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ENH1217

Armillaria Root Rot (Also known as Mushroom Root Rot, Shoestring Root Rot, Honey Mushroom Rot) [1]

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Summary

Armillaria root rot is a disease that decays the root system of many common trees and shrubs. It is caused by several species of *Armillaria,* fungi that can be recognized by the clusters of yellow to honey-colored mushrooms that emerge during moist conditions. The disease is often lethal, and infected trees may have wilting branches, branch dieback, and stunted growth. Infected trees and shrubs should be removed and replaced with resistant species (Table 1).

Introduction

Armillaria spp. cause root and butt rot of trees and shrubs worldwide, from tropical to boreal regions (Sinclair and Lyon 2005). *Armillaria* spp. have a wide host range, including many hardwoods and conifers. The fungus infects the roots and bases of trees, causing them to decay, weaken, or die. Some species of *Armillaria* are primary pathogens, capable of attacking and killing trees, but others are opportunistic pathogens that kill only unhealthy or stressed trees. In some western conifer forests, *Armillaria* is considered a major forest pathogen, and silvicultural practices must be tailored to prevent major tree loss (Hagle 2008). In Florida, *Armillaria tabescens* is the most common pathogenic species (Sinclair and Lyon 2005) and is primarily an opportunistic pathogen, but it may kill seemingly healthy trees and shrubs in both urban and natural areas, particularly when host species are stressed.

Signs and Symptoms

Trees with Armillaria root rot display one or more of the following symptoms:

- Fading, wilting, or thin foliage (Figure 1)
- Overall decline
- Dead branches
- Branch or trunk failure
- Dieback (Figure 2)
- Stunted growth
- Death (Figure 2)

During high winds, trees infected with *Armillaria* may break from the weakened base and cause damage or injury. Large trees infected with *Armillaria* are considered hazard trees and should be removed when near targets, such as property or people.

Armillaria root rot can be easily recognized by a few distinct signs. Clusters of short-lived yellowish to honey-brown mushrooms (Figures 3 and 4) are the reproductive structures of the fungus and are usually observed when there are cool, moist conditions during the fall and winter, or occasionally in late spring. The mushrooms often occur at the base of an infected tree (Figure 5) or on and near stumps of previously killed trees (Figure 6), but they may

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also grow from the underground roots of an infected tree away from the main stem. White fans of mycelia (the vegetative form of the fungus) (Figure 7) can be observed under the bark of stems and roots of infected trees. The purpose of the mycelia is to absorb nutrients and decompose dead vegetative matter. The mycelia of most *Armillaria* species is bioluminescent (it glows in the dark); however, that is not the case for *Armillaria tabescens*, the most common species in Florida. *Armillaria* can also be identified by dark, string-like, underground mycelial growths known as rhizomorphs (Figure 8), which originate at the infected root system.

Figure 1. Thinning foliage of a laurel oak (*Quercus hemisphaerica*) infected with *Armillaria tabescens*.
Credits: Jason Smith

Armillaria rhizomorphs are also vegetative parts of the fungus. They are thick mycelial growths that transport nutrients and increase the fungus's size. Rhizomorphs look like long, black shoestrings, giving Armillaria root rot the nickname "shoestring root rot." They are frequently overlooked because they blend in with the tree's existing root system. This is especially true with trees that tend to have many aerial and surface roots, such as those in the *Ficus* species. However, rhizomorphs are frequently absent in Florida.

Armillaria root rot in Florida is primarily caused by *Armillaria tabescens* and *Armillaria mellea* (Alfieri et al. 1984). The disease is found primarily on hardwoods, especially oaks (*Quercus* spp.) and hickories (*Carya* spp.). It spreads through the soil by the movement of the rhizomorphs that spread from infected trees to adjacent noninfected roots and stumps (Sinclair and Lyon 2005). Root-to-root contact is important for disease transmission. Damaged roots are susceptible to infection; however, healthy roots apparently resist infection (Sinclair and Lyon 2005). In both natural and urban landscapes, Armillaria root rot is often a secondary condition that affects a stressed tree. Drought, disease, pest infestation, cold injury, planting too deep, overpruning, and improper fertilization are some of the stresses that may initially affect trees.

Figure 2. Oak stand exhibiting pocket mortality typical of Armillaria root rot.
Credits: Ed Barnard

Figure 3. Young developing mushrooms of *Armillaria tabescens*.
Credits: Jason Smith

Armillaria root rot can spread both between trees and shrubs by either airborne spores that come from mushrooms at the base of the trunk, or by the rhizomorphs.

