Forest Pest Control

General Forestry

LSU AgCenter
Research & Extension

Forest Pest Control: General Forestry

Preface

The information in this booklet, as well as the study manual titled "Pest and Pesticide Management on Southern Forests," is intended to provide the information you will need to meet the standards of the U.S. Environmental Protection Agency for certification as a commercial pesticide applicator and to prepare you to take an examination given by the Louisiana Department of Agriculture on Forest Pest Control: General Forestry.

Louisiana's Forests

Chances are some of the people closest to you earn at least part of their livelihoods from Louisiana's biggest crop, which is tree production. About 45 percent of the state's entire land area is used to grow trees – more land than is devoted to any other single purpose. There are 114,000 forest landowners. More than 33,000 people are directly employed by forest-related industries, and thousands more work in service industries. The economic influence of the forest industry benefits the lives of more Louisianans than all other agricultural products.

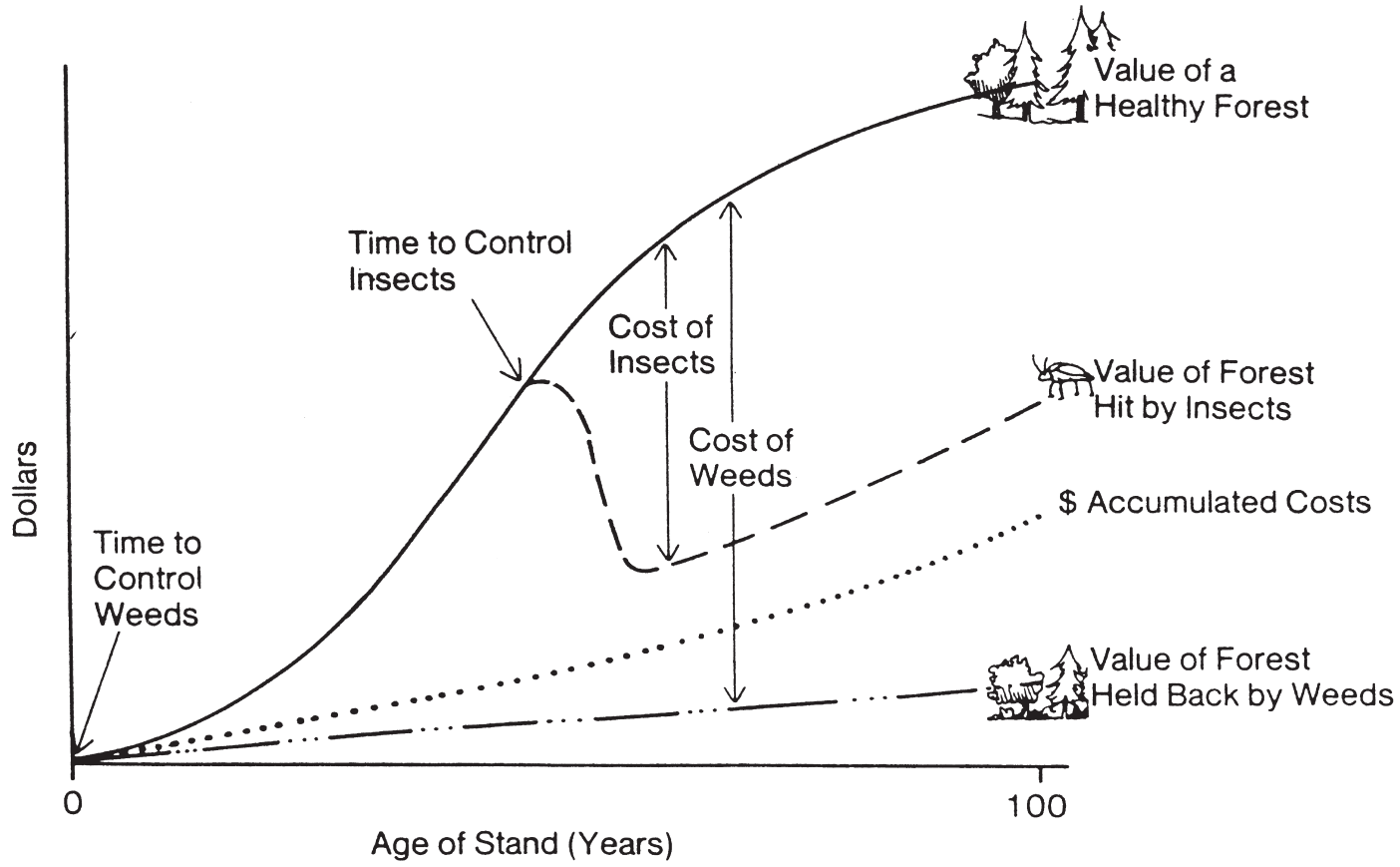
Commercial forestland in Louisiana is primarily managed to grow trees as a crop to provide wood for the thousands of useful and essential products our growing population needs. Management means the forest is protected from fire, insects and disease and that timber is harvested according to good conservation practices and harvested areas are promptly reforested to ensure tree crops for the future. Management advice and assistance is available through the Louisiana Forestry Association, the Louisiana Department of Agriculture and Forestry, the LSU AgCenter / Louisiana Cooperative Extension Service, Soil Conservation Service, industry foresters and private consultants.

