How to

Identify and Control Littleleaf Disease

Protection Report R8-PR 12
September 1988

United States Department of Agriculture
Forest Service Southern Region

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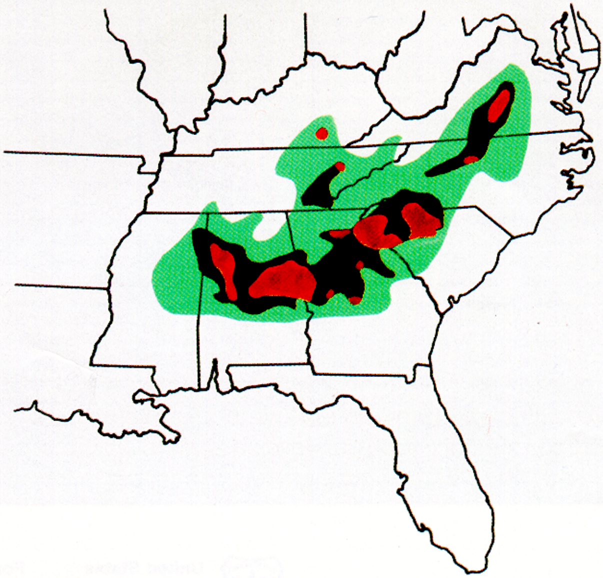
Littleleaf, the most important disease of shortleaf pine, is a significant constraint on management of the species on about 1.4 million acres in the Piedmont plateau of North Carolina, South Carolina, Georgia, and Alabama. Loblolly pine, while considered less susceptible, may suffer growth losses on high-risk sites in this area or be killed by associated bark beetles.

Littleleaf disease losses are difficult to determine. Included are growth reduction, mortality from disease or associated bark beetle attack, or even elimination of severely affected areas from timber production. Losses to littleleaf disease have been estimated at $15 million annually, but this number is surely conservative. Another indicator of littleleaf disease severity is a very large reduction in the acreage of shortleaf pine in managed forests on high-risk sites and its partial replacement by more resistant loblolly pine. However, when it is managed on long rotations, even loblolly pine is damaged.

Littleleaf disease is unusual in that it is not caused by a specific pathogen. Rather, it results from a complex of factors that stress the tree and increase its susceptibility to infection by root rotting fungi. The history of land use on the Southern Piedmont plays a major role in this disease complex.



Range of shortleaf pine (green) east of the Mississippi River, general range of littleleaf disease (brown), and areas of highest incidence (red).

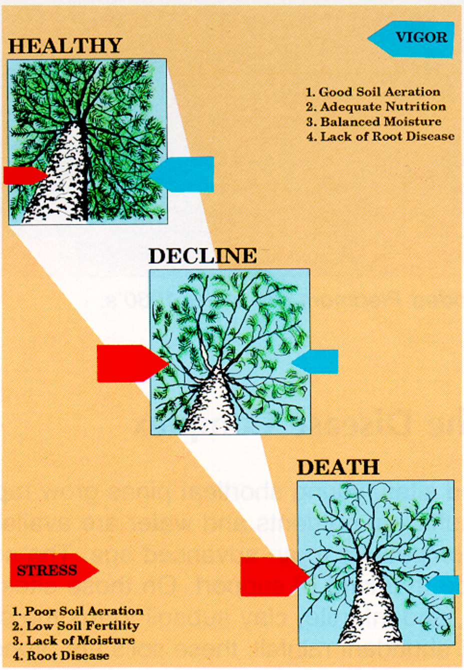
The rolling hills of the Southern Piedmont have been cleared, cropped, and abandoned by several waves of settlers and farmers, beginning in the 1700's and ending in the 1930's. Each period of cropping caused considerable sheet and gully erosion. Now, thin topsoils cover clay subsoils with poor internal drainage, low fertility, and limited aeration. In many areas, topsoil is completely removed. Shortleaf pine seeded extensively from trees on uncultivated ridges onto fields abandoned in the 1920's and 1930's, and improved fire protection kept the trees alive.

