Littleleaf Disease On Loblolly Pine: Symptom Outline

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Littleleaf disease is a soil, pathogen, and tree management syndrome. Littleleaf can destroy pockets of mature and over-mature loblolly pines (Pinus taeda) over a period of 5-15 years. Declining patches of trees average 1/10 to 2 acres in size (maximum 25 acres). Trees decline through a correlated loss of absorbing root surface, loss of carbohydrate dedicated to new root production, and loss of effective crown area. The presence of this disease syndrome has been cloaked in forest production activities when early declining pockets of trees are attacked by Southern pine beetles. In long rotation forest production and under landscape preservation activities, a significant number of trees can be lost.

Littleleaf disease was not recognized as a unique mortality-causing agent until the mid-1930's. Littleleaf disease is considered a major disease of shortleaf pine (Pinus echinata). Loblolly pine is approximately 2-4 times less susceptible to littleleaf disease than shortleaf pine. Most of the literature and pathological efforts to manage this disease has been targeted at shortleaf pine. The disease on loblolly has been concentrated in soil areas where shortleaf pine has been severely infected.

Littleleaf disease in loblolly pine is concentrated on the eroded clay soils of the Piedmont area of the Southeastern United States. The primary range for littleleaf disease includes the northern halves of Alabama, Georgia, and South Carolina, the western and central portions of North Carolina, eastern Tennessee, and central Virginia.

Pathogen

The causal organism that interacts with the soil and tree to generate littleleaf symptoms is a common soil root rot fungi, Phytophthora cinnamomi. This fungi was first identified and recognized as problem for loblolly in 1951. Phytophthora cinnamomi is a root disease associated with many woody plants such as chestnuts, chinkapins, and avocados. It is also found on azaleas and oaks. It is proposed that the long decline of chestnuts and chinkapins in the Southeast forests (before the introduction of chestnut blight) was because of the spread and effect of this fungi.

Phytophthora cinnamomi is a fungi found in almost all soils. It can be found in soil under pines throughout the year. It can be found in soils with no pines. This fungi can be found in soil with pine roots and yet not cause littleleaf disease. It is the soil characters and drainage, coupled with tree reactions, that generate littleleaf symptoms. Under diseased trees, the fungi is physi-

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cally located where the concentration of absorbing roots is greatest (depth of 2.5 inches). Another soil root rot fungi (Pythium sp.) has also been cited as a secondary participant in littleleaf disease symptom generation, as has nematode injury to the absorbing roots.

Symptoms

The symptoms of littleleaf disease on loblolly pine are a discolored or yellowed crown (sometimes bleached-looking), a declining crown area, and a premature death (many times from other agents or factors). The symptoms in a pocket of pine spreads outward as soil and roots are colonized and damaged. Littleleaf disease symptoms closely mimic essential element shortages and usually are misidentified and mistreated as such.

STAGE #1:   Littleleaf disease symptoms have been identified as occurring in three stages. The stages are not discrete but blend together and are dependent upon the tree and the soil conditions for symptom expression. Symptoms can be expected to begin on loblolly pines after the age of 40, potentially accelerating after 70 years of age. The first stage of the disease shows shorter current-year needles, less and shorter shoot elongation, and a slight yellowing of the foliage.

STAGE #2:   The second symptom stage shows foliage that is sparse and tufted near the shoot ends, where only the new needles are retained. The thin, yellowed and tufted appearance of the foliage arise from multiple years of shoot and needle shortening accompanied with severe internal resource reallocation problems. The second stage can also include a seasonal chlorosis pattern where foliage is yellowish in fall and winter, but green in spring and summer.

STAGE #3:   The third stage of symptom development include twig and branch dieback throughout the crown and accelerated branch self-pruning from the bottom of the crown upward. What chlorotic foliage remains is confined to branch tips. With this stage the tree usually begins a mortality cycle where more of its resources are taken away and its defenses become more and more dysfunctional. Other pests in the area finish off the tree.   The time between decline and death can take from 5-15 years in loblolly pine.

Tree Impacts

Littleleaf disease symptoms are brought about by the infection and destruction of the absorbing roots. As the absorbing root are infected, and as more carbon resources are demanded from the tree for root maintenance, the absorbing roots are sealed-off. New absorbing roots are then initiated and expanded into the soil where they are infected. This cycle of infection and tree reaction drains the tree of energy reserves which can not be effectively replenished because of the lack of root-gathered resources.

The yellowing of the needles is caused by a lack of element uptake from the roots, particularly nitrogen.   Diseased needles only have approximately 40% of the nitrogen content of normal needles.   Other elements that are difficult to attain and control can be of concern, including potassium (K), phosphorus (P), and magnesium (Mg). It is estimated that more than 50% of the absorbing root system in a symptomatic pine is continually compromised by littleleaf disease.

The continual compartmentalization activities in the roots generate a secondary symptom on root bark called "brown patch." Although visible on normal loblolly roots, with littleleaf disease infection there is a greatly increased incidence of root bark "brown patch." Brown patch is a small lesion in the cortical area of larger roots generated from the excessive and premature formation of corky bark. The cork cambiums are generated in small, localized layers deep in the phloem tissues. This symptom is considered a result of root starvation and compartmentalization activities.

