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# Workshop 5
# "So You Have Root Rot Under Control, is Black Streak, Bacterial Canker, or Some Other Disease Reducing Yield? How are these Diseases Managed in the Various Avocado-Growing Countries?"

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Of the many diseases that affect avocado *(Persea americana* Mill.) production throughout the world, *Phytophthora* root rot (PRR), caused by *Phytophthora cinnamomi* Rands, is certainly the most destructive and important. The significance of PRR is indicated by the number of papers on this disease that were presented at the Congress; 15 of 21 oral or poster presentations on avocado diseases dealt with PRR.

Despite the importance of PRR, many other diseases also affect avocado. Since they are often overlooked, the purpose of this workshop was to reveal the importance of such diseases. The workshop's objectives were to: (i) review the most prevalent diseases of avocado, other than PRR; (ii) discuss the respective symptoms, causal agents, and worldwide occurrence of these diseases; (iii) outline various management strategies for some of the diseases; and (iv) compare and contrast diseases with similar symptoms and discuss ways in which they can be distinguished. The list below reflects only those diseases that were discussed during the workshop, and is not intended to be a comprehensive list of avocado diseases.

## Root/soilborne diseases

Armillaria root and crown rot: *Armillaria mellea* (Vahl:Fr.) P. Kumm., *Armillaria tabescens* (Scop.) Dennis, Orton and Hora *(Clitocybe tabescens).* This is a widespread, but usually unimportant disease. In affected orchards, it may spread slowly for many years. Trees decline gradually and may eventually die if completely girdled. Unlike poria root rot (see below), these trees do not fall to the ground. Basidiocarps (mushrooms) at the base of affected trees, the presence of rhizomorphs in the soil, and mycelial mats beneath the bark are diagnostic for this disease.

Dematophora root and crown rot: *Rosellinia necatrix* Prill, *Dematophora necatrix* R. Hartig (anamorph). Recognized in California (USA) since at least 1947, this disease has never been a major problem in the state. However, it now causes considerable damage in Israel and Spain. Growth of affected trees is retarded. Wilted leaves on such trees

may remain attached for a long time after they are killed and branches or entire trees may die. White mycelial plaques are produced in the bark, and dark, hard mycelial mats may form on the outside of roots after trees die.

Dothiorella stem canker and fruit rot: *Dothiorella* Sacc. spp., *Botryosphaeria* Ces. and De Not. spp. (teleomorph). This disease is widespread (Australia, Israel, New Zealand, South Africa, USA, and parts of South America), but the species of causal fungi vary among the affected countries. The stem canker phase of the disease was first reported in California in 1934 as a minor problem, and, in general, the fruit rot, post-harvest phase of the disease is most important.

Phvtophthora stem canker and fruit rot: *Phytophthora citricola* Sawada. The stem canker phase of the disease is currently increasing in importance in California. Some root-stocks that are resistant to PRR are highly susceptible to stem and root disease caused by *P. citricola* (Tsao *et al.,* 1992). A conspicuous, sugary white exudate which forms at the base of affected trees resembles that produced on trees affected by black streak (see below). However, *Phytophthora* canker does not spread higher than about 20 cm above the soil surface, whereas black streak may develop throughout the tree canopy. In addition, *Phytophthora* canker may kill and discolor tissue as deep as the cambium, but black streak only produces superficial damage on bark. Damage caused by *Phytophthora* stem canker is often associated with irrigation emitters that are placed close to trunks. To avoid damage, emitters should be positioned such that water is directed away from the trunk surface.

The fruit rot phase of this disease is most prevalent close to the soil surface, reflecting the soil-borne nature of the disease. Damage begins at the distal end of fruit, and all fruit sizes and maturities are susceptible. In contrast, fruit affected by bacterial blast (see below) may be found throughout the tree canopy and symptoms usually develop on mature fruit. The two diseases are distinguished on these bases.

Poria root rot: *Poria* Pers. sp. Roots on affected trees may be weakened such that trees fall to the ground, but do not die or stop setting fruit. The causal fungus forms basidiocarps at the base of affected trees. Many species in this genus have been transferred to other genera and the taxonomic status of the genus is currently uncertain.

Verticillium wilt: *Verticillium alboatrum* Reinke and Berthier, *V. dahliae* Kleb. This disease causes infrequent, but sometimes spectacular damage (as in 1990 in California). The disease is also found in Australia, Florida, Israel and Spain. The causal fungus infects and discolors the vascular system of avocado and may kill single branches or entire trees; badly damaged trees occasionally recover. The disease is most prevalent when trees are planted in soil in which other susceptible hosts (e.g., tomato) have been grown. The disease becomes less of a problem as canopies in new plantings close in and reduce the prevalence of weed hosts in the understory. Guatemalan cultivars are more susceptible than Mexican cultivars.

**Foliar/fruit diseases**

Algal leafspot: *Cephaleuros virescens* Kunze. This unusual disease of foliage is caused by a plant parasitic alga. Found in the humid subtropics and tropics, the disease usually has a minor affect on avocado.

