

Symptoms and Diagnosis

Symptoms and Diagnosis of Annosus Root Disease in the Intermountain Western United States¹

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Abstract: Stand patterns of annosus root disease include various degrees and patterns of tree mortality; tree crown, root collar, and root symptoms; and the condition and location of stumps. In the Intermountain states of Montana, Idaho, and Utah, annosus root disease is found in the ponderosa pine, mixed conifer and high-elevation fir forests. Stand patterns are of value in diagnosing the disease in each of these forest types, but other root pathogens may cause similar symptoms. Confirmation of annosus root disease depends upon further steps in the diagnosis process.

Annosus root disease, which is caused by Heterobasidion annosum, is one of several important root diseases of the Intermountain States of Montana, Idaho, and Utah. In the first section of this paper I will discuss stand patterns of annosus root disease. Other root diseases cause similar patterns, however. In the second section I will discuss annosus root disease diagnosis in the three major Intermountain area forest types: ponderosa pine, mixed conifer, and high-elevation fir.

THE USE OF STAND PATTERNS IN ANNOSUS ROOT DISEASE DIAGNOSIS

Stand indicators of annosus root disease are based mainly on various degrees and patterns of tree mortality; tree crown, root collar, and root symptoms; and the condition and location of stumps. Each of these will be discussed.

Degree and Pattern of Tree Mortality

The main effect of annosus root disease is that it kills trees, either directly by destroying their roots or indirectly by predisposing them to

bark beetles and other agents. But trees die from many other causes. How can tree mortality from annosus root disease be distinguished from that resulting from other causes?

First, tree mortality resulting from annosus root disease tends to be concentrated in centers or patches rather than distributed at random in a stand. This pattern is due to the unique tree-to-tree spread of root pathogens through contacting root systems. Trees that do not belong to a recognizable center of mortality are sometimes killed, and many groups include only a few trees. However, the typical mortality pattern for most annosus root disease is what is referred to as the annosus root disease "center," "pocket," or "patch."

A second characteristic of tree mortality caused by annosus root disease is that it is chronic. Root disease patches enlarge slowly as the pathogens spread from diseased trees to the roots of uninfected neighbors, and in turn are killed and become avenues of spread for the pathogen to still other neighbors. Bark beetle attack can kill a group of trees, but unless a root pathogen is also present, bark beetle outbreaks usually do not last more than 2 or 3 years. Tree killing by annosus root disease may persist for decades, resulting in stand openings that are ringed with dead and dying trees, and that contain older tree kills in various stages of decay farther into the opening.

Attack by bark beetles or wood borers can be an indicator of annosus root disease, whether or not the trees are killed immediately. The presence of root disease is particularly likely in trees attacked by bark beetle species that prefer weakened trees. These are Dendroctonus valens, Dendroctonus brevicornis, Scolytus ventralis, Dryocetes confusus, and except when it is in the outbreak stage, Dendroctonus pseudotsugae.

Annosus root disease may be suspected when trees of various size or age classes are killed. Many insects and pathogens tend to attack and kill trees of a particular size class. Many bark beetles, for example, attack the larger size tree classes. The annosus root pathogen kills large overstory trees, but also smaller trees in the patch including regeneration of seedlings and saplings of susceptible species that come up in stand openings caused by the root disease.

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Tree Crown and Root Symptoms

Trees may live for many years following infection by the annosus root disease pathogen. The progressive killing and decay of a tree's root system results in a gradual decline of its crown.

The decline of sapling-sized trees is expressed in reduced height growth for a few years before death. Compare the lengths of recent leader growth on dead trees and living trees suspected of being diseased with the lengths of their earlier growth and the growth of leaders of similar-aged neighbors. Young trees also may become chlorotic before death and may have reduced needle retention. Closely examine trees whose needles are more yellow than those of others in the stand and that have shorter lengths of needle-bearing branches.

Terminal growth of both pole-sized and mature trees may be reduced for many years, resulting in a distinctly rounded top compared with healthy trees in the stand. Foliage may be chlorotic. Needles, especially older needles, are cast prematurely and the crown becomes thin. Thinning is most noticeable in the lower and interior parts of the crown.

Mature trees may also produce an abundant cone crop immediately before death. The stress cones may remain on the tree for several years following tree death, after all foliage is gone.

Finally, symptoms of root disease may be present at the root collar and in the roots of infected trees. Root and root collar symptoms include excessive pitch production, stringy, white root decay, root lesions, and various types of stains in the root and bole.

