Elytroderma Disease of Ponderosa Pine

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The most important needle disease of ponderosa pine in the Pacific Northwest and parts of adjacent regions is caused by a native fungus, *Elytroderma deformans*. This disease also occurs on Jeffrey pine and occasionally on other pines.

Damage varies greatly in severity from place to place and from time to time. It is usually slight or moderate, even where the disease is common; but stands in widely separated localities are sometimes badly damaged during outbreak periods. Although some mortality results, especially during severe outbreaks, the greatest impact is on growth.

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Figure 1.—Elytroderma disease is concentrated in the lower crown of this pole-size ponderosa pine. Foliage "flags," normally reddish-brown, appear white in the photograph.

Description

The most prominent features of Elytroderma disease are the red-brown "flags," which appear in spring (fig. 1). Infected needles are reddish brown during spring and early summer of their second year. These needles gradually fade and become partially obscured by new foliage until, in late summer, it is difficult to distinguish them at a distance from old needles

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that fade prior to normal fall defoliation.

The characteristic long, dark, slender fruiting bodies of the fungus (fig. 2) first appear in the spring as faint lines on the convex (outer) surfaces of the red needles. By late spring or early summer, the fruiting bodies are plainly visible, but they may be small and sparse when needle vigor is poor. These lines of fruiting bodies readily distinguish this disease from other foliage diseases. Spores mature in late summer and fall and are ejected when the needles are wet. Most of the infected needles fall during the winter, but a few old bleached needles with sooty, ragged remnants of fruiting bodies still visible sometimes remain attached.

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Figure 2.—Infected ponderosa pine needles, showing dark, slender fruiting bodies of the fungus *Elytroderma deformans*.

Vigorous infected branches on thrifty trees often develop into globose, but sometimes irregular, witches'-brooms (fig. 3), which are denser and more rounded than those caused by dwarf mistletoe. Twigs once flagged usually will flag again each spring and soon curve upward (fig. 3).

The fungus is perennial, as vegetative mycelia, in the inner bark of infected branches. When the inner bark is exposed, characteristic lesions (fig. 4) are plainly visible on branch segments from 2 to 12 years old. In saplings, at least, lesions may occur in adjacent parts of the trunk and in the bases of unflagged adjacent branch whorls. On small stems in-

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Figure 3.—Witches'-brooms and upward-curved twigs caused by Elytroderma disease on ponderosa pine.

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Figure 4.—Brown, necrotic lesions characteristic of Elytroderma disease occur in the bark of infected branches and stems.

vaded by Elytroderma, branches soon becomes noticeably flagged because of vegetative spread of the fungus. Because the fungus can live from year to year in invaded bark, the disease can be perpetuated without conditions favorable for spore infections of new needles.

Relation to Environment

Blight spread and intensification probably depend on climatic conditions favoring spore infection. Since dry spores cannot germinate, pine foliage must be wet and temperatures must be favorable when living spores are being dispersed. Local outbreaks characteristically start in sheltered situations, such as bottoms of draws. They may also occur along edges of meadows, or less frequently on middle and upper slopes where moisture is available from heavy dews, frequent or persistent fogs, and condensation in ascending air currents. Infection by spores is invariably more severe in shaded thickets of reproduction, in the interiors of groups of pole-size trees, and on the lower crowns and north to northwest sides of pole-size and larger trees.

Except for very general moisture and temperature relationships, little is known about the conditions determining disease prevalence. Some infection of needles by spores may occur every year, especially during wet cycles; but damaging intensities result only when conditions are exceptionally favorable. Once established, however, vegetative spread of the fungus in the inner bark perpetuates the disease until conditions are again favorable for additional new infections by spores. Infection intensities tend to be highest in stands of moderate overstory density and at elevations intermediate in the altitudinal range of ponderosa pine. In central and eastern Oregon, infection is most severe at about 5,000 feet above sea level, presumably because lower elevations are too dry and higher elevations too cold.

Effect

Damage by the disease is often overestimated because of the great contrast between blighted and healthy foliage in the spring. Blight is most injurious to trees with poor crowns, although it

is most conspicuous in good crowns. When the proportion of blighted foliage is low, damage is slight although the flags may be conspicuous.

When infection of mature trees has been moderately severe (fig. 5), crowns gradually become thin, ragged, or short, and trees are

F-520237

Figure 5.—Ponderosa pines with crowns thinned by Elytroderma disease. Several other diseases cause similar thinning of crowns.

correspondingly reduced in vigor. Rapid and direct killing by blight is infrequent in such stands, and most of the trees survive for at least several years. However, mortality gradually increases as weakened trees are attacked by bark beetles, root rots, or other enemies.