Littleleaf disease symptoms are the result of growth changes over years. Significant root damage occurs before any symptoms arise. Infection and symptom expression occur in trees planted and growing in areas with heavy inoculum as early as six months. The attack location is at the primary root tips just in front of mycorrhizal infection or lignification. The fungi actively infects pine roots in temperatures above 70°F. Damage to roots occur when the soils are wet and roots are actively growing (early spring and mid-autumn).

Soil Constraints

Littleleaf disease is associated with heavy soil, eroded land, frequent burning, low site index, shallow soils, low organic matter, low nitrogen, low cation exchange capacity, impervious soil layers or soil texture interfaces, poor water infiltration, poor soil drainage, low surface layer porosity, and loss of the A horizon. Generally, less pore space, poorer drainage, and more heavy, plastic soils lead to symptom development.

Primary soil attributes leading to littleleaf symptoms are concentrated around internal drainage (cited as 60% of problem) and erosion class (40%) on heavy soils. Disease symptoms can be generated if a hardpan or plow layer was exposed at the surface or located somewhere below, compaction exists, and/or percolation and infiltration is reduced by 50%. Impervious layers effectively constrain root colonization volumes and provide a limited amount of available water storage capacity. Warm spring, fall and winter soil temperatures, winter rainfall, and extended soil saturation periods lower redox potentials (average -50 millivolts at pH 7.0), reduce aeration, and increase disease symptoms.

A soil characteristic guidance for susceptible conditions include very firm to extremely firm sub-soil consistency, moderate to strong sub-soil mottling (with grays and browns), reduced permeability peak at less than 17 inches of soil depth, and severe erosion with almost all of A horizon gone. These heavy soils mean that tree roots are under near-anaerobic conditions when water is present, although most of the water is held too tightly to be available. When dry these soils can be crusted, impervious, and droughty. Pine roots seldom have ideal growing conditions and many times are under significant water and oxygen stress (too much or too little).

Non-Impact Circumstances

The literature on littleleaf disease in loblolly pine contains a number of agents that were tested to see if infections were initiated or if symptoms developed. Rainfall patterns, drought and temperature effects were found to not be correlated with littleleaf disease. MLOs and virus interactions in the tops were eliminated as agents. Grafting experiments were used to show no spread of the disease occurred from symptomatic shoot tissues to uninfected tissue. One experiment even grafted large littleleaf affected tops successfully onto normal root systems. Under these extreme grafted conditions, littleleaf symptoms in the affected tissues were reversed by connection to healthy roots.

From an essential element standpoint, no beneficial effects were seen with calcium addition to the soil. No beneficial effects were seen with minor elements. In one experiment, specific additions of zinc, boron, manganese, and iron all failed to change symptoms. Soil parent material and topographic position made no significant difference in infection or symptoms expression.

Accelerated Symptom Development

Some treatments or activities were found to accelerate symptom development and eventual mortality. Large amounts of organic matter (high carbon : nitrogen ratio), composted leaf litter, and various organic matter additions without nitrogen additions accelerated symptoms. Both oxygenation and nitrogen were limiting factors. Surface soil tilling and associated absorbing root area damage accelerated symptoms, as did general root zone disturbances.

Many treatments for littleleaf have concentrated on reduction of symptoms, not necessarily attacking the primary cause of the syndrome. Positive symptom control was attained with additions of inorganic nitrogen and a sewage sludge product (milorganite). Heavy nitrogen fertilization with moderate potassium and phosphorus were found to minimize symptoms and delay mortality. Fertilization of trees in the third stage of symptom development (severe decline) were not helped by nitrogen additions. Increasing the micro-organism diversity and improving soil aeration also helped reduce symptoms.

Growth Decline

Within the tree, the decline in crown function can be seen in sapwood basal area and in annual growth increment width. Usually sapwood basal area continues to geometrically increase in absolute value between 40-75 years. Under littleleaf disease stress, the sapwood basal area rate of change is a constant, arithmetically increasing value after the age of 50 years. In a large tree this is visualized by drastically smaller annual growth rings. Site density also plays a role through competitive stress and pest interactions. Keeping mature / over-mature trees at a basal area below 100 square feet per acre is critical for good growth and minimizing insect attacks.

Conclusions

Littleleaf disease is a serious chronic problem for loblolly pine on fine textured, heavy clay sites. Most of time this disease syndrome is mis-identified and mis-treated, usually as an essential element deficiency treated with nitrogen and chelated iron. This disease destroys the absorbing root interface between the tree and the site, leaving the tree no way to survive. More effective management utilizing appropriate responses to this disease is required. Understanding the causal mechanisms is an important first step.

Further Information

Coder, Kim D. 1997. Littleleaf disease on loblolly pine: A selected bibliography. University of Georgia Cooperative Extension Service publication FOR97-19. 2pp.

Coder, Kim D. 1997. Pest review bibliography for loblolly pine (Pinus taeda). University of Georgia Cooperative Extension Service publication FOR97-25. 12pp.