Unlike other crops for which the growing season is measured in months, it's measured in decades fir trees. This requires a long-term investment from a tree farmer and an abiding faith in the future.

The harvest of the forest crop sets off an extensive chain reaction of economic activity that affects virtually everyone. The house in which you live and paper on which publications are printed are ideal examples of wood products on which we depend in our daily lives. Fortunately, we can have the products we need, along with the jobs, income and economic prosperity of the

Some Louisiana forest facts and figures:

- Trees account for about 61 percent of the annual agricultural income of the state.
- Louisiana forest landowners annually receive more than $200 million from the sale of their timber, and timber contractors and their employees earn another $200 million for harvesting the trees and hauling wood to the mills.
- Severance taxes from timber sales totaled $7.5 million in 1985. Three-fourths of this was returned to the parishes where the timber was grown.
- The number of large wood processing mills (producing more than 10 million board feet annually) has grown from 24 in 1971 to 29 in 1976 and 30 in 1983. The number of smaller mills increased from 75 in 1976 to 86 in 1983.
- Private landowners own more than two-thirds of Louisiana's 13.9 million acres of commercial forestland. The forest products industry owns 26 percent ,and federal, state and local governments own 7 percent.



forest industry and the forest-related benefits such as wildlife habitat, recreation and watershed protection. Furthermore, this resource can be renewed on the same land so all of these benefits can be enjoyed by another generation.

Even with Louisiana's forest production, we can do much better. The 1984 Forest Inventory found we are growing only about one-half of our potential wood. This inventory also found we also are not regenerating about 70,000 acres that are annually harvested.

Control of forest pests is a long-term proposition. The goal is to keep pest populations at a level low enough to prevent destruction of forest trees. Chemical pest control must be combined with other management methods to minimize recurrence of pest problems.

Poor harvesting practices have left forest problems such as weed trees and brush and weed-covered lands without commercial stands. Fire control efforts increase pest-susceptible species. Increased travel of man helps introduce weeds, insects, diseases and animals that may cause widespread damage. Forests are attractive to people for the beauty of the scenery, the abundance of wildlife and the quiet environment. Choose effective pest control methods that are the least disruptive to these values.

Tree cover affects all other forest resources (water, wildlife and aesthetics). Methods used to improve or protect the tree cover have a great influence on the other resources. Pesticides generally are not used except to improve the timber. Take care to avoid injury to the other resources.

Habitat management will control many forest pests. Good vegetation control and management will not only control pests but will enhance the timber production and may permanently solve some forest problems.

Types of Louisiana Forests

Major Forest Types

The Southeast's varied climate and site conditions have contributed to the large number of tree species found. There are about 250 different native trees. Almost half are considered commercially important. There are five major forest types:

Longleaf-Slash Pine

This type of forest occurs in the Coastal Plain. Its stands are 50 percent or more longleaf and slash pine, singly or in combination. Other trees commonly associated with this type of forest include other southern pines, oaks and gums.

Loblolly-Shortleaf Pine

This type of forest is found in most of the Upper Coastal Plain. Its stands are 50 percent or more loblolly pine, shortleaf pine and other southern pines (except longleaf or slash), singly or in combination. These forests may also include oaks, hickories and gums.

Oak-Pine

This type of forest is found primarily in the transition zone between swamp and uplands. It also is a later stage of plant succession throughout the state. Its stands are 50 percent or more hardwood, usually upland oaks. Southern pines make up 25 to 49 percent. Other trees commonly associated with it include gums and hickories.

Oak-Hickory

There has been an increase in acreage of this type. This category sometimes is referred to as the cutover pine type because it occurs predominantly in acreage that originally supported pine but, because of harvest practices and a lack of planned regeneration, has been invaded by upland hardwood species.

Oak-Gum-Cypress

This type of forest is found primarily along major stream bottoms and swamps. Stands are 50 percent or more tupelo, black gum, sweet gum, oaks and cypress, singly or in combination. Other trees commonly associated include cottonwood, willow, elm, hackberry and maple.

