



Oak (*Quercus*) and Numerous Other Species Disorder: Armillaria Root Rot

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Symptoms and Effects

Armillaria root rot is a common, yet infrequently identified and poorly understood disease capable of attacking virtually all species of trees growing in Wisconsin. It is sometimes called "shoestring root rot" and the causal fungus is often referred to as the "honey mushroom." Because oak is one of the preferred hosts, it is also called "oak fungus" and we are including the primary discussion of the disease under this species. Its effects may be equally severe on other trees including maples, apples and conifers.

If a tree undergoes a slow to rapid decline without any obvious reason, suspect Armillaria root rot as the cause. Certain areas, such as sites of previous forests, particularly oak forests, are likely areas for this disease. Old roots left underground provide a food base for continued fungal growth and survival.

General symptoms of Armillaria resemble those of other root disorders. These symptoms are disrupted growth, yellow foliage, branch dieback, and resin or gum exudates (oozes) at the root collar of conifers. Trees may die rather abruptly without showing any decline symptoms. Conifers are particularly likely to die quickly.

Only rarely can the disease be diagnosed without examining the larger (buttress) roots and root collar of the tree. After carefully removing the soil, examine for the presence of:

1. **Rhizomorphs**, or fungal "shoestrings" attached to the wood under the bark. These may occur beneath the bark for some distance above the soil line in advanced cases, or they may radiate from the wood into the soil. Rhizomorphs may also grow out from the larger roots, resembling feeder roots in appearance. They are about the diameter of a pencil lead and vary in color from black to reddish-brown. The interior consists of white mycelial tissue. The untrained observer will have difficulty distinguishing tree roots from the rhizomorphs.

2. **Decayed areas of wood** at the root collar or on the buttress roots. Armillaria causes a white rot and the wood develops a stringy texture. Roots in advanced stages of decay may be soft, yellowish and wet.



Stages of Armillaria development that are helpful in diagnosis: a. soil adhering to the roots, especially on pines; b. white mycelial fan of the fungus just beneath the bark; c. mushrooms, or fruiting structures of the fungus; d. rhizomorphs.

3. **Veined, white mycelial fans** between the bark and wood where the cambium has been killed. Sometimes this fan (or fans) extends quite far above the soil line beneath the bark.

4. **Resin flow**, especially at the root collars of conifers.

5. **Soil remaining attached to the roots.**

6. **Characteristic mushrooms** on the lower trunk or on the ground near infected roots. These short-lived annual fruiting structures of the disease-causing fungus may develop during the fall season and may occur singly, in small clusters or in large numbers.

The stalk is typically yellow and 3 inches or more long. Usually a ring is connected to the stalk just below the cap. The cap is 2 to 5 inches across and often honey-yellow. It may be dotted with dark brown scales. The underside is covered with loosely spaced white or yellow gills radiating from the stem. Most mushroom hunting textbooks offer excellent illustrations and descriptions and are very useful for those familiar with the fungus.

The trained arborist can diagnose *Armillaria* infection in the field with confidence when most of the symptoms are evident. A plant disease diagnostic laboratory can assist diagnosis if you submit proper materials. Your local Extension office may be able to help you in submitting for examination root and bark sections containing suspect rhizomorphs or mycelial fans. Leaves, branches, bark and above-ground wood do not aid diagnosis.

Other Roles of the Fungus

*After the disease has been identified, the arborist should study the situation to determine the role *Armillaria* root rot has played in causing the decline or death of the tree.* The disease can cause death directly as it has done in many pockets of conifer plantations and isolated shade tree locations in Wisconsin.

Frequently the fungus is only involved in a secondary manner by invading and destroying roots after the tree has been exposed to stress of some form, such as severe drought, heavy defoliation or soil fill over the roots. The fungus can also act as a saprophyte—an organism that lives on dead matter—and it is frequently involved in the decay of old tree stumps and roots.