Figure 4. Mature mushrooms of *Armillaria tabescens* and root of an oak infected with the pathogen.
Credits: Ed Barnard

Figure 5. White mycelial fan under the bark of a root infected with *Armillaria tabescens*.
Credits: Ed Barnard

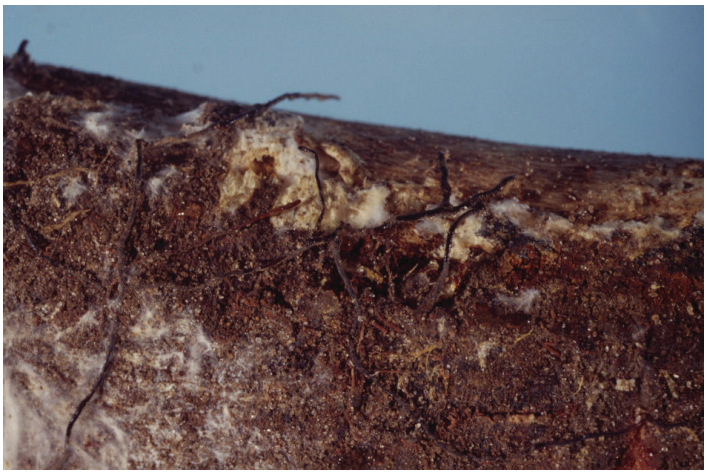

Figure 6. Rhizomorphs of *Armillaria* spp. produced under the bark of an infected root.
Credits: Ed Barnard

One infected tree can infect neighboring trees and shrubs through close root association or open wounds. An infected landscape tree may serve as inoculum for shrubs and other trees. For example, *Armillaria* may spread from an infected oak to azaleas planted underneath it and to other trees in the yard. Because of the nature of the disease spread, it is not uncommon to find groupings of trees and plants affected by *Armillaria*.

Figure 7. Mushrooms of *Armillaria tabescens* at the base of an infected mockernut hickory (*Carya tomentosa*)
Credits: Jason Smith

Figure 8. *Armillaria tabescens* fruiting near a stump of a previously killed laurel oak.
Credits: Jason Smith

Management

As with many landscape disorders, **the most appropriate management technique is the avoidance of infection**. Maintain healthy trees by using proper pruning, fertilization, irrigation, and pest management practices. One

should commit to planting a more diverse landscape because they tend to better withstand pests, diseases, and even severe weather events.

Symptoms of Armillaria root rot often do not appear until 1–3 years after infection has taken place. Therefore, it is difficult, if not impossible, to save trees once they become infected. There are no fungicidal cures for *Armillaria*. However, fungicidal soil treatments can be used at planting to reduce the likelihood of infection in newly planted trees (Cox, Scherm, and Beckman 2004). Always disinfect pruning tools between plants to reduce the possibility of transmitting diseases. Some plants that have only a small area of infected roots or root collar may be saved by exposing the area to aeration, drying the fungus, and halting growth (Sinclair and Lyon 2005). Because *Armillaria* spp. can live in dead stumps and roots for years, an infected tree or shrub should be completely removed, including the stump and major roots. Replanting a resistant (Table 1) species (Davidson and Byther 1994; Raabe 2008) can follow tree removal (Worrall 2007), but special care should be taken not to damage the new plant's root system. Removal of other susceptible trees or shrubs near the infected plant may be necessary to prevent the disease from spreading over a large area (Williams et al. 1986).

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Table 1. Resistant species[1]

*Acer negundo**	Box elder
Acer rubrum	Southern red maple
Acer saccharum	Sugar maple
*Albezia julibrissin**	Silk tree/mimosa
Asimina triloba	Pawpaw
Buxus sempervirens	Boxwood
Catalpa bignonioides	Southern catalpa
Celtis occidentalis	Hackberry
Cryptomeria japonica	Japanese cedar
Cupressocyparis leylandii	Leyland cypress
Diospyros virginiana	Common persimmon
Ficus carica 'Kadota'	Kadota fig
Ficus carica 'Mission'	Mission fig
Ginkgo biloba	Ginkgo
Ilex opaca	American holly
Ilex cassine	Dahoon
Jacaranda acutifolia	Jacaranda
Lagerstroemia indica	Crapemyrtle*
Liquidambar styraciflua	Sweet gum
Liriodendron tulipifera	Tuliptree
Magnolia grandiflora	Southern magnolia
Maytenus boaria	Mayten tree
Morus spp.	Mulberry
Myrica pensylvanica	Bayberry
Nandina domestica	Heavenly bamboo
Platanus species	Sycamore
Prunus caroliniana	American cherry laurel
Prunus serotina	Black cherry
Raphiolepis umbellata	Yedda hawthorn
Rhus aromatica	Fragrant sumac
Sophora japonica	Japanese pagoda tree
Taxodium distichum	Bald cypress
[1]Adapted from Davidson, and Byther (1994) and Raabe (2008).	