Major Species

An estimated 60 percent of the land area in Louisiana is best suited for pine production. The remaining 40 percent of the land, primarily bottomland and drainages, is well suited for growing hardwoods.

Commercial Species

Pines are the most important commercial species because of existing income, growth and acreage. The four major species of pine are slash, loblolly, longleaf and shortleaf. All are classed as southern yellow pines.

Another important conifer in the Southeast is the baldcypress. It is restricted to bottomland, pond or swamp areas.

Oak, ash and gum are the major commercial hardwoods. Most important are white oak, cow oak, water oak and red oak. Black gum and water tupelo are important in veneer manufacturing. Sycamore is also commercially important. Ash and pecan are among our most important woods. They are highly regarded for paneling, furniture and specialty products.

Diseases in Forest Stands

Tree diseases take a heavy annual toll on forests/timber and damage seedlings in nurseries, as well. But much of this loss is preventable.

Each year in the United States, diseases ruin 20 to 40 percent as much timber as is cut. Many diseases kill trees or reduce their growth rate, but the major loss to forests results from diseases that cause standing timber to decay or otherwise become defective. Trees decaying faster than they are putting on new wood, or trees so defective they will never produce a usable product, are liabilities rather than assets. The space such trees occupy remains unproductive until they are removed.

Much disease damage, such as that caused by rots, does not become evident until timber is cut. To appraise these losses, it is first necessary to recognize them. To prevent them, the factors that lead to them must be known.

This portion of the manual will help you recognize forest diseases and gain some insight into the factors influencing them. Diseases will be considered from a species standpoint.

Pine Tree Diseases

Fusiform Rust of Pine

Fusiform rust of pine derives its name from the fungus organism that causes it, Cronartium fusiforme. It is a serious disease of slash and loblolly pines in Louisiana, causing a spindle-shaped swelling on branches or the main trunk of infected plants. During the spring, the swelling may become covered with a large yellow mass of spores, which are blown to the alternate host of this disease, the oak tree.

These spores do not reinfect the pine directly but are blown by wind to oak trees, where leaf infection occurs. The oaks are harmed very little, but spores produced on the underside of infected oak leaves blow back to the pine trees in late spring and early summer to again infect the pines.

Infections on the small branches of pine trees don't cause too much injury to the tree and can be removed without trouble. Infection on the main stem may kill the tree in time, however. As a general rule, the smaller and more vigorous the tree at the time of infection, the more severe the damage. The trees often break off at the infection site during high winds, creating an additional danger.

Littleleaf of Pine

Littleleaf is primarily a disease of shortleaf pines. Loblolly pines may be attacked at times. This disease is characteristic of parts of the Piedmont plateau on soils with poor internal drainage. It results from root destruction by a combination of factors: attack by the fungus Phytophthora cinnamomi, poor soil aeration and low fertility.

The disease appears any time after about 20 years of tree life. The needles typically appear short and yellowish, and new shoot growth is short, giving the shoots a tufted or "paintbrush" appearance. Affected trees die anywhere from about two to 15 years after the first symptoms appear.

The management of forests in which littleleaf is common involves harvesting sick trees before they die or clear cutting if more than 25 percent of a stand is diseased. On the poorly drained clays that support shortleaf stands infected with littleleaf, it is often wise to attempt to convert the stands to pines other than shortleaf or to some of the better hardwoods. Littleleaf can be prevented in high-value trees by applying a fertilizer that will supply nitrogen, phosphorus and potassium.

Fomes Annosus Root and Butt Rot

The fungus Formes annosus causes a root and butt rot of conifers in many temperate parts of the world. Annosus root rot damage now appears to be increasing in the eastern United States, especially in planted forests following thinning.

In the East, annosus root rot has killed loblolly, longleaf, slash and shortleaf pines. The fungus attacks many other conifers and is a major cause of death of eastern red cedar. Most of our native conifers are probably susceptible to infection under some conditions, but their relative susceptibility is unknown. Slash and loblolly, the most commonly planted species of southern pines, are very susceptible to the disease.

Fomes annosus produces fruiting bodies, conks, with a light gray to dark grayish-brown upper surface. The undersurface is creamy white, with small pores. This spore-producing undersurface becomes dark brown with age. Conks may be perennial but usually are destroyed after a relatively short time and therefore seem to be annual. Conks are irregularly shaped and range from very small buttons about 1/8 inch across up to brackets several inches across. They are formed on stumps, slash, dead trees and at the root collar or on the roots of living infected trees.

Conks are characteristically found at or even below the ground line, and it is often necessary to remove the duff at the base of the tree to see them. In some instances, matlike fruiting bodies are formed in the needle litter.

