



Avocado root rots: How to spot the difference



Since disease symptoms of PRR and WRR are similar, they are often mistaken for each other, leading to misdiagnosis and improper treatment methods. However, there are certain specific symptoms to help differentiate between them.

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Avocado production in South Africa is challenged by different root pathogens, notably *Phytophthora cinnamomi* Rands causing Phytophthora root rot (PRR), and *Rosellinia necatrix* Berl. ex Prill. causing white root rot (WRR) (Rands, 1922; López-Herrera *et al.*, 1998). Both PRR and WRR share common foliar symptoms, such as wilting of leaves, chlorosis and canopy dieback. Plants may also die rapidly or survive asymptotically for many years (Erwin and Ribeiro, 1996; Pliego *et al.*, 2012).

PRR foliar symptoms are normally characterised by chlorosis, brown necrotic leaf tips, wilting and sparse foliage due to leaf drop (Fig. 1A). *P. cinnamomi* is an oomycete and infection mainly occurs through fine feeder roots. Therefore, PRR starts with rotting of feeder roots that eventually progress into the larger roots during disease development. Infected feeder roots turn black and brittle, becoming few in number (Fig. 2A). *Phytophthora* spp. also infect crowns, trunks and woody stems, forming reddish-brown cankers, although this is not common for avocado (Fig. 2B). Wet conditions and waterlogged soils enhance disease development and help motile zoospores move through water (Hardham, 2005).

Some commercial avocado rootstocks are partially resistant to PRR and different fungicides can prevent and/or control disease (Bender *et al.*, 1999; El-Hamalawi and Menge, 1994). Currently, Phosphorous-based injections are used for avocado tree maintenance and disease control. However, *P. cinnamomi* can still infect and cause tree stress if not managed properly, leading to secondary infections and decline in vigour.

WRR foliar symptoms include leaf yellowing, wilting and drying on the tree (Fig. 1B) (Pliego *et al.*, 2012; Van den Berg *et al.*, 2018). *R. necatrix* is an ascomycete that usually infects

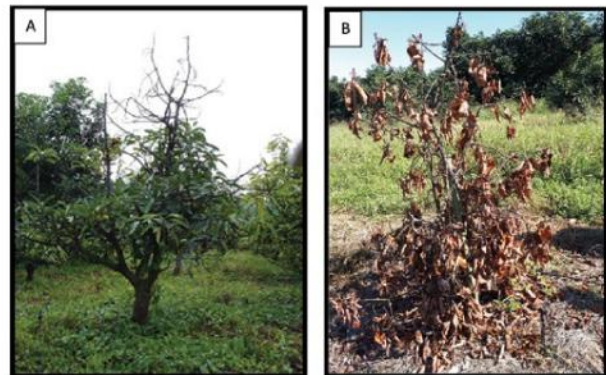


Figure 1. Typical foliar symptoms of A) *Phytophthora* root rot caused by *Phytophthora cinnamomi* characterised by chlorosis, brown necrotic leaf tips and sparse foliage due to leaf drop. B) White root rot caused by *Rosellinia necatrix* characterised by leaf wilting and drying on the tree.

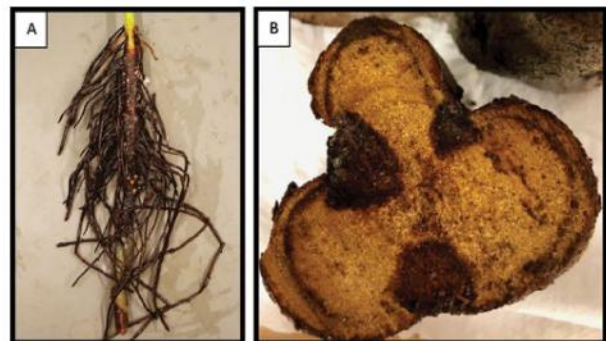


Figure 2. *Phytophthora cinnamomi* infection A) causing avocado roots to turn black and brittle B) causing the formation of reddish-brown cankers on the trunk of an avocado tree.

larger roots at multiple points (Pliego *et al.*, 2009). The white, cottony mycelial growth of the pathogen is visible on the root surface and inside the larger roots (Fig. 3A), in the soil (Fig. 3B) and underneath/on top of the bark at the crown (Fig. 3C) as it spreads into the vascular system.

