



Biology, Diagnosis, and Management of Heterobasidion Root Disease of Southern Pines

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Heterobasidion root disease (previously called annosum, annosus, or Fomes root disease / root rot) is one of the most economically damaging forest diseases in the Northern Hemisphere^{5,7}. Heterobasidion root disease (HRD) in the southeastern U.S. is caused by the pathogen *Heterobasidion irregulare*, which infects loblolly, longleaf, pitch, shortleaf, slash, Virginia, and white pine; eastern red cedar; and incense cedar⁷. This disease is predominately found in pine plantations after thinning on sites with well-drained sandy soils^{2,14}. HRD



Figure 1. Resinosis is the result of resin collecting in an infected area of a root infected with *H. irregulare*. These roots have a strong pine sap smell and are discolored compared to healthy roots.



Figure 2. White-stringy rot is a symptom of advanced root decay by HRD.



Figure 3. Sand can clump around resinosis areas on infected roots.

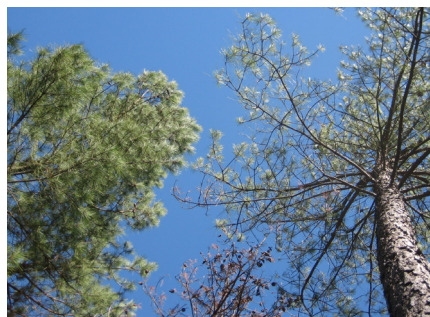


Figure 4. Trees with HRD often show aboveground symptoms such as fading crowns. The tree on the left is healthy, while the tree in the middle is dead and the tree on the right has a sparse crown.

weakens the tree and can cause reduced growth, tree mortality, and may contribute to increased susceptibility to bark beetle attacks^{3,4,6,13,16}.

Diagnosis

Root symptoms of HRD begin with resin-soaked wood (Fig. 1) that decays to a white-stringy rot (Fig. 2) and external resinosis (i.e. copious amounts of resin flow onto the bark or outer wood) is common. This resinosis often results in clumps of resin-soaked sand becoming attached to excavated roots (Fig. 3). Once the root system is weakened other symptoms may become apparent, including a thinned tree crown (Fig. 4), and an increased risk of bark beetle attack or windthrow (Fig. 5).

Because symptoms of HRD often overlap with other diseases, definitive field diagnosis requires identification of *H. irregulare* fruiting bodies (i.e. conks) or lab confirmation of the pathogen. *Heterobasidion irregulare* conks (Fig. 6a,b) can be found in the duff layer at the base of infected trees and stumps during times of high moisture and average daily temperatures below 70° F¹⁵.

Pathogen Biology

The HRD pathogen (*H. irregulare*) is introduced into previously uninfected stand by airborne spores produced by conks on infected trees and roots during cool, moist weather. When spores land on freshly cut stumps or fresh wounds on roots of live trees,



Figure 5. Trees impacted by HRD have weakened root systems, and are more susceptible to being windthrown.

the spores germinate and the fungus grows through the root systems¹⁰. Direct infection of unwounded roots can occur, especially in sandy soils where the litter and duff have been removed, but this is believed to be responsible for less than 10% of new infections^{9,11}. The HRD pathogen can spread to neighboring trees through root contacts and grafts leading to tree mortality. As this fungus invades the host tree, it decreases the capacity of the tree's root system to supply water and nutrients to the rest of the tree. Symptoms of HRD can include crown thinning and yellowish, shorter needles. The fungus also weakens the structural integrity of the root system, which can result in windthrow or increased risk of bark beetle damage^{4,10}. The HRD pathogen colonizes the living and freshly dead root systems and persists until they are completely decayed. In the southeastern U.S., symptoms tend to first appear 2 to 3 years following thinning, exhibit greatest severity 4-6 years after thinning, and then subside by the 10th year¹⁶.

Risk Factors

In the southeastern U.S., soil characteristics are used to determine the hazard rating of a site for HRD^{2,14} (Fig. 7). High hazard sites have sandy or sandy loam soils (65% sand) at least 12 inches deep with good

internal drainage and a low seasonal water table¹. Generally, losses are greater on former agricultural lands than on forest soils^{7,16}.