Pines in the earlier stages of infection sometimes can be recognized by the thin appearance of their crowns compared with nearby healthy trees. This thin appearance is caused by short needles and twig internodes and loss of all but current year's needles, which result from reduced tree vigor. When residual pines or other conifers die within a few years after the stand was thinned, annosus root rot should be suspected. The pattern of group killing by Fames annosus closely resembles that of bark beetle killing, and careful examination is necessary to distinguish between the two.

The primary means of entrance of Fomes annosus into a healthy stand is through infection of freshly cut stump surfaces by airborne spores of the fungus. The fungus then colonizes the stump and its root system and spreads to adjacent healthy trees by means of root grafts or contacts.

One point stands out clearly. The highest losses occur in plantations in conjunction with thinnings. In the South, seedling losses after five years in plantations established on sites clear cut because of heavy infestation by Fomes annosus have averaged only about 1 percent per year. Moreover, the infected stumps from the previous stands are rapidly decaying and seemingly will not long serve as inoculum sources. These factors would seem to indicate that Fomes annosus may not be an important consideration when regenerating pine plantations.

Brown Spot Needle Blight

Brown spot needle blight, the most serious disease of longleaf pine both in the forest and in the nursery, has been a primary reason for the widespread planting of other pine species on former longleaf sites. The casual organism, Scirrhia acicola, severely affects growth and vigor in the nursery, and a control program is essential.

Brown spot needle blight is common in nurseries in the natural range of longleaf pine (U.S. coastal plain from North Carolina to Texas). It may infect loblolly and slash pines within or beyond the range of longleaf.

Brown spot lesions typically develop on secondary needles at any season of the year, but they appear most commonly from May through October. The first evidence of infection is the presence of small, circular, grayish-green spots. These become straw yellow and later change to a light brown. A darker chestnut-brown discoloration often borders the spot when fruiting bodies form in the lesion. The individual spots, which are about 1/8 inch in diameter, frequently coalesce. Eventually the needle tissue beyond and between groups of spots dies. Needles with multiple infections take on a mottled appearance. Another type of lesion, known as bar spot, consists of an amber-yellow band with a small brown center encircling the needle. Both types of spots have well defined margins.

The infected needle usually has three definite zones: (1) the basal portion, which is green; (2) the middle portion, which is spotted with lesions that alternate with green needle tissues; and (3) the apical portion, which consists of dead needle tissue.

Needle Cast of Pine

Needle cast of pine, caused by the fungus Lophodermium pinastri, is a serious disease on Christmas tree pines but is rarely important under forest conditions or on trees grown for timber. Needle cast may attack shortleaf, longleaf, loblolly or slash pine.

The first symptoms of the disease are brown-black spots on infected needles. Greenish-brown bands appear on infected needles in late summer and fall. These infected needles turn brown the following spring. On most pine hosts, the damage from L. pinastri has been limited to premature dropping of only part of the needles. Many other fungi also cause a "needle cast" and various conditions.

Needle Rust of Pine

Needle rust occurs quite commonly in Louisiana but seldom induces severe losses. Loss of needles because of infection by the casual fungus (Coleosporium sp.) will reduce growth rates when abundant needle drop occurs. Moist and cool weather conditions during the spring favor this disease.

Many conifers are susceptible to the attack of Coleosporium sp. In Louisiana, the principal hosts are loblolly and shortleaf pines. The presence of the casual fungus itself is the best diagnostic tool used in determining the cause of the disease. White-yellow fruiting bodies (Aecia) erupt through the needle surfaces. Infected trees are yellow-green in the spring but rapidly turn brown in early summer. Trees remain brown throughout the entire season, or, in the case of severe infection, new growth may occur and once again the tree is green. Usually, infected needles are cast from the tree, but mildly infected needles may remain attached.

Diseases of Hardwoods

Oak Wilt

Oak wilt, caused by the fungus Ceratocystis fagacerarum, has been found in many states, from Nebraska and Kansas in the West to Pennsylvania and North Carolina in the East. No one knows the origin of the disease. Oak wilt has not been reported in Louisiana at this time. No native oak species is known to be immune to oak wilt, however.

Symptoms of oak wilt in the red or black oak groups differ considerably from those in the white oak group.

In red and black oaks, early symptoms usually are limited to a wilting and bronzing of foliage in the upper crown, beginning at the ends of branches. The symptoms spread rapidly through the tree crown, downward from the top and inward along the lateral branches. The entire crown may be involved within a few weeks, and large trees may be killed within one or two months after the onset of symptoms.

The bronzing of leaves usually begins at the apex and lobes of the leaf blades, spreading to the midrib and base until the entire leaf blade is involved. As a rule, defoliation accompanies the development of foliar symptoms, and affected leaves may fall at any stage, including those fully green.