Typical eroded Piedmont site in the 1930's.

Identifying The Disease Complex

On good sites, young shortleaf pines grow rapidly. Even after crown closure, sufficient nutrients and water are available to sustain the vigor of good competitors to an advanced age. The soils on littleleaf sites do not provide that kind of support. On those sites, topsoil is absent or nearly so, and infertile, clay subsoil forms the surface rooting zone. In periods of abundant rainfall, these soils are prone to waterlogging, which stresses roots by limiting oxygen supply. During droughts, soil moisture is tightly held by the fine clay particles and is unavailable for tree growth.

Profile of a typical Piedmont soil showing absence of the A horizon and restricted zone (3 to 6 inches).



Factors contributing to decline caused by littleleaf disease.

Despite slow growth, young trees may appear healthy, because they are not yet competing with neighboring trees for water and nutrients. As root systems compete for soil space, however, competitive stresses exceed the resistance of dominant shortleaf pines.

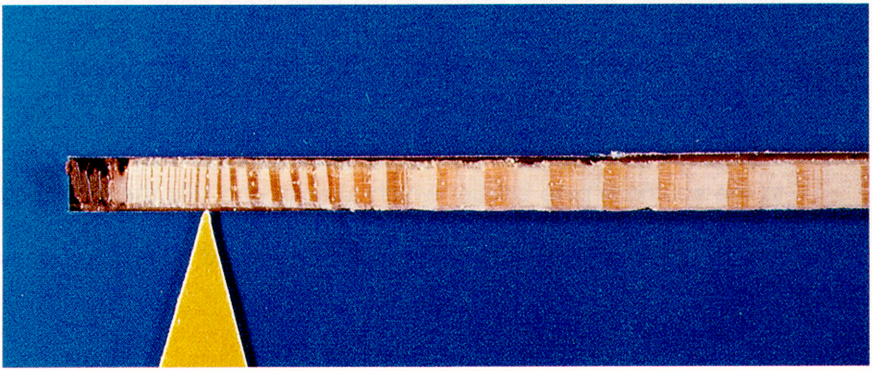
Stressed roots become susceptible to several soil-inhabiting organisms. On littleleaf-prone sites, the most important is *Phytophthora cinnamomi*. While not ordinarily aggressive on vigorously growing shortleaf pine roots, this fungus is able to infect the feeder roots of stressed trees. The death of these vital root tips further stresses the tree because the root area available for nutrient and water absorption is reduced. Crown symptoms develop as the uptake of nutrients slows and becomes critically low. Once the decline is visible, death of the affected trees usually occurs within 6 years. Loblolly pine may persist for longer periods after crown symptoms appear.

Symptoms

Unlike some other root diseases, littleleaf does not occur in infection centers. Rather, diseased trees in various stages of decline are scattered randomly throughout the stand. These subsequently coalesce where conditions permit disease and symptom development on more trees. The name "littleleaf" describes the reduced needle length of affected shortleaf pines. Needles on affected trees usually also turn yellowish. Twig growth slows and only current year needles are retained, giving the crown a tufted appearance. These symptoms usually do not appear until the trees are from 20 to 30 years old. Concurrent with crown symptom development, diameter growth of the main stem slows dramatically. The entire visible decline process, which may take from 2 to 6 years in shortleaf pine, culminates in death. Symptom development is similar in loblolly pine, but the symptoms may appear later and the progression to death may take longer.

During the entire decline cycle, littleleaf-affected trees are susceptible to the southern pine beetle, which attacks and kills them, and then spreads to adjacent trees which may be healthy, killing them as well. The results are losses far in excess of those caused by littleleaf disease alone.

Healthy shortleaf pine (right) and range of littleleaf disease symptoms.



Reduced radial growth associated with littleleaf disease.