When infection of mature trees has been severe for 2 or 3 years, the foliage consists principally of needles produced during the preceding spring. These needles are usually stunted and pale and die shortly before the new needles appear the next spring. Such trees often die as a direct result of almost complete defoliation. Mortality from defoliation is common only in a few locations. On these locations most trees on areas up to 100 acres or more may be affected. Severely infected trees, however, seldom are attacked by bark beetles.

The probable consequences of the disease on individual overstory trees of average vigor can be roughly forecast as follows: *Needles diseased on less than one-fourth of the twigs*—little or no injury; *needles diseased on one-fourth to three-fourths of the twigs*—host weakened and more likely to be killed by bark beetles or other parasites; *needles diseased on more than three-fourths of the twigs*—host likely to die soon as a direct result of defoliation. Large increases in infection severity are infrequent; but when they do occur, they usually develop rapidly and have culminated by the time they are noticed.

Recovery of mature trees appears to be a very slow process and may be more apparent than real because the flags disappear as affected twigs die, but lost foliage is replaced to only a small extent by growth elsewhere in the crown.

Killing and deforming in smaller size classes are usually restricted to crowded or sup-

pressed trees of little value. Although lower branches or even entire lower crowns are often killed on vigorous young trees, the upper crowns of such trees usually are affected only slightly; and foliage losses are soon recovered by new growth at the tops.

Control

Elytroderma disease is too important to be ignored. Its importance sometimes has been overrated because of its sudden and alarming appearance; but, like other destructive agents, the disease merits the foresters' attention. The foresters must rely on personal judgment in deciding how much weight to give the disease in management plans. Evaluations should be made in spring or early summer when infection is most apparent. Damage can be reduced by maintaining thrifty young stands and salvaging threatened mature trees before they die. The following practices are recommended:

Young stands.—Where infection during past outbreaks has remained light, the disease is unlikely to cause serious damage in the future. At the other extreme, stagnated stands on or near former centers of outbreak are likely to be damaged by another outbreak before they mature.

To minimize damage:

1. Maintain good spacing. Infection is heaviest on crowded trees, and most injurious to slowly growing ones. Sometimes, large openings apparently create an environment favorable to spread by spores.

2. Select no trees for crop that are flagged within 3 feet of the leader and preferably none flagged within 6 feet. Infections near the leader often spread vegetatively to it, and small trees with infected leaders often develop into "coniferous brush."

3. Select uninfected or only lightly infected trees for crop. Flags visible during early stages of outbreak are a small fraction of those that eventually result from vegetative spread. Trunk infections often deform small trees.

4. Prune where economically justified. The majority of spore infections occur in the lower crown where they produce quantities of spores for further spread. The fungus may also spread vegetatively into the trunks and upward into the higher branches.

Mature stands.—Future outbreaks will undoubtedly cause some damage even in vigorous young-mature stands and more severe and rapid damage in decadent overmature stands. The problem is to save threatened trees without harming the remaining stand.

When the disease becomes conspicuous in mature stands:

1. Do not act hastily; proceed slowly. Serious damage will not occur for a few years. Although new flags in vigorous crowns are striking, they do not indicate greatly reduced growth or imminent mortality.

2. Evaluate each stand annually. Flags are easiest to see in spring and early summer.

Assume that:

a. Flagged twigs will die in a few years.

b. Additional flagging will occur, probably more than twice as much as is visible during early outbreak stages.

c. Trees with half the twigs flagged or killed are likely to be attacked by bark beetles or root diseases.

d. Trees with more than three-fourths of the twigs flagged or killed are likely to die directly from the disease.

e. Trees with originally poor crowns will be damaged more rapidly and severely than equally infected trees with originally good crowns.

3. Give high priority to stands where appreciable damage is expected within the next few years; log immediately when mortality rates or bark beetle populations start to increase.

4. When logging selectively in lightly infected stands, remove the occasional tree with more than one-fourth of its twigs flagged or killed and, where feasible, remove the most heavily infected other trees.

5. When logging moderately to heavily infected stands, either cut drastically, leaving only trees with very good crowns and no more than a few scattered flags, or plan to relog within a year or so if necessary. Partial cuts in diseased stands usually are followed by rapid crown deterioration and high mortality of residuals.

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