Forest Insect & Disease Leaflet 171

Limber pine dwarf mistletoe

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Limber pine dwarf mistletoe (*Arceuthobium cyanocarpum* (A. Nelson ex Rydberg) Coulter & Nelson) is a damaging parasite of limber pine (*Pinus flexilis* James), whitebark pine (*P. albicaulis* Engelm.), Rocky Mountain bristlecone pine (*P. aristata* Engelm.) and Great Basin bristlecone pine (*P. longaeva* D.K. Bailey). Limber pine dwarf mistletoe occurs in the Rocky Mountains from southern Montana to southern Colorado and Utah. It also occurs in widely scattered populations in the Great Basin (southern Idaho, western Utah and Nevada), and in the southern Sierra Nevada Mountains (Figure 1). Several isolated populations are reported for this dwarf mistletoe, including one in the central Cascade Mountains of Oregon (west of Bend), in northern California (Mount Shasta area), and in the San Bernardino and San Jacinto Mountains of southern California (Figure 1). This dwarf mistletoe causes severe mortality of limber pine in many areas of the Rocky Mountains and whitebark pine on the northwest slopes of Mount Shasta, CA. Because of its widespread occurrence on limber and whitebark pines, and the high level of mortality it causes, limber pine dwarf mistletoe is considered to be one of the most important diseases of high-elevation 5-needle pines in the West. Only white pine blister rust (*Cronartium ribicola* Fisch.) is considered more damaging.

Limber pine dwarf mistletoe primarily parasitizes limber pine, whitebark pine, Great Basin bristlecone pine and Rocky Mountain bristlecone pine, but it has also been reported to severely infect western

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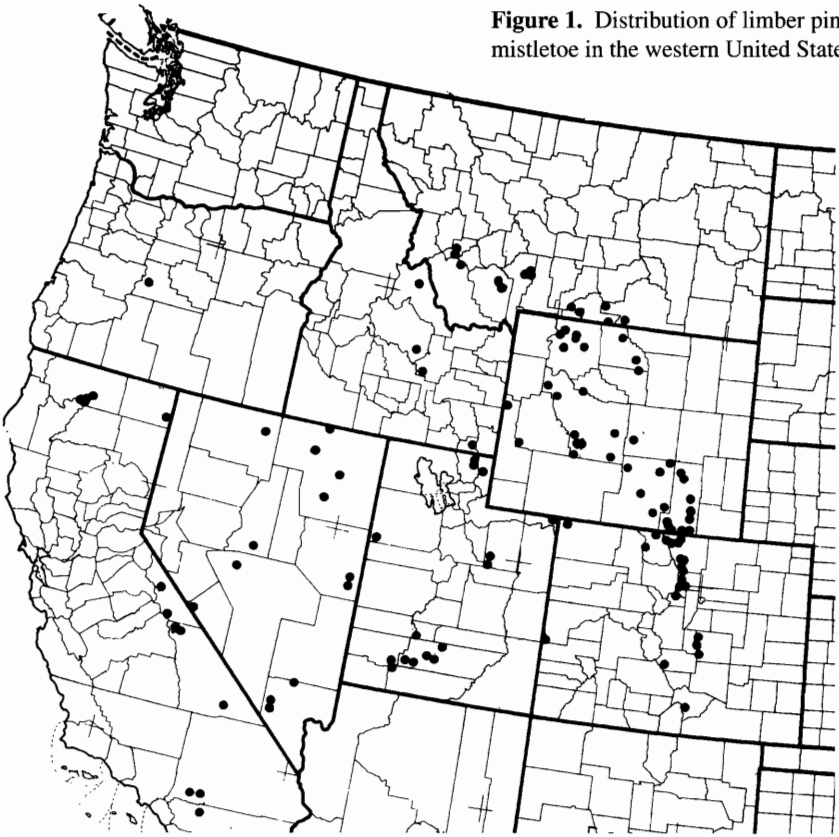

Figure 1. Distribution of limber pine dwarf mistletoe in the western United States.