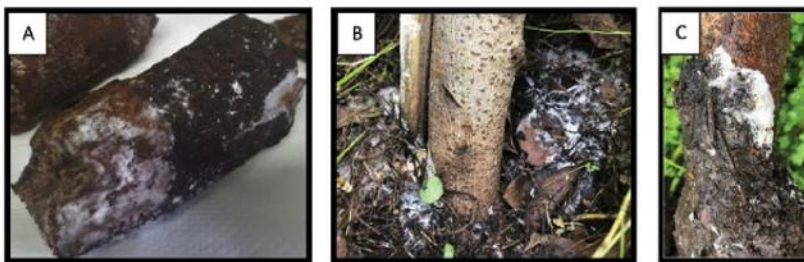


Figure 3. White, cottony mycelial growth of *Rosellinia necatrix* on A) root surface and inside a large root of an infected avocado tree, B) in soil around an infected tree, C) on the bark surface at the tree crown.

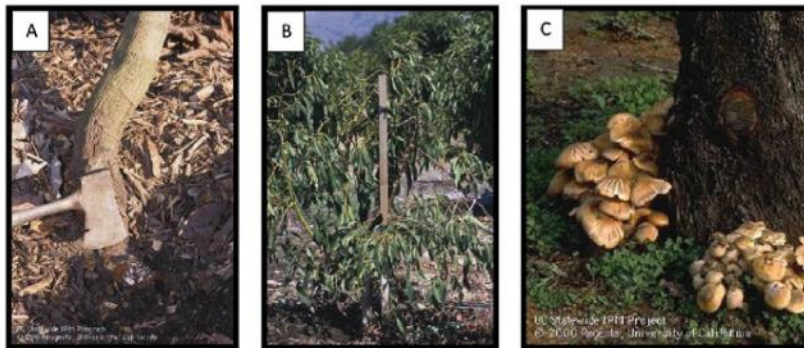


Figure 4. A) White-cream mycelia of *Armillaria* spp. growing under the bark of an infected avocado tree. B) Foliar symptoms of *Armillaria* root rot such as decline in vigour and leaf chlorosis. C) Short-lived mushrooms (*Armillaria* fruiting bodies) around the base of an infected tree during or after rainy weather. Photos by David Rosen and Jack Kelly Clark, provided by Dr. Akif Eskalen and University of California Agriculture & Natural Resources (UCANR).

Table 1. Symptoms of *Phytophthora* root rot compared to white root rot on avocado.

Phytophthora root rot	White root rot
Infects feeder roots progressing into the larger roots	Infects larger roots at multiple points
Infected feeder roots turn black and brittle becoming few in number	White, cottony mycelial growth visible on root surface and inside roots, in soil and underneath/on top of bark at the tree crown
Chlorosis, brown necrotic leaf tips, wilting and sparse foliage due to leaves dropping readily	Leaf yellowing, drooping of leaves, wilting and drying on the tree

Rosellinia necatrix spreads to adjacent trees through root contact, and growth through soil causes trees in close proximity to each other to die consecutively (Ten Hoopen and Krauss, 2006). All commercial avocado rootstocks used in South Africa seem to be susceptible to WRR. Thus sudden decline or tree death is more likely caused by WRR than PRR (Van den Berg *et al.*, 2018).

WRR control options are limited, so usually infected trees are removed and burnt. However, Fluzinam has shown potential in controlling WRR in greenhouse trials, although it has not yet been registered on avocado in South Africa (Magagula *et al.*, 2021). Soil solarisation of infected areas is also used but is an expensive option. Biocontrol agents (e.g. *Trichoderma* spp.) may also aid in treatment.

WRR is often mistaken for *Armillaria* root rot, as both display similar symptoms. However, *Armillaria* spp. have never been detected on avocado

samples received in the ARP diagnostic clinic.

Armillaria spp. infect the large roots and crown of avocado trees and white-cream mycelial growth can be observed along roots and underneath bark at the crown (Fig. 4A), eventually progressing to the cambium and inner bark at the tree base (Pérez-Jiménez, 2008; Eskalen *et al.*, 2016). This causes symptoms such as decline in vigour and leaf chlorosis (Fig. 4B) (Pérez-Jiménez, 2008).

Following wet weather conditions, honey-coloured *Armillaria* fruiting bodies may be produced near the base of infected trees (Fig. 4C) (Pérez-Jiménez, 2008). White mycelial fans produced by *R. necatrix* resemble the growth of *Armillaria* spp., however *Armillaria* spp. produce a mushroom-like odour.

Although these root rot pathogens are threatening, accurate and timely diagnosis is crucial in combatting diseases caused by them. It is therefore very important to note specific differ-

ences between these pathogens (Table 1), even though proper diagnosis by a diagnostic clinic is always advised.

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