Loblolly pine with littleleaf disease symptoms.

Recognizing High-Risk Sites

Risk and severity of littleleaf disease varies widely by site on the Southern Piedmont. Recognizing the elements that comprise high-risk sites gives land managers the opportunity to take preventive measures early in stand history before problems arise and before economic losses occur.

There are two methods for rating littleleaf disease risk. One requires detailed field observations, while the other relies summarily on soil maps. In the first method, a points scale was developed to place sites in three risk classes on the basis of degree of erosion, subsoil consistency, depth to a zone of reduced perme-ability, and presence of subsoil mottling. Values for each of these characteristics are obtained from table 1. To classify risk, these values are summed: 0-50 = high risk; 51-74 = moderate risk; 75-100 = low risk. These ratings correlate closely with symptom incidence and associated growth loss and mortality.

Table 1.—Points scale for field rating sites for littleleaf disease risk based on soil characteristics (Campbell and Copeland 1954)

Soil characteristics	Value
Erosion	
Slight - Depth of A horizon not seriously changed, less than 25 percent	40
Moderate - 25-75 percent of A horizon lost, shallow gullies may be present	30
Severe - All of A horizon lost, often some of B gone, shallow gullies common	20
Rough gullied land - Soil profile has been destroyed except in small areas between gullies	10
Internal drainage	
Subsoil consistency (when moist)	
Very friable - Crushes under gentle pressure, coheres when pressed	32
Friable - Crushes under gentle to moderate pressure, coheres when pressed	24
Firm - Crushes with moderate pressure, but resists	16
Very firm - Crushes under strong pressure, barely crushes between thumb and forefinger	8
Extremely firm - Cannot be crushed between thumb and forefinger	0
Depth to zone of greatly reduced permeability	
24-36 inches (61-90 cm)	15
18-23 inches (46-60 cm)	12
12-17 inches (30-45 cm)	9
6-11 inches (15-29 cm)	3
Subsoil mottling (grays and browns)	
None	13
Slight	9
Moderate	5
Strong	1

The second method (tables 2 and 3) capitalizes on the consistent association of these factors with soil series classification. This method provides general ratings without field work, and is approximately as accurate as the available soils maps. It is best suited for larger scale planning purposes (multiple stands or compartments).

Severe erosion is one component of high-risk littleleaf disease sites.

Table 2.— Internal drainage characteristics of selected soil series with known relationships to littleleaf damage classes.

Soil series [2]	Damage[2] class	Internal drainage characteristics[1]		
		Subsoil	Permeability	Mottles
Catawba, Herdon, Manteo, Mecklenburg, Orange, Tatum, Vance, Wilkes	High	Mostly clay	Slow to moderately slow with marked reduction at 12 inches or less; exception: Herndon	Present within 18-24 inches
Appling, Helena, Louisa, Madison	Intermediate	Mostly clay	Moderate to moderately slow without marked change; exception: Helena	Usually greater than 24 inches
Alamance, Cecil, Davidson, Durham, Georgeville, Lloyd, Lockhart, Nason	Low	Loamy clay or coarser	Moderate without marked change	Usually greater than 36 inches

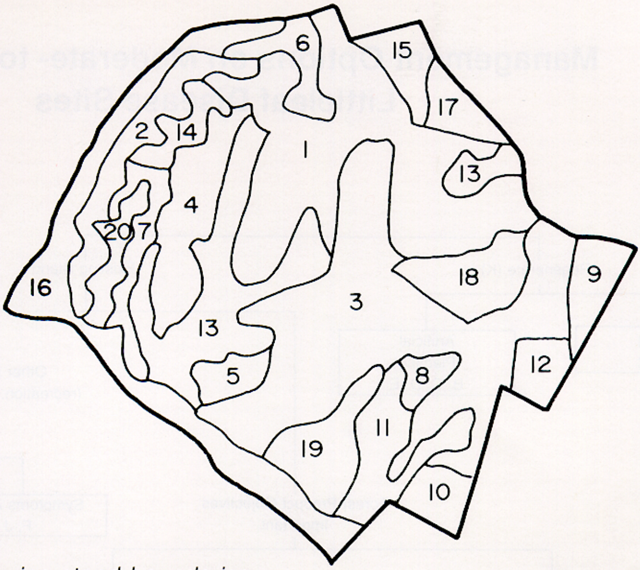
[1] Available in Soil Conservation Service county reports.