Premature leaf shedding during the growing season is one of the best diagnostic symptoms in red or black oaks. Sprouting frequently occurs along the trunk and larger branches before an infected tree dies.

In the white oak group, the wilt usually develops more slowly than in the red oaks. With most white oaks, only a single branch dies in a year, but the disease persists, killing additional branches each succeeding year until the entire tree dies, usually within three to seven years.

Oak wilt fungus may spread locally from tree to tree through natural root grafts, which are common among oaks growing close together. About half the infection areas observed have enlarged through local spreading.

In some trees, following death, the fungus forms mats just under the bark. Pressure pads on these mats push against the bark and may even crack or split it. These mats give off a sour odor that attracts many insects.

Sap-feeding beetles of the family Nitidulidae are common among the insects attracted to these mats, and fungus spores adhere to their bodies. These insects might transmit the fungus when they subsequently feed on the sap from a fresh wound on a healthy tree. Several other insects, taken from infected trees on which no fungus mats occurred, also have been found to be contaminated with the wilt. These include an oak bark beetle, an ambrosia beetle, the two-lined chestnut borer and a round headed borer. It is not definitely known that any of these insects spread the disease, but the possibility exists. Several states are actively engaged in control programs for the suppression of oak wilt. Though control methods vary, all are designed either to prevent local spread through root grafts or to eliminate the hazard of overland spread from wilt-infected trees, or both.

Shoestring Root Rot of Hardwoods

One of the most inconspicuous and underestimated fungal pathogens of forest trees is Armillaria mellea. This fungus causes a root rot of most major tree species, particularly hardwoods. The fungus produces dark shoestring-like masses of fungal mycelium called rhizomorphs beneath the bark of infected trees; hence the name "shoestring fungus." The fruiting structure of the fungus is a mushroom, and A. Mella is known as the "honey mushroom" because of its color.

The activity of root-rotting fungi is expressed initially at the apex of the tree crown or in a general decline in vigor of the entire tree. Premature leaf coloration, yellowing of foliage, and twig, branch and main stem dieback are successive symptoms of attack. As decline progresses, decay of buttress roots and the lower trunk usually is evident. Diseased trees may be found scattered throughout the stand, or infection centers composed of several declining trees may be found.

Armillaria mellea has been reported to attack only trees that have been predisposed to a condition that initiates low tree vigor. Practices that keep stand vigor and growth at an optimum level will reduce the chance of heavy attack by this fungus.

Oak Root Rot

Oak root rot is very similar in appearance to shoestring root rot. The fungus Clitocybe tabesens attacks many species of hardwood trees and shrubs. Mycelial mats are white and not as leathery in texture as those of shoestring root rot.

If infected roots and crowns are examined, the white mycelial fans can be found under the bark. The symptoms are expressed as general decline and lack of vigor. Eventually foliage, twigs and branches die back. Death follows. Since the organism more commonly attacks trees that are injured or are in low vigor, use practices that avoid these conditions.

Decay of Hardwood Trees

Half the timber lost to disease in the United States is caused by decay and discoloration of standing, living trees. Discoloration and decay of living trees occur through a progression of events that depends on an injury or wound for the process to begin. The presence of a large wound caused by any of several factors will initiate a process whereby the entire tree may soon become of little economic value. Most of the resultant loss is unseen by the casual observer because it is hidden within the tree until the tree is felled during harvest.

All hardwood tree species are susceptible to the discoloration and decay process. Injuries to branches and trunks from ice or wind storms, fire scars, insect

or bird feeding activities and logging operations are just a few of the possible ways wounds occur. Chemical changes rapidly take place in the exposed wood and surrounding tissues.

Immediately after the wounding and staining have begun, bacteria and fungi begin to grow and colonize the stained tissues. These pioneer organisms invade only the injured tissues and associated stained column and do not affect the new tissues laid down after the injury occurred. At that point, little, if any, of the strength properties of the wood are lost, but the wood has been prepared for the decay fungi that follow.

The final and most destructive stage of the process occurs when the decay fungi enter the "prepared wood" and begin to destroy the wood itself. Newly formed wood is not invaded. The decay fungi advance into the column of affected wood, and serious degradation of quality and strength occurs. The decay fungi follow the path of the pioneer organisms and stop only when all tissues are used. A hollow tree results after several decades of such progression.

Decay and discoloration of living trees may be easy or difficult to diagnose, depending upon the presence of the indicators that the process has begun. The most prominent indicator of decay is the presence of the fruiting bodies of the decay fungi. These are called conks or sporophores and usually are found on or near the wounded areas of decaying trees. Some examples of these diseases are oak heart rot, Hispidus canker and Strumella canker.