Management Strategies

Integrated disease management systems are generally more effective and less costly than single control methods for HRD^{7,16}. The following treatments are commonly used to reduce tree losses from HRD on high hazard sites:

- Stump treatments for thinnings in white pine and in southern pines on high hazard sites to reduce primary stump infection.
- Summer thinnings in stands on high hazard sites south of 34° N latitude (Fig. 7).
- Wider spacing between trees to delay and reduce required number of thinnings.
- Select species that are less susceptible to HRD – for example, plant longleaf pine on high hazard soils.

Management of stands affected by HRD is determined by the level of infection and the objectives for

the stand. In uninfected stands on high hazard sites, and all white pine stands, treatment of stump surfaces following thinning is the primary management method (Fig. 8).

The liquid formulation of borate, Disodium Octaborate Tetrahydrate (DOT) labeled Cellu-Treat® (Nisus Corporation), is currently available in the United States. DOT is applied to the stump surface after tree felling to prevent the establishment of the pathogen. One gallon of DOT (0.5 lb) typically treats 250 6" stumps or 90 10" stumps. While the DOT label indicates the application can be made up to three days after cutting, the application is commonly applied within 24 hours. It is not known if waiting longer to apply DOT causes a reduction in effectiveness. This treatment is not advised if HRD is already present in the stand because sealing the stump can prevent other natural competitors from entering the stump and the pathogen can pass through the treated stump to adjacent trees¹⁶. The other available stump treatment is the biofungicide Rotstop®C (BioForest Technologies Inc.), which contains *Phlebiopsis gigantea*, a common fungus that colonizes stumps. This stump treatment can be used to prevent both new infections and the movement of the HRD pathogen through the stump to adjacent



Figure 6. *Heterobasidion irregulare* fruiting bodies on a stump. Note the brown top and white edge. These fruiting bodies, or conks, commonly have leaves, needles, small twigs, or dirt attached to them.

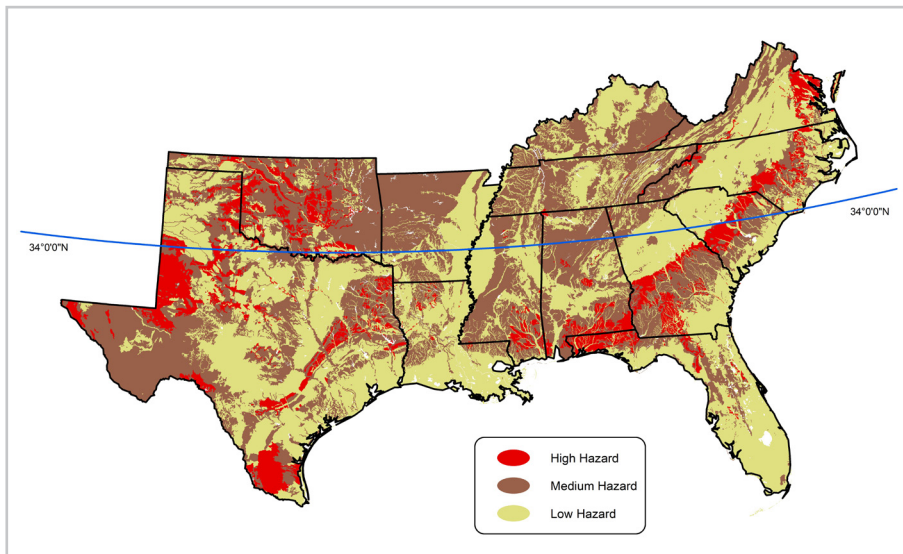


Figure 7. *Heterobasidion* root disease hazard rating map based on soil characteristics for the southeastern U.S.^{1,14}. Sites with higher hazard tend to have sandier soils. The blue line represents 34° north latitude.

trees^{7,16}. One gallon of Rotstop®C will treat 145 6" stumps or 65 10" stumps. In infected stands, partial salvages should use the biofungicide Rotstop®C on newly cut stumps or cut in the summer if the site is located south of 34° N latitude¹.

In the southeastern U.S., high temperatures on stump surfaces from May through August are often lethal to *H. irregulare* spores and growth in wood^{8,16}. Since conks are produced during the winter, few fungal spores are available in the summer to infect stumps. South of 34° N latitude, conks are rare during the summer (the high heat inhibits fungal growth) and thinning and salvage cuts during the summer can be used to reduce the potential for new infections¹⁵. North of 34° N latitude, summer thinning without stump treatment is not recommended, as cooler temperatures do not inhibit fungal growth or spore production like they do relative to areas south of 34° N latitude.