[2] Association of soil series with damage class (Campbell and Copeland 1954).

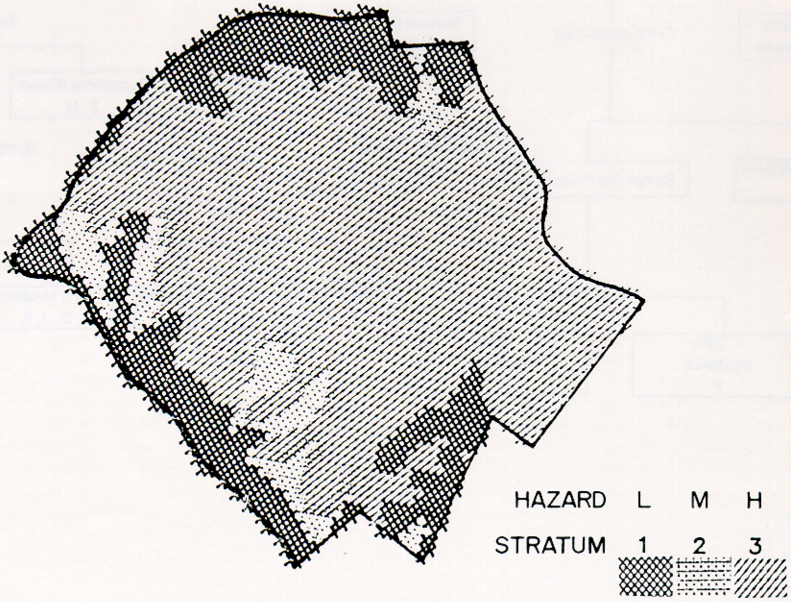
Table 3.—Selected soil series classified for littleleaf disease risk according to internal drainage characteristics of previously classified soils (ref. table 1)

High	Intermediate	Low		
Efland	Colfax	Ailey	Gwinnett	Rion
Enon	Vaucluse	Altavista	Hiwassee	Starr
Goldston		Armenia	Lakeland	Tirzah
Iredell		Blanton	Louisburg	Toccoa
Susquehanna		Buncombe	Norfolk	Wateree-Rion
Winnsboro		Chewacla	Orangeburg	Wehadkee
		Congaree	Pacolet	Wickham
		Enoree	Red Bay	Worsham
		Eston		

"Application of Risk Rating"