white pine (*P. monticola* Dougl. ex D. Don) at Mount Shasta, CA and mountain hemlock (*Tsuga mertensiana* (Bong) Carr.) in the Cascade Mountains, OR. It occasionally infects foxtail pine (*P. balfouriana* Grev. and Balf.) in the Siskiyou Mountains of northern California and rarely infects lodgepole pine (*P. contorta* Dougl. ex Loud) and ponderosa pine (*P. ponderosa* Dougl. ex Laws.) in Colorado. Several conifers including white fir (*Abies concolor* (Gord. and Glend.) Lindl. ex Hildebr.), California red fir (*A. magnifica* A. Murr.) , subalpine fir (*A. lasiocarpa* (Hook.) Nutt.), pinyon pine (*P. edulis* Engelm.), Douglas-fir (*Pseudotsuga menziesii* (Mirab.) Franco) and sugar pine (*P. lambertiana* Dougl.) are reported to be immune to infection by limber pine dwarf mistletoe.

Life History

Limber pine dwarf mistletoe is a small, parasitic flowering plant. The external (aerial) shoots are yellow-green, have inconspicuous scale-like leaves at the nodes, and are perennial. Plants are typically densely clustered around infected tree branches. On the average, plants are only 1 inch (3 cm) tall, but they are sometimes as tall as 3 inches (7 cm) (Figure 2). Aerial shoots arise from a network of root-like, absorbing strands imbedded in host tissues. This network, called the endophytic system, consists of cortical strands growing within the bark and sinkers within the wood. The endophytic system extracts nutrients and water from the host tree. The endophytic system lives as long as adjacent host

Figure 2. Female shoots of limber pine dwarf mistletoe.

tissues are alive. The mistletoe is dependent upon its host for water and nutrients. The aerial shoots do contain chlorophyll, but they produce minor amounts of carbohydrates.

The major function of aerial shoots is reproduction. Male and female flowers are small and are produced on separate plants. Flowering takes place in July through September. Both insects and wind are involved in pollination.

Fruits complete development within 12 to 13 months after pollination. Mature fruit contain one seed averaging less than 0.1 inch (2 mm) in length. Seed dispersal is one of the most interesting characteristics of dwarf mistletoes. Seeds are discharged explosively from mature fruits in August and September. They may travel 35 to 45 feet (12-15 m), but most land within 10-15 feet (3-5 m) of the parent plant. The seeds have a sticky coating, called "viscin", that enables them to adhere to any surface they contact. Many seeds land on foliage. Viscin, when first moistened by rain, acts as a lubricant. Seeds slide down and either fall off needles or become lodged on bark at the base of needles. When the viscin dries, seeds become fastened in place on small branches and overwinter in a dormant state. Seeds are often destroyed by insects and fungi, or dislodged by rain and snow, and only a small proportion of those dispersed actually survive to cause new infections.

Seeds usually germinate in June. Radicles grow along the bark surface until an obstruction, usually a needle base, is encountered. The radicles then form mounds of tissue called holdfasts. Host tissue is then penetrated by infection pegs that develop from the holdfasts during the summer. The mistletoe's endophytic system then develops in the bark and wood of the host. Infection occurs most readily in 1- to 5-year old twigs because their bark is more easily penetrated than older twigs.

Aerial shoots typically appear 2 to 3 years after initial infection. Infections that have not yet produced aerial shoots are called latent infections. The typical length of time needed for female plants to

complete their life cycle from initial establishment to production of the first seed crop is 4 to 5 years. Aerial shoots may be produced from an established endophytic system for many successive years.

Symptoms and Signs of Infection

The first symptom of dwarf mistletoe infection is the appearance of slight swellings at infection sites. Swellings become visible 1 to 2 years after infection occurs. The presence of aerial shoots is the most obvious visual sign of dwarf mistletoe infection. If the plants have dropped, small brown shoot remnants, called basal cups, often remain attached to the bark. Porcupines and squirrels often preferentially feed on bark associated with mistletoe infections, and this chewing activity can make the infection sites more visible.

The most striking symptoms of dwarf mistletoe infection are witches' brooms. Witches' brooms are variously shaped clumps of branches caused by an abnormal proliferation of tree branches and twigs. Brooms caused by limber pine dwarf mistletoe are usually small and compact (Figure 3). Severely infested stands typically have many trees with multiple brooms, trees with significant branch mortality, and dead trees.