Discoloration and decay in living trees can be reduced through good management and logging practices. Small woodlot owners can enhance the values of their woodlots by removing deformed, rough and rotten trees and trees with the indicators of decay.

Oak Leaf Blister

Lead blister or curl of oak leaves is caused by the fungus Taphrina coerulescens, which is closely related to the fungus that causes peach leaf curl.

During cool, wet springs, almost all species of oaks are affected by the leaf blister or leaf curl disease. Affected leaves may be unsightly, but they remain attached to the tree, and there appears to be no noticeable impairment in their functions – hence, no damage to affected trees.

Blister causes circular, raised areas up to 1/2 inch in diameter over the upper leaf surface. Depressions of the same size occur on the lower surface. The upper surface of the blisters is yellowish-white, and the lower part is yellowish-brown.

Since the disease does not harm the tree, preventive measures are rarely recommended. Infections on valuable yard trees may be prevented by spraying in early spring before the buds burst with recommended chemicals.

Melampsora Rust on Cottonwood

Cottonwood rust was not recognized as an important disease in the southern United States until the late 1960s. More and more acres of bottomland hardwood forest were planted to cottonwoods, and a buildup of rust developed. In such areas, rust causes defoliation prior to normal leaf drop, and for some years, defoliation occurs in summer, reducing growth and vigor in planting stock.

The first symptoms, which may appear as early as April, are minute chlorotic spots on upper or lower leaf surfaces. The spots enlarge, and yellow, powdery pustules develop to produce spores that start new infections. If humidity is high, infections may recur until the entire leaf is covered with yellow spores. Defoliation will result when rust covers 50 percent or more of the leaf tissue.

Septoria Leaf Spot and Canker on Cottonwood

Septaria musiva causes leaf spot on all native species of aspen and poplars. It produces cankers on P. deltoides and also causes cankers on many introduced species and hybrids.

Leaf infections usually precede infection of stems. Tender leaves are infected at bud break, and leaf spots develop one to two weeks later. Spots first appear as depressed black flecks. Under favorable moisture conditions, flecks increase to a size of 2 to 5 millimeters. Spots coalesce on leaves with multiple infections, and as much as 50 percent of the leaf tissue can be affected. As the necrotic tissue dries, it fades to light tan or white in the center. Since the margin remains black, the leaf spot has a "bull's-eye" appearance.

Dutch Elm Disease

Dutch elm disease probably originated in the Orient but was first found in the Netherlands in 1919 and then spread rapidly through Europe. In 1930, the fungus accidentally was brought into the United States with elm logs imported from Europe. Since then, the fungus has spread to eastern Canada; south to Georgia, Mississippi and Louisiana; north to North Dakota; and recently as far west as Idaho. It has caused serious losses of shade trees.

Dutch elm disease is caused by the fungus Ceratocystis ulmi. It is spread by the smaller European elm bark beetle, Scolytus multistriatus, and the native elm bark beetle, Hylurgopinus rufipes. So far as is known, these bark beetles attack elms only. The fungus enters the tree through wounds made by these beetles,

or it moves through grafted roots from infected to healthy trees.

Dutch elm disease is a vascular wilt disease, with the most notable symptom being a fairly rapid wilting of infected trees. Although some trees may die within a few weeks after being infected, others, especially large vigorous trees, may become infected during one year and not die until the following season. During the early stages of infection a sudden wilting or "flagging" occurs on single large branches or portions of the crown. The leaves turn dull green and then yellow and die. The wilting condition quickly extends to all other branches and the stem, and the tree dies. Wilting is especially rapid during droughty weather.

Wilting branches show brown discolorations in the outer sapwood. Abnormal cells form, and gums are deposited in the vessels, preventing upward movement of water, which results in wilting.

Once a tree is infected, the first line of defense against Dutch elm disease is proper sanitation. Maintaining good vigor by controlling other diseases and insects and by supplying adequate moisture and nutrients is a second defense. Chemical controls are being tried on specimen landscape trees but are not practical for forest purposes.

Elm Phloem Necrosis

Phloem necrosis, caused by a virus-like organism, has killed large numbers of elms in the central United States and as far south as Mississippi. The disease is highly infectious and is spread from tree to tree by leafhoppers or root grafts.

The first symptoms of the disease become conspicuous around July when leaves of diseased trees begin to roll, yellow and fall. In later stages of the disease, the inner bark next to the sapwood becomes butterscotch in color and is sometimes brown or black flecked. If the butterscotch color is apparent, this bark will have a wintergreen smell when gently warmed. Control of phloem necrosis is not practical in forest situations.