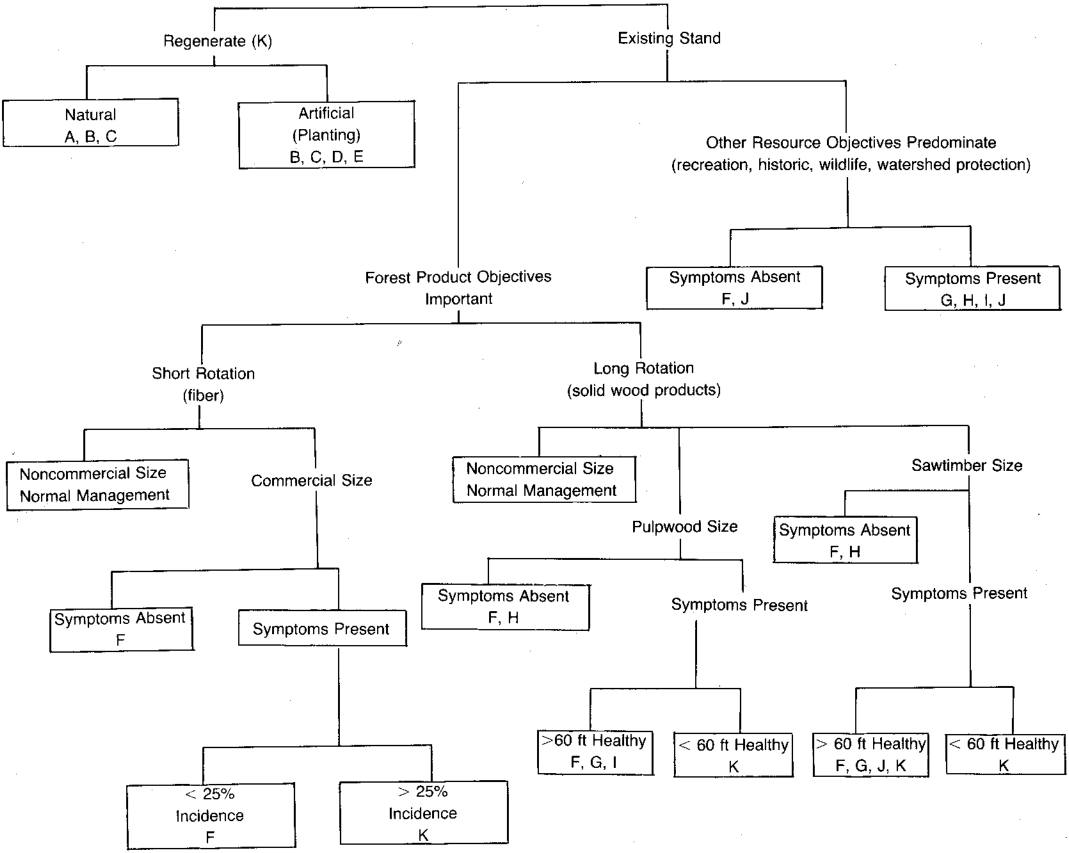


Compartment map showing stand boundaries.



Compartment map showing littleleaf disease risk.

Management Options on Moderate- to High Risk Littleleaf Disease Sites



Management Options

The best practices for minimizing losses to little-leaf disease vary with stand conditions and management objectives. By following the flowchart in figure 1, the land manager can obtain options (represented by letters) to consider while making stand prescriptions. A short statement and explanation of each option follows.

A. Use symptom-free pines as seed sources. Many littleleaf disease sites are marginally productive and cannot support large investments in timber growing. Natural, even-aged regeneration utilizes potential genetic resistance in disease-free trees for the next stand and is less expensive than artificial regeneration. This option applies to resistant species (e.g., loblolly and Virginia pines) already present in the stand, as well as to disease-free individuals of the more susceptible shortleaf pine.

B. Favor resistant conifer species. This option may be applied in uneven-aged or even-aged systems with natural or artificial regeneration. Loblolly and Virginia pines should be favored over shortleaf pine in damaged, mixed stands. Although loblolly may be damaged under some conditions, it is less susceptible than shortleaf pine, and individuals will be larger when symptoms appear. Consider plantings of custom-grown seedlings inoculated with the ectomycorrhizal fungus *Pisolithus tinctorius*. In comparison with uninoculated seedlings, they have been shown to be more resistant to infection by *Phytophthora cinnamomi*. Further, survival and early growth are better on harsh regeneration sites such as mine spoils and borrow pits, which share many common characteristics with littleleaf sites.

C. Manage hardwoods. Hardwoods are immune to littleleaf disease and are a long-term solution to site amelioration. They can be favored in low cost natural regeneration systems or planted when wood products are not an overriding management objective. Black locust, sweetgum, and wildlife food species are potentially useful.