Anthracnose: *Colletotrichum gloeosporioides* (Penz.) Sacc. This disease has a worldwide distribution, but is most significant in humid environments. Although anthracnose can affect foliage and fruit at all stages of development, its primary importance is as a post-harvest disease of fruit. Symptoms on fruit include red to black, circular depressions which extend into the pulp. Limited control of the disease can be achieved with pre-and post-harvest chemical treatments.

Bacterial canker: *Pseudomonas syringae, Xanthomonas campestris.* Currently recognized in Australia, California and South Africa, this disease apparently has different etiologies in each of the affected areas. *Xanthomonas campestris* and *P. syringae* have been associated with the disease in California and South Africa, respectively, whereas the disease has been attributed to boron deficiency in Australia. Pockets of affected tissue develop on affected trunks and scaffold limbs, and spread linearly up trees. Active, watery pockets of the disease may eventually become inactive (see *Phytophthora* canker for contrasting symptoms).

Bacterial blast: *Pseudomonas syringae.* Symptoms include dark, irregular areas and white exudate on hard fruit which can be distinguished from soft rot (see below) by the firmer texture and the lack of a rank odor of affected fruit. This disease occurs mainly as a pre-harvest problem (see also *Phytophthora* fruit rot).

Bacterial soft rot of fruit: *Erwinia carotovora.* The disease is easily diagnosed by the relatively soft texture and offensive odor of affected fruit.

Black streak: Unknown agent. This is a significant problem only in California, although it is probably also found in Florida (see *Phytophthora* stem canker for diagnostic characteristics). Black streak is transmissible and water stress can trigger symptom development. The disease causes a gradual decline in tree vigor resulting in reduced production of fruit and the eventual death of trees. Other symptoms of black streak include leaf blotching, bunchy growth, wilting and early bloom. Double-stranded dsRNAs have been detected in symptomatic tissue, but have not been unambiguously correlated with the disease syndrome.

Cercospora spot or blotch: *Pseudocercospora purpurea* (Cke.) Deighton *(Cercospora purpurea).* This is a leaf and fruit blemish that causes pre-harvest damage which can be significant if not controlled. Enhanced development of anthracnose is frequently associated with blotch lesions on fruit.

'Duke 6' phenomenon: Unknown agent. This disorder has been observed in California

and South Africa. Stems on 'Duke 6' rootstocks become pitted and trees can be severely stunted and eventually killed. The disease is graft-transmissible and is stress-related. Although dsRNA is not consistently associated with the syndrome, the symptoms and transmissibility suggest a viral etiology.

Ringneck: water stress. This disorder develops as a necrotic ring around peduncles and is associated with water stress. Work in Australia indicates that trees with PRR are often affected by ringneck because they are commonly water-stressed.

Scab: *Sphaceloma perseae* Jenk. The disease is found throughout the humid subtropics and tropics. Only young leaves and fruit are infected by the causal fungus. Although damage is superficial, fruit with lesions may be unmarketable and are more susceptible to anthracnose.

Sooty blotch: *Akaropeltopsis* sp. A major problem in South Africa, the disorder is characterized by sooty blotches on branches, stems, leaf veins and fruit. Although the causal fungus does not parasitize avocado, its black, superficial growth reduces the market value of fruit.

Stem end rots: *Lasiodiplodia theobromae* (Pat.) Griffon and Maubl., *Thyronectria pseudotrichia* (Schw.) Seeler., *Phomopsis perseae* Zerova, *Dothiorella aromatica* (Sacc.) Petrak and Sydow, and *C. gloeosporioides.* Stem end rots generally occur wherever avocados are grown. These and several other fungi are known to cause this type of disease, and damage caused by the diseases can be significant. Pre- and post-harvest chemicals used against anthracnose can reduce stem end rot severity.

Sunblotch: sunblotch viroid. A relatively minor problem in several avocado-growing regions around the world, this disease may remain quiescent in infected tissue; thus, detection of the disease can be a problem. Fruit, twigs, and foliage (infrequent) can be disfigured and discolored with white to yellow streaks which for 'Hass[1] may also be red (rarely). Bark on affected trees may take on "alligator-hide" appearance. The causal viroid can be transmitted mechanically by pruning tools and similar instruments, and via pollen and root grafts. Host tissue can be indexed for the presence of the causal viroid by either grafting to indicator plants or by detection with a DNA probe specific for sunblotch viroid RNA.

In closing, we note that the World Avocado Society that was conceived at this Congress has expressed an interest in producing an avocado disease handbook. Although other booklets on avocado diseases exist or will be produced in the future, they either cover a limited number of diseases or have a regional focus. Since the proposed World Avocado Society handbook will include information on most of the avocado diseases that are known throughout the world, it should be a significant and useful publication for all individuals who are interested in avocados.

## Literature Cited

P.H. Tsao, A. Alizadeh, E. Krausman, J.G. Fang, J.A. Menge, and F.B. Guillemet. 1992. Susceptibility to *Phytophthora citricola* of certain avocado rootstock cultivars that are known to be tolerant to *P. cinnamomi.* Proceedings of the Second World Avocado Congress, pp. 89-94.