Many oaks are lightly infected with the disease for years with no resultant damage except for isolated pockets of buttress root rot which are walled off by the tree and have no ill effects. Other infected trees show no damage until subjected to stress. Accumulating evidence suggests the type of root exudate (discharge) that is produced influences the susceptibility of the tree. Certain forms of stress cause a shift in exudates that promote rapid development of the fungus and may hasten tree invasion and decay.

The common association of rhizomorphs with roots of oaks, and perhaps other hardwoods as well, poses a potential threat to conifers—especially pines—planted in the vicinity. If the hardwoods are killed or cut, *Armillaria* immediately uses the root system as a food base from which it sends out rhizomorphs for a period of several years thereafter. Contact of rhizomorphs with the pine roots results in infection and death of the pine, or other susceptible coniferous trees. This happens when converting low quality hardwood stands to coniferous plantations, and could occur in parks or ornamental landscapes.



Note rhizomorphs emerging from the food base on the right and attacking the pine root on the left. This is approximately normal size.

Cause—Fungus (*Armillaria mellea*)

Spores are produced by the mushroom fruiting structures, disseminated by air currents and introduced into new areas. Under proper conditions spores may infect old stumps or the bases of dead trees or woody shrubs. Such an infected stump or root system serves as a food base from which rhizomorphs are produced. Rhizomorphs may grow through the soil for several feet from the food base, and when they make contact with the roots of a susceptible host, they may penetrate unwounded bark directly in the cambium region. Once the fungus enters the cambium and bark tissues, mycelial fans develop during the parasitic phase of the attack. Subsequently, mycelium invades and decays the woody tissue of the roots and sometimes also the base of the trunk. Under proper conditions the fruiting structures (mushrooms) form at or near the base of the infected host, completing the life cycle.

Control

Direct control of the fungus in a diseased tree is not possible with present technology. However, in many instances the fungus is incapable of causing severe damage unless the tree is first subjected to substantial stress. Thus, keeping the tree healthy and avoiding severe stress is one important approach in preventing loss of shade and ornamental trees to Armillaria root rot.

Drouth and leaf defoliation are two major forms of stress that favor Armillaria. In dry years it is advisable to water valuable trees to a depth of 1 to 2 feet. For instance, root waterers effectively provide water penetration 12 to 18 inches into the soil. Slow sprinkler irrigation of 2 to 3 inches of water is also effective if done so that the water penetrates the soil rather than running off the surface. From 1 to 2 inches of water is required to wet the soil to a depth of 1 foot. Sandy soils require about 1 inch; heavier soils require 2 inches. Because soil may absorb less than 1/2 inch of water per hour, apply it slowly especially on heavy sloping soils.

Protect valuable trees from severe leaf loss from insects and avoid subjecting trees to other forms of stress such as soil compaction and physical injury. Fertilizing a tree occasionally may minimize Armillaria effects, although no research information apparently exists on the subject.

The second most important means of minimizing Armillaria damage is to avoid or eliminate the fungus inoculum *before planting*. Trees planted in prairie soils are unlikely to be affected by the disease, but those planted in former forest or woodland sites will quite likely be exposed. As these sites cannot always be avoided, here are a few suggestions that may be helpful.

1. Remove stumps and old roots in construction sites or other areas where it is possible.

2. If you are removing old trees some time before new trees will be planted, kill the old trees by deep girdling to exhaust the nutrient reserves of their roots.

3. Avoid planting extremely susceptible trees—oaks, maples and conifers—in heavily infested areas.

4. Deep fumigation of the planting area maybe effective in destroying the fungus. The soil area should be loosened with a mechanical “back hoe” to a depth of 36 inches before fumigation.

California orchardists have fumigated for Armillaria control on several occasions. The chemical they used is not registered for such purposes in Wisconsin. Other fumigants such as Vapam (metam sodium) may be effective if applied deeply and heavily enough. Ample aeration of the soil after treatment and before transplanting is necessary to prevent chemical injury to the new transplant. Follow label directions carefully. See extension publication A2612, *Selecting and Using Chemical Fumigants and Soil Sterilants for Seedbed and Garden Disease Control*, for more information.

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