Spread and Intensification

Several interrelated factors influence tree-to-tree spread of dwarf mistletoes. These factors include tree size, stand structure, species composition of stands, tree spacing, and infection position within tree crowns. In single storied stands, lateral spread is estimated to be 1.5 to 2 feet (0.5-0.6 m) per year. Spread in multistoried stands is more rapid because dwarf mistletoe seeds from infected overstory trees readily "rain down" on understory trees. Non-host tree species can slow the spread of limber pine dwarf mistletoe by acting as a screening agent. Spread rates in very dense stands are less than in more open stands because fewer dwarf mistletoe seeds are produced due to limited light and reduced host vigor, and seeds that are produced have a limited spread capability because of the closely spaced crowns.

Nearly all spread is local and results from explosive discharge of seeds. Wind exerts a minor influence on distance and direction of seed travel. Birds and other animals are responsible for some long-distance spread when seeds stick to their bodies and later are rubbed off onto susceptible trees. Widely scattered populations of limber pine dwarf mistletoe, such as those in the Great Basin, southern California, and Oregon, probably represent situations where this

Figure 3. Witches' brooms on a severely infected limber pine.

dwarf mistletoe has survived in isolated populations of its hosts rather than long-range dissemination by animals.

The 6-class dwarf mistletoe rating (DMR) system is useful for quantifying severity of infection in pine trees and stands. For this system, the live crown of the tree is visually divided into thirds and each third is given a numerical rating: 0 = no visible infection, 1 = light infection (less than half of the branches in the third infected), or 2 = severe infection (more than half of the branches in the third infected). The three ratings are then added to obtain a total tree rating from 0 to 6. A stand rating can be obtained by averaging the DMR's of all live trees (infected and uninfected) in the stand.

Tree and Stand Impacts

The parasitism of limber pine dwarf mistletoe causes increased tree mortality, reduced height and diameter growth rates, loss of vigor, lowered timber quality, reduced cone and seed production, and increased susceptibility to other damaging agents. The effects of dwarf mistletoe on growth increases with severity of infection and is especially acute in severely infected trees (DMR 5 or 6). Tree volume growth can be reduced by as much as 50% in severely infected trees. Because of the negative effects on cone and seed production, the reproduction potential of limber pine in severely infested stands will be reduced. Seedlings and saplings growing within the mistletoe spread distance of infected taller trees will potentially become so severely infected that they will never reach cone-bearing stage. Often young trees are reduced to bushy "shrubs". The long-term scenario in a severely infested stand could be the gradual death of mature trees and little or no future regeneration of limber pine.

Mistletoe-caused mortality can affect the ability of limber pine stands to function as wind or snow breaks. Dead and dying trees can detract from visual quality in scenic areas. Potential for destructive wildfires is increased because of fuels ladders created by numerous witches' brooms, the increased number of dead trees, and the accumulation of dead witches' brooms around the base of infected trees.

Animal Utilization

Dwarf mistletoe flowers, shoots and fruits are food for insects, birds, and mammals. The witches' brooms produced in severely infected trees may be used for hiding, thermal cover, and nesting sites by birds and other animals. The mortality caused by dwarf mistletoe, either directly or by predisposing trees to other agents, provides snags as habitat for cavity-nesting birds and, eventually, coarse woody debris on the forest floor. Dwarf mistletoe may also have negative consequences for some animals. Animals which depend on limber and whitebark pine seeds will be impacted by the reduced seed and cone production and mortality of cone-bearing trees. The loss of limber pine in the range-forest interface zone will impact animals such as deer and elk which rely on the trees for hiding and thermal cover.

Management

In natural ecosystems, dwarf mistletoes have value as biological species and act as disturbance agents, influencing both the structure and function of forest communities. Management strategies should take into consideration the value of dwarf mistletoes as functional

components of forest ecosystems in which they occur. The key to proper management of this parasitic plant is to recognize its importance in the overall diversity of ecosystems and to devise management alternatives that recognize and maintain that diversity while meeting management objectives.

Limber pine stands are generally not managed for timber production, and management that is carried out is usually done for range/grazing objectives. If the loss of limber pine is not contrary to management objectives, it may not be desirable to treat for the reduction of mistletoe. There may even be situations where it is desirable to maintain or increase the dwarf mistletoe population. However, if the mortality and reproduction effects are not acceptable due to wildlife, water quality, or biodiversity values, direct control of dwarf mistletoe may be warranted.

Cultural Controls

The only practical control of limber pine dwarf mistletoe is through cultural treatments. There are no chemical or biological controls available at this time for treating stands. Because the dwarf mistletoe requires a living host to survive and reproduce, its impact can be effectively reduced through the use of cultural treatments that emphasize the removal of infected trees.

The greatest opportunity to control dwarf mistletoe is through the removal of infected trees and the encouragement of mistletoe-free regeneration. The more complete the cutting, and the larger the harvested area, the more complete the mistletoe reduction will be. Circular or square harvest units are more effective than long, narrow strips because they have a larger area/perimeter ratio which minimizes the invasion of regeneration by dwarf mistletoe from infected border trees. Reinvasion can also be minimized by taking advantage of natural or man-made barriers such as roads, ridgetops, meadows, and changes in forest types when laying out the cutting boundary.

When large harvest units are not desirable, shelterwood and seed tree harvests can be good alternative even-age management methods. Trees selected to provide shelter or seeds should be uninfected or only lightly infected (DMR less than 3). Moderately and severely infected trees, in addition to being a source of dwarf mistletoe seeds, produce poorer crops of tree seeds. Infected shelterwood or seed trees should be removed as soon as susceptible reproduction becomes established. As a general rule for most dwarf mistletoes, it is desirable to remove the infested overstory before the young stand is 3 feet (1 m) tall or 10 years old. As an alternative to felling and removal, infected overstory trees can be girdled and left as snags for wildlife use.

In mixed-species stands, silvicultural treatments should favor the retention of less susceptible or immune tree species. Non-hosts left between infected and non-infected limber pine prevent or slow spread and intensification of the parasite.

Thinning or sanitation by removal of infected trees can be an effective treatment in lightly infested stands. Lightly infested is defined as those stands in which there are acceptable numbers of desirable dwarf mistletoe-free or lightly infected (DMR 1 to 2) trees. Pines with one-half or more of their crowns infected by dwarf mistletoe (DMR 3 to 6) may decline rapidly about 10 years after they are exposed to full sunlight by thinning. Because of their rapid decline, moderately infected trees (DMR 3 and 4) should not be left when stands are being sanitized. Latent dwarf mistletoe infections in trees in densely stocked stands and in shaded reproduction are very difficult to detect.

It should be assumed that understory trees more than 4 feet (1.3 m) tall that have been overtopped by infected trees for at least 15 years are probably infected.

In overly dense stands, thinning can be used as a tool to increase growth and vigor of lightly infected trees and help them withstand mistletoe effects. The use of silvicultural thinning is only recommended when there are no infected overstory trees present.

Note:

All silvicultural treatments in limber pine stands should include a consideration of white pine blister rust. Whenever decisions are made concerning tree retention during a harvest, especially when selecting seed trees, attempts should be made to select trees that appear to be rust-resistant. It may be better to leave a mistletoe-infected tree with apparent rust resistance, and remove a mistletoe-free tree with severe rust infection. Likewise, it may be desirable to take extra measures to protect rust-resistant individuals from mistletoe impacts by removing all mistletoe-infected trees within 50 feet of the tree and pruning out branches with mistletoe infections.

Recreation Management

In recreation sites, sanitation treatments that favor non-susceptible hosts or remove infected overstory trees are appropriate. Pruning, in conjunction with removal of severely infected trees, can prolong the life of individual trees. For high value trees, removal of live witches' brooms, which exert a large drain on infected trees, can improve their vigor and prolong their life. Trees may have to be repruned occasionally to remove developing witches' brooms. The best candidates for pruning are trees with infections only in the lower half of their crown. In addition to prolonging tree life, pruning can reduce the danger of infected trees or branches breaking and causing accidents.

Assistance

Resource managers and land owners can get more information about the identification and management of limber pine dwarf mistletoe by contacting a County Cooperative Extension agent, their local state forestry office, or their regional USDA Forest Service, Forest Health Protection (FHP) office.

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