cephaleuros virescens* in the Americas. The alga thallus is orange to rust colored and develops below the host cuticle. It produces 32 X 25 µm sporangia on the terminals of erect stalks (Figure 10). Biflagellate zoospores are produced in the sporangia.



**Figure 10.** Erect stalks of *Cephaleuros virescens*.

Leaf spots appear round, orange to red, raised, velvety and are produced predominately on leaves (Figure 11). Numerous infections can cause some leaf drop. The spots turn greenish gray with age and become quite prominent. Spots turn red to bright red when the alga is reproducing. A yellow halo may surround the spots.



**Figure 11.** Symptom and sign of alga leaf spot.

### **Disease Cycle and Epidemiology**

The pathogens spores are spread from old leaves to new leaves by wind and rain. Spores are produced continuously during periods of high rainfall and

prolonged humidity, which contribute to disease development.

### **Management**

Humidity in the canopy should be reduced by judicious pruning. Use of copper-based fungicides in the spring to control other diseases of avocado will aid in the control of alga spot.

### **Sunblotch**

Sunblotch was originally described as a physiological disorder in California in 1928, but with the description of viroids in 1970s, sunblotch was established as a viroid-induced disease. It is the only known disease of avocado caused by a viroid. Sunblotch can occur anywhere avocados are grown. It is considered to be a minor problem, although there have been reports of serious outbreaks in the past.

### **Symptoms and Causal Agent**

Symptoms on twigs include a yellow, red, or necrotic streaking that often is associated with a shallow indentation along the length of the twig. Fruit appear white or with yellow blotches or streaks that may or may not be depressed (Figure 12). Leaves may have white or yellow variegated areas and they may be deformed. Trees are often stunted and display a sprawling growth. Symptomatic trees may have reduced yield.



**Figure 12.** Symptoms of avocado sunblotch viroid on fruit.

Sunblotch is caused by the avocado sunblotch viroid (ASBVD). ASBVD is a single-stranded,

circular RNA molecule of 247 nucleotides with a molecular weight of  $0.8 \times 10^5$ .

### ***Disease Cycle and Epidemiology***

The viroid is carried within the host tissue. Cultivar, environmental conditions, and possibly the viroid strain all impact symptom expression. Some trees are symptomless carriers in that the symptoms are absent even on vegetative tissue that have high titers of the viroid. A drastic reduction in yield of a healthy appearing avocado tree may indicate symptomless infection of ASBVD.

The viroid is transmitted through the seed of infected trees with great frequency. Although symptoms may not be present when infected seedlings are used as rootstocks, the disease will often appear on scions grafted to them. Trees with symptoms transmit the viroid to seed infrequently, and the resultant infected seedlings often show symptoms. The most frequent method for transmitting the viroid is through the use of infected budwood or rootstock seedlings when grafting. The viroid can be transmitted by the use of contaminated pruning tools, by root-to-root grafting, and in seed resulting from fertilization of a non-infected tree with pollen from an infected tree. Other than root-to-root grafting of infected trees, sunblotch has not been observed to spread in the field.

### ***Management***

Trees with symptoms can be removed from the grove and the remaining stumps killed. Pruning tools and harvesting clippers should be disinfested between trees. Practice careful selection of disease-free scions and seed sources.



**Table 1.** Fungicides registered for use on Avocado in Florida.

Chemical	Fungicide Group <sup>1</sup>	Maximum Rate/ Acre		Minimum Days to Harvest	Disease or Pathogen	Remarks <sup>2</sup>
		Application	Season			
Abound, Heritage (azoxystrobin)	11	15.4 oz.	1.5 lbs.	0	Anthracnose Cercospora & Pseudocercospora Leaf Spot	Abound applications should begin prior to disease development.
Aliette (Fosetyl-Al)	33	5 lbs.	20 lbs.	12 hrs	Phytophthora root rot	Do not mix with copper.
Armcarb (potassium bicarbonate)		2.5-5.0 lbs./100 gal water		0	General contact biocide, numerous pathogens	Refer to label.
Fosphite Fungicide, Helena Prophyt, and others (potassium phosphite)		1-2 qts.			Scab	Do not mix with copper.
Kocide and others (copper hydroxide)	M1	4.5 lbs.		1	Anthracnose Algal Leaf Spot Pseudocercospora Leaf Spot	Make initial applications just before flowering and repeat on a weekly schedule until just before harvest. Apply in sufficient water for thorough coverage. Use the higher rates for severe disease.
Oxidate, Oxyfresh (hydrogen dioxide)		40-128 fl.oz.			General contact biocide, numerous pathogens	Refer to label.
Phostrol (phosphorous acid)	33	4.5 pints in up to 500 gal water	18 pints		Phytophthora root rot	Apply at transplant or beginning of growing season.
Ridomil Gold EC, Ridomil Gold GR (mefenoxam)	4	1/8-14.5 fl.oz	1.5 gal/A	28	Phytophthora root rot	Refer to label.
Rootshield ( <i>Trichoderma harzianum</i> )		5.5-12 lbs.			Root system disease protectant	Soil temp must be greater than 50°F
Serenade Max ( <i>Bacillus subtilis</i> )		1-3 lbs.		0	Anthracnose	
Sulfur 6L, Sulfur Flowable, Thiolux (Sulfur)					Powdery Mildew	See label.
Trilogy (Neem oil)		32 fl.oz/25 gal water			Anthracnose, Scab	See label.

**Table 1.** Fungicides registered for use on Avocado in Florida.

Chemical	Fungicide Group <sup>1</sup>	Maximum Rate/ Acre		Minimum Days to Harvest	Disease or Pathogen	Remarks <sup>2</sup>
		Application	Season			
<p><sup>1</sup>Fungicide group (FRAC Code): Numbers (1-37) and letters (M, U, P) are used to distinguish the fungicide mode of action groups. All fungicides within the same group (with same number or letter) indicate same active ingredient or similar mode of action. This information must be considered for the fungicide resistance management decisions. M= Multi -site inhibitors, fungicide resistance risk is low; U= Recent molecules with unknown mode of action; P= host plant defense inducers. Source: <a href="http://www.frac.info/">http://www.frac.info/</a> (FRAC = Fungicide Resistance Action Committee). Be sure to read a current product label before applying any chemicals.</p> <p><sup>2</sup>Information provided in this table applies only to Florida. Be sure to read a current product label before applying any chemical. The use of brand names and any mention or listing of commercial products or services in the publication does not imply endorsement by the University of Florida Cooperative Extension Service nor discrimination against similar products or services not mentioned.</p>						