Chestnut Blight

Chestnut blight, caused by the fungus Endothia parasitica, was first observed in 1904 in the New York Zoological Gardens. The native American chestnut (Castanea dentate) had no resistance to attack by this pathogen, so the fungus spread rapidly, and the disease destroyed nearly 100 percent of the commercial value of chestnuts by 1940. The rapid spread was caused, in part, by transmission of the fungus by migratory birds.

Chestnut blight eventually encompassed the entire range of the American chestnut. Today, the fungus may be found throughout this range because of the repeated infection of chestnut sprouts.

The fungus induces a canker on the bark of the tree that eventually girdles the stem or branch and brings on subsequent wilting and death (blight) of the portion beyond the canker. Callous development around cankers in response to infection may cause stems and branches to appear several times larger in diameter than normal. Cankers first appear as sunken areas. That is followed by a reddish-orange to yellow-green coloration of affected bark.

The fungus produces several signs of its presence. Tan colored mycelial fans may be found under the bark of cankered areas. Two fruiting structures, both burnt orange, are produced by the fungus on the canker surface. Current efforts at control are aimed at production of a resistant plant.

Mycorrhizae

All species of trees growing under normal soil conditions in the forest are dual organisms – part plant and part root-inhabiting fungi. These highly specialized, root-inhabiting fungi are not pathogenic and do not cause root disease. They are beneficial to their tree hosts. They infect, symbiotically, the cortical tissues of young feeder roots of trees and form mycorrhizae.

The word mycorrhizae means "fungus roots." Mycorrhizae are the normal feeder roots of all forest trees as they are for the vast majority of other plant species, including agronomic, horticultural, ornamental and turf crops.

A considerable amount of research has been done on the benefits of mycorrhizae to trees. These are some of the benefits of mycorrhizae to tree growth:

1. Tremendous physical increase in absorbing surface of root system, including both mycorrhizae and hyphae growing from mycorrhizae into soil.
2. More selective ion absorption and accumulation, especially phosphorus. '
3. Solubilization of normally nonsoluble minerals and their constituents.
4. Increased longevity of feeder root function; mycorrhizal roots persist longer on root systems than do nonmycorrhizal roots.
5. Resistance to feeder root infections caused by pathogens, such as Phytophthom and Phythiu1n sp., present in many forest and nursery soils.

Considerable research has demonstrated that mycorrhizae are not only beneficial to growth of trees but actually are indispensible for survival and growth of transplant stock, in particular Pinus sp. Thus, to ensure survival and good growth of normally ectomycorrhizal trees, seedlings used in reforestation should have abundant mycorrhizae.

Insects in Forest Stands

Wood and Bark Feeding Insects

Forest Tent Caterpillars

The forest tent caterpillar is a serious defoliator of hardwood forests in Louisiana. Gums, oaks and pecans are preferred hosts of this insect, but these caterpillars also damage other shade and ornamental plants.

In early May, the buff-colored female moth lays about 350 eggs in a mass around a small twig of the host plant. Small, black, hairy larvae hatch the next spring just as the new leaves begin to unfold. When fully grown, the larvae are about 2 inches long and blue-gray with distinctive white, keyhole-shaped spots down the middle of the back. There is only one generation per year.

Eastern Tent Caterpillar

The eastern tent caterpillar is a serious defoliator of ornamental hardwood trees and fruits. It overwinters in the egg stage on branches of the host. In late March or early April, the eggs hatch, and the larvae spin a silken web in the crotch of infested trees, enlarging it as they develop.

They are hairy caterpillars with a yellowish-brown, velvety appearance. The yellow petal on the body matches the yellow strip down the center of the back. At maturity, they are about 2-2½ inches long. Once mature, they leave the trees and crawl about looking for places to pupate. The adult emerges in May, mates, lays eggs and dies. There is only one generation per year.

Control of Forest Pests

Pesticide Labeling

Forestlands are considered to be cropland when a stand of commercial trees is present. This means that "noncropland uses" listed on a pesticide label may not apply to forests. Pesticides used in forests, seed orchards, Christmas tree plantations or nurseries must bear directions for use on the specific crop and pest species.

Some forestry uses are included on labels principally devoted to other uses. For example, pesticides may be applied to Christmas trees, seed orchards or nurseries if the label gives directions for use on ornamental or shade trees, including conifers, and the pest you need to control.

Herbicides registered for other crops, range or noncroplands may be used before crop trees are planted. Some pesticides registered for use in forestry may be tank mixed. In mixtures of two or more products, the rate of each component may not exceed the rate prescribed on its label. Check labels or recognized authority for details.

