

## 38. Armillaria Root Disease

James T. Blodgett; revised from Lloyd R. Fuller and Robert L. James  
(Riffle and Peterson 1986)

Armillaria root diseases are caused by several species of fungi in the genus *Armillaria*. These pathogens are common facultative parasites on more than 600 plant species throughout the world. Root diseases caused by these fungi are responsible for considerable economic damage in natural forests, plantations, orchards, and vineyards.

### Hosts and Distribution

Root diseases caused by *Armillaria* species occur sporadically throughout the Great Plains, but their distribution in most of the Great Plains states is not well documented. Most trees, shrubs, vines, and some herbaceous plants are susceptible to these pathogens. Armillaria root diseases are common in windbreaks, forests, and landscapes. Some susceptible plants native to or planted in the Great Plains include: apples (*Malus* spp.), aspen (*Populus* spp.), boxelder (*Acer negundo*), cottonwoods (*Populus* spp.), oaks (*Quercus* spp.), paper birch (*Betula papyrifera*), Peking cotoneaster (*Cotoneaster acutifolius*), ponderosa pine (*Pinus ponderosa*), poplars (*Populus* spp.), Scots pine (*Pinus sylvestris*), stone fruits (cherry, peach, and plum; *Prunus* spp.), Tatarian honeysuckle (*Lonicera tatarica*), willows (*Salix* spp.), and members of the rose family (Rosaceae).

### Symptoms and Signs

Symptoms are not always diagnostic, and trees with Armillaria root disease do not always show well-defined symptoms. When present, crown symptoms resemble those of other root disorders: chlorotic foliage, reduced terminal growth, premature foliage drop,



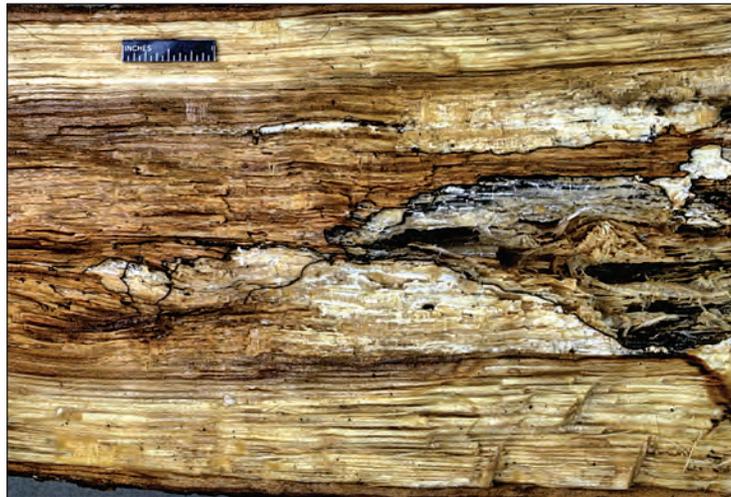
**Figure 38-1**—Chlorotic foliage with extensive dieback, a typical symptom of (A) lodgepole pine (*Pinus contorta*) and (B) aspen infected with Armillaria root disease (James T. Blodgett, U.S. Forest Service).

branch dieback, and stress crop of seeds or cones (fig. 38-1). One or more of these symptoms may be present on a single tree over many years or sudden crown mortality may occur. Sudden crown mortality can occur even if a tree was infected for several years. Hosts infected at the base of the trunk (root collar) may have external basal resinosis or gummosis (fig. 38-2), but these symptoms may not always be present. *Armillaria* species cause white rot, often with zone lines (fig. 38-3), in roots and lower stems. Decay can be difficult to detect unless trees are uprooted or break at the root collar.

Diagnostic signs include mycelial fans under or in the bark, rhizomorphs (a cordlike structure containing mycelia, which resembles roots or shoe strings), and mushrooms. *Armillaria* species produce characteristic mycelial fans (fig. 38-4) that appear as white to light cream-colored, fanlike mycelial mats beneath or inside the bark of roots and lower stems (butts).



**Figure 38-2**—Lodgepole pine infected with Armillaria root disease showing resinosis at the root collar (James T. Blodgett, U.S. Forest Service).



**Figure 38-3**—Armillaria white rot with zone lines (Daniel H. Brown, U.S. Forest Service, Bugwood.org).



**Figure 38-4**—Mycelial fan, a diagnostic sign of Armillaria root disease, seen here on aspen (James T. Blodgett, U.S. Forest Service).



**Figure 38-5**—Rhizomorphs (gray to black, see arrows) in soil growing into a root and root collar, diagnostic signs of *Armillaria* root disease (James T. Blodgett, U.S. Forest Service).



**Figure 38-6**—Fruiting bodies of an *Armillaria* species at the base of a paper birch (James T. Blodgett, U.S. Forest Service).