D. Decrease planting density. Widening of initial spacing reduces root competition and competitive stress. It therefore delays the onset of littleleaf disease symptoms, lengthens the possible rotation, promotes species diversity beneficial to wildlife and esthetic values, and carries lower regeneration costs.

E. Ameliorate the site and plant. Wood product values alone may not justify this very intensive, high-cost option. However, watershed protection, recreation, and historic values may. Deep plowing, called "sub-soiling," breaks up impervious clays and promotes deeper, more extensive rooting; deep gullies can be filled; and, where values permit, topsoil or organic amendments, such as municipal sewage sludge, can be applied to improve the site.

F. Conduct regular surveillance. Early detection aids in management planning. Stands over 30 years old on high-risk sites are the most vulnerable to damage. If symptoms appear early in stand history, long rotations are precluded. Thinnings can salvage potential mortality, reduce competitive stress, and lower risk of southern pine beetle attack. Ground surveys on a 7-to 10-year cycle are recommended.

G. Remove high-risk trees. Severely affected trees are hazards to people when they occur around recreation sites. They also are hazards to neighboring trees because they attract southern pine beetles. In forest stands, it may be profitable to remove affected trees, delaying final harvest in stands that are adequately stocked with healthy trees that are near the size threshold for higher value products (pulpwood to small sawtimber; saw-timber to large sawtimber). Presalvage cuts recover the volume in weak trees before it is lost to littleleaf disease or to the southern pine beetle.

H. Thin. The primary objectives of thinning are to reduce stress and southern pine beetle risk while promoting good growth on residuals. Although the distinction is solely a matter of terminology, we view thinning as a preventive treatment prescribed before symptoms develop. Salvage or presalvage treatments are prescribed after damage is apparent (see option G). Basal area limits are determined by management objectives, markets, and stocking.

I. Manage species composition. Changing the species composition can be effective in reducing future losses in stands where damage is occurring but harvest is not desirable. (Options B and C are closely related but are regeneration options.) Short-leaf pine is most susceptible, with loblolly somewhat less so. Practices that increase the components of loblolly and other resistant species, such as hardwoods, are desirable.

J. Consider fertilization. Where nontimber resource values are predominant (such as recreation sites, historic sites) or where potential timber values permit, fertilization may be justified. Increasing nutrient supplies forestalls symptom intensification and improves tree vigor. Diameter growth may be sufficiently improved over a short period, pushing tree diameters over a threshold to a higher value product and justifying the cost of fertilization. Formulations should include phosphorus, which stimulates root growth. One ton of 5-10-5 plus one-half ton of ammonium sulfate per acre have been recommended.

K. Consider regenerating the stand. Short rotations should be considered when symptoms appear on more than 25 percent of a stand before age 25-30. Regeneration is called for in sawtimber size stands when healthy stocking drops below 60 ft^2. Stands in this condition are vulnerable to littleleaf disease and southern pine beetle losses. Mortality may exceed growth in the years ahead. Even when healthy stocking is adequate, the presence of symptoms may indicate a low vigor, which is an invitation to southern pine beetles. The risk of southern pine beetle losses must be weighed against future increases in product value.

Suggested Reading

Belanger, R. P.; Hedden, R. L.; Tainter, F. H. 1986. Managing piedmont forests to reduce losses from the littleleaf-southern pine beetle complex. Agric. Handb. 649. Washington, DC: U.S. Department of Agriculture, Forest Service. 19 pp.

Campbell, W. A.; Copeland, O. L. 1954. Littleleaf disease of shortleaf and loblolly pines. Circ. 940. Washington, DC: U.S. Department of Agriculture. 41 pp.

Mistretta, P. A. 1984. Littleleaf disease. For. Insect & Dis. Leafl. 20. Washington, DC: U.S. Department of Agriculture, Forest Service. 6 pp.

Oak, S. W.; Tainter, F. H. 1988. Risk prediction of loblolly pine decline on littleleaf disease sites in South Carolina. Plant Disease 72:289–293.