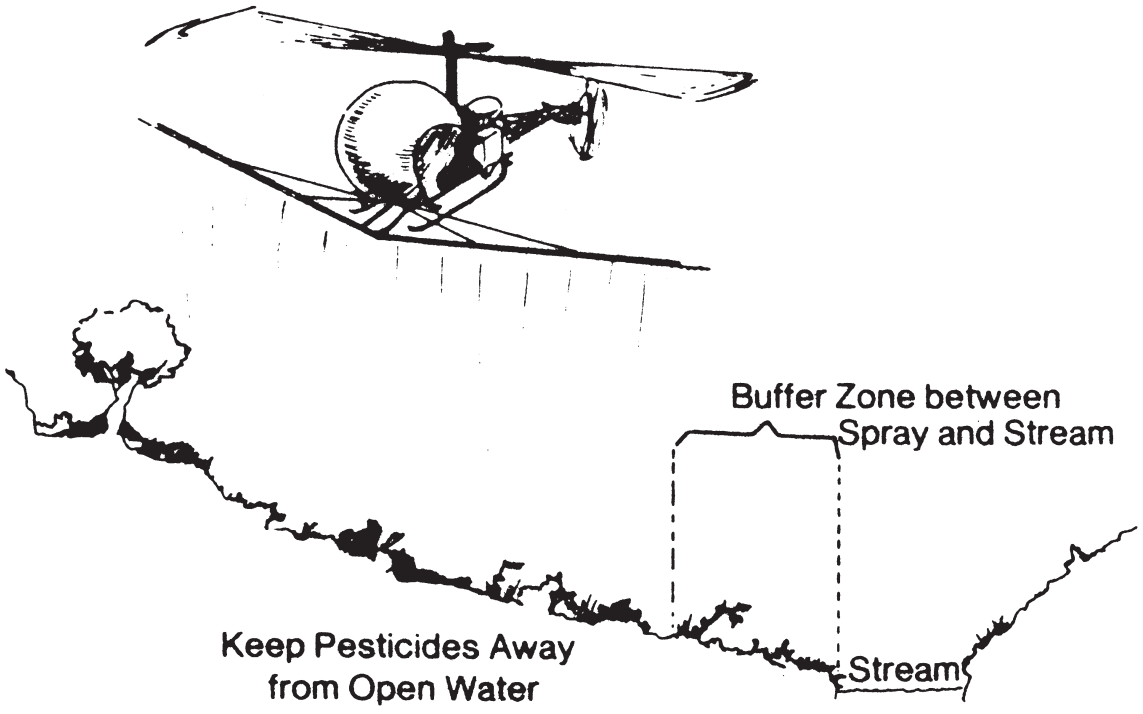
Herbicides

You must understand the terms used on herbicide labels to describe their uses in forestry. These terms include:

- Reforestation – the process of establishing tree seedlings.
- Site preparation – preparing an area for reforestation by clearing or other vegetation control.
- Plantation weed control – using herbicides for selective weed control to ensure survival and rapid growth of planted tree seedlings. This is one method of animal habitat management.
- Release – applying selective herbicides to woody or herbaceous weeds competing with commercial crop species.
- Desiccation – applying herbicides to vegetation in preparation for burning as part of site preparation.
- Timber stand improvement – selective removal of undesirable trees to improve growing conditions for desirable trees.

- Chemical precommercial thinning – removing all excess trees in a young forest by applying chemicals to individual trees. Herbicides labeled for basal spraying, cut-tree application, trunk injection, frilling or stump treatment may be used for this purpose.
- Preharvest drying of softwood timber – the treatment of trees with chemicals to allow timber to season before cutting. May also loosen bark and control insects and diseases. Herbicides registered for conifer thinning may be used for this purpose.
- Dormant spray – applying before buds open in the spring or after trees go dormant in the fall.
- Early foliage spray – application while new growth is elongating rapidly after first leaves are fully expanded.
- Summer foliage spray – application to mature foliage near midsummer.
- Fall foliage spray – application in late summer to early fall. Generally used with readily translocated herbicides.
- Cut-surface – includes trunk injection, bore-hole, frill, frill-girdle, girdle and stump treatment.
- High-volume ground spray – application of herbicides to low brush with power sprayer delivering enough volume to wet foliage to the drip point. Noncrop herbicides may be used when crop species are not present.
- Low-volume spray – broadcast application by aircraft or ground rig, including air blast sprayers, at the rate of 30 gallons per acre or less. Does not soak foliage. Aircraft application must appear on the label if crop species are affected.

Herbicides generally move very little in forest soils. They are broken down in place by microorganisms, sunlight and chemical reactions. A compound that has an effective life of several months usually will move less than a foot or two from the site of application. Therefore, herbicides are not a serious threat to water supplies or fish unless they are placed directly (especially by spillage) into forest streams or on areas that will become waterways during storms.



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