Mycelial fans develop in the cambial zone of roots and root collars, and can spread into stems. The rootlike rhizomorphs may be found on root surfaces, in adjacent soil (fig. 38-5), in decayed wood, or under the bark of living or dead trees. These structures are gray, reddish brown, or black on the exterior with a white inner core and tip. Rhizomorphs branch like roots, but typically have less variation in diameter (0.5 to 2 mm) compared to roots. Rhizomorphs that occur on root surfaces, in soil, and in decayed wood tend to be round; ones beneath bark tend to be flat.

*Armillaria* species might produce mushrooms in sporadic years (fig. 38-6). Mushrooms are short-lived, but may be present from late summer through fall if moisture is adequate. The mushrooms grow in small to large clusters on living and dead hosts, or on soil near underground wood. *Armillaria* mushrooms can be identified by their honey-yellow caps 1 to 5 inches across with a persistent annulus (ringlike structure) on the upper stem. Caps have fine erect hairs or scales on the upper surface. The white gills on the underside of the cap are attached to the stem. Spores are white to light cream colored.

Differences among the *Armillaria* species and host species result in variation among symptoms and signs, and *Armillaria* species are

often somewhat host specialized. *Armillaria* can be identified to species by traditional morphology, mating types, cultural characteristics, and DNA sequences. Additional studies are needed to identify *Armillaria* species present in many areas of the Great Plains.

### Disease Cycle

These pathogens spread primarily as vegetative mycelium by root contact, root grafts, or rhizomorphs. Rhizomorphs can grow considerable distances (up to 6.6 ft per year) through soil and initiate parasitic infections or saprotrophic colonization of roots or root collars. *Armillaria* species can occupy sites for many years. In one relatively dry region, a single vegetative clone of *Armillaria* was shown to occupy an area of approximately 2,384 acres and was estimated to be up to 8,650 years old. During favorable late summer or fall weather, mushrooms of *Armillaria* species may produce prolific wind-dispersed spores. However, unlike many other decay pathogens, the spores rarely initiate disease.

Mycelial strands can colonize susceptible host cambium and initiate canker formation. Cankers can remain dormant (quiescent) or progress into lethal infections. Healthy, vigorous hosts or resistant host species may survive for many years. Stressed hosts, hosts with numerous or extensive infections, and susceptible host species can be killed quickly. Successfully infected hosts usually die when the fungus kills the cambium around root

collars. Live trees can be uprooted or break at the lower stem because of mechanical failure resulting from decay. Although such mechanical failures are more frequent during high-wind conditions, they can occur during conditions of low or no wind.

Saprotrophic colonization of wood tissues occurs after trees or tree tissues die. *Armillaria* species can also colonize trees killed by other damage agents. The fungus can survive for decades in dead roots or stumps, and can infect new trees over the course of decades.

## Damage

Armillaria root diseases affect trees used for many forest services and products including recreation, aesthetics, timber, windbreaks, watershed protection, soil stabilization, and carbon sequestration. Root diseases in developed sites can produce hazard trees that threaten life and property because of an increased probability of hosts falling. Armillaria root diseases cause direct tree mortality and indirect mortality through uprooting or breakage of lower stems, growth reduction, and wood loss from decay. They also predispose trees to other lethal agents including insects and other diseases. Armillaria root diseases are common contributing factors in many declines and can increase the likelihood of fire by increasing the accumulation of dead fuels.

In some situations, *Armillaria* species are not damaging unless hosts are under stress. Stresses can include extended droughts or dry sites, competition for light or nutrients, insect attacks, infections by other pathogens, or poor planting technique including offsite plantings. Young trees are often quickly killed by *Armillaria* species, whereas 15- to 20-year-old trees tend to be more tolerant.

## Management

These pathogens are difficult or impossible to eradicate. Management measures can include removing infected stumps and roots, limiting underground spread of the fungus, managing for resistant species, using proper planting techniques, and maintaining tree health. Management of root diseases over extensive acreage is seldom possible or practical. Valuable ornamental, shade, and orchard trees that are adjacent to infected trees may be protected somewhat by removal of infected stump and root material from the soil. Chemicals have been used to sanitize infested soil and wood, but only professional chemical applicators should apply these chemicals near healthy trees. Favoring healthy existing species and favoring species that are resistant to Armillaria root disease during thinning or planting offer the most promising and long-lasting approaches to disease control. Lists of resistant plants that are well adapted to a locale can be obtained from local extension educators or from the reference by Raabe and McCain (1967). Use proper planting methods, such as adequate site preparation, selection of species suitable for the site, use of foliage that is in balance with root systems, selection of disease-free planting stock, and prevention of J-roots (tap roots pointing up; usually the result of improper planting). Reduce host stress by thinning, weed control, watering during droughts, and managing other diseases and insect pests so that the impact of Armillaria root diseases can be minimized.

## Selected References

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