Clearcut harvesting of stands generally interrupts the progression of HRD and severely infected stands can be safely replanted as usual¹². In the

southeastern U.S. the high temperatures and moisture help stumps to degrade quickly, limiting the spread to newly planted seedlings¹⁶. The disease kills usually less than 8% of seedlings when previously infected stands are immediately planted following harvesting, even when employing no other control methods¹², Cram unpublished data.

Proactive HRD management on high hazard sites includes planting less

susceptible species, such as longleaf pine on well-drained sandy soils, and planting on a wider spacing to reduce the number of required thinnings. The use of stump treatments in pine stands on high hazard sites will significantly reduce stand infection, as will summer thinning under hot and dry conditions found south of 34° N latitude. Once a stand is affected by HRD, management of losses is more limited. HRD mortality will continue for up to 10 years from the time of thinning, and the potential for bark beetle attack is greater in these infected stands. Managers may choose to monitor the infected stand or perform a salvage cut or harvest depending on the level of HRD damage and expected outcome. Proactive management of HRD in pine stands on high hazard sites and in white pine stands in the southeastern U.S. can substantially reduce the risk of serious losses to this disease.

For more information contact your local extension agent or state forest health specialist. Additional resources are located at www.southernforesthealth.net.



Figure 8. Stump treatments can reduce the chance of infection by *H. irregulare*. This can minimize the likelihood of the stand developing HRD.

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Resources

For the location and phone numbers of state agencies in the southeastern U.S. providing forestry assistance and information, see the following websites:

Alabama Forestry Commission: <http://www.forestry.alabama.gov/>

Arkansas Forestry Commission:
<http://forestry.arkansas.gov/Pages/default.aspx>

Florida Forest Service: <http://www.floridaforestservice.com/>

Georgia Forestry Commission: <http://www.gatrees.org/>

Kentucky Division of Forestry:
<http://forestry.ky.gov/Pages/default.aspx>

Louisiana Department of Agriculture and Forestry:
<http://www.ldaf.state.la.us/>

Mississippi Forestry Commission: <http://www.mfc.ms.gov/>

North Carolina Forest Service: <http://www.ncforestservice.gov/>

Oklahoma Forestry Services: <http://www.forestry.ok.gov/>

South Carolina Forestry Commission:
<http://www.state.sc.us/forest/>

Tennessee Division of Forestry:
<https://www.tn.gov/agriculture/section/forests>

Texas A&M Forest Service: <http://texasforestservice.tamu.edu/>

Virginia Department of Forestry: <http://www.dof.virginia.gov/>

For the location and phone numbers of University Extension personnel in the southeastern U.S. providing forestry assistance and information, see the following websites:

Alabama Cooperative Extension System:
<http://www.aces.edu/main/>

University of Arkansas Cooperative Extension Service:
<http://www.uaex.edu/>

University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS):
<http://solutionsforyourlife.ufl.edu/>

University of Georgia Extension: <http://extension.uga.edu/>

Kentucky Cooperative Extension Service:
<https://extension.ca.uky.edu/>

Louisiana Cooperative Extension Service:
<http://www.lsuagcenter.com/>

Mississippi State University Extension Service:
<http://extension.msstate.edu/>

North Carolina Cooperative Extension:
<https://www.ces.ncsu.edu/>

Oklahoma Cooperative Extension Service:
<http://www.oces.okstate.edu/>

Clemson Cooperative Extension (South Carolina):
<http://www.clemson.edu/extension/>

University of Tennessee Extension:
<https://extension.tennessee.edu/>

Texas A&M AgriLife Extension: <http://agriflifeextension.tamu.edu/>

Virginia Cooperative Extension: <http://www.ext.vt.edu/>

To locate a consulting forester:

Association of Consulting Foresters:
<http://www.acf-foresters.org/acfweb>.

Click on "Find a Forester", then select your state in the "People Search – Public" search page.

For more information on how to select a consulting forester, go to:

<http://msucare.com/pubs/publications/p2718.pdf>

<http://texashelp.tamu.edu/011-disaster-by-stage/pdfs/recovery/ER-038-Selecting-a-Consulting-Forester.pdf>

<http://www.uaex.edu/environment-nature/forestry/FSA-5019.pdf>

Additional information on Annosum Root Rot is available at:

<http://southernforesthealth.net/fungi/annosum-root-rot>

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