Condition and Location of Stumps

Not all root infection results in tree death. The true firs and hemlocks are especially prone to annosus root and butt rot, for example. The presence of root disease in stands of these species is most easily detected by examining stumps from an earlier harvest for the presence of butt rot or stump cavities.

The mere presence of stumps in and near groups of dead trees is itself an indication of root disease. Stump-centered tree mortality is one of the best indicators of annosus root disease. Airborne spores of the pathogen are transferred to the freshly cut surface of the stump where it germinates and establishes an infection. The annosus root rot pathogen then uses the stump as a food base from which to spread through its roots to neighboring trees forming a new center of annosus root disease.

DIAGNOSING ANNOSUS ROOT DISEASE IN THE INTERMOUNTAIN WESTERN UNITED STATES

It is a common practice to classify annosus root disease by forest type. These classes include (1) annosus root disease of ponderosa pine in the pine type forest, (2) annosus root disease of grand fir, white fir, and sometimes other species in the mixed conifer-type forest, (3) annosus root disease of subalpine fir or red fir in high-elevation forests, and (4) annosus disease of western hemlock in the coastal hemlock type forests. Three of these forest classes are present in the Intermountain area. The amount of damage can vary greatly, but annosus root disease can be found in these forest types in each of the Intermountain States--Montana, Idaho, and Utah.

Ponderosa Pine Type

Ponderosa pine is killed by annosus root disease in low-elevation, dry, pine forests where ponderosa pine or Douglas-fir is the climax species. The mortality usually occurs as small pockets, but disease centers also can be quite large. In diagnosing this disease, look for single affected pines or groups of pines that are associated with pine stumps from logging 10 or more years earlier. Large or small pines or both may be killed. Evidence of attack by the western pine beetle, pine engraver, or other beetles may be present. Infected trees may exhibit crown symptoms, but those are often subtle and easily overlooked. Similar mortality is sometimes caused by Ceratocystis wageneri or Armillaria obscura, although most A. obscura killing occurs on wetter sites where Douglas-fir is the climax species.

Mixed Conifer Type

Annosus root disease is found in grand fir and several other species, including Douglas-fir, in mixed conifer forests. These are on sites where grand fir, hemlock, or cedar is climax. Tree mortality may occur in large or small patches that may or may not be related to stumps from an earlier timber harvest. Annosus root disease may also cause decay in grand fir roots and butts without causing subsequent mortality. To diagnose this disease in mixed-conifer forests, look for butt rot in stumps and old-growth true fir trees. Tree mortality similar to that in grand fir and Douglas-fir may also be caused by Phellinus weirii and Armillaria ostoyae. In fact, the presence of two or more of these pathogens is common in the same stands and in the same trees in northern Idaho. The association may be particularly close between annosus root disease and Armillaria root diseases there.

Signs and symptoms of A. ostoyae are usually found on grand firs and Douglas-firs showing crown symptoms of root disease on the Clearwater and

Nezperce National Forests, for example. Root collars of such trees exude pitch, and chopping into them reveals the typical mycelial fans of Armillaria. On a number of occasions we have also confirmed the presence of annosus root disease in these trees by culturing the pathogen from decay in deeply positioned roots or uprooted or excavated trees. In addition, we have cultured the pathogen on both species on stained portions of disks cut from boles near the soil line. So another key in diagnosing annosus root disease in the mixed conifer type is to look for annosus root decay and evidence of stain columns in stems of true firs or Douglas-fir species infected by Armillaria.

High-Elevation Fir Forests

Annosus root disease tree mortality or butt rot or both has also commonly been found in subalpine fir forests of the Intermountain area. It occurs as pockets of mortality. Dryocoetes confusus is typically present. Armillaria ostoyae also causes similar damage, and both pathogens may be present in the same trees, especially in north Idaho. The diagnosis is similar to that on grand or white fir.

CONCLUSION

Annosus root disease is active in ponderosa pine, mixed conifer, and subalpine fir forest types in Idaho, Montana, and Utah. Stand patterns of tree mortality, tree crown symptoms, and tree stump characteristics are helpful in diagnosing this disease. However, several other root pathogens may cause similar stand mortality patterns, and a complex that includes two or more of these greatly complicates diagnosis. Stand patterns alone are not sufficient for diagnosis, but it is the first step.

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