TREE NOTES

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Dwarf Mistletoes in California

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What Are Dwarf Mistletoes?

Dwarf mistletoes are flowering plants that are obligate parasites (dependent on their host) of conifers. They are usually small, leafless, orangish colored plants that explosively discharge their seeds. Seeds are shot for distances of up to 45 feet on the horizontal and may go much further from the tops of tall trees in a strong wind. Birds may be involved in long distance dispersal.

Dwarf and leafy mistletoes should not be confused. Leafy mistletoes are larger, leafy plants that produce fruit (berries) that are bird disseminated. Leafy mistletoe plants can produce much of their own food, and while they are obligate parasites like dwarf mistletoes, they primarily obtain water and minerals from their host. Leafy mistletoes (*Phoradendron spp.*) are found on three conifers: white fir, Juniper, and incense cedar, as well as many hardwoods in California. Dwarf mistletoes (*Arceuthobium spp.*) are found only on conifers.

Why Are They Serious Pests?

In California, dwarf mistletoes are considered to be the most serious pathogen of conifers. They cause extensive volume (wood) loss through increased mortality, reduced growth, reduced seed production, and poor wood quality. The average annual mortality losses in California are estimated to equal 100 million cubic feet over 2.3 million acres of commercial forests. Annual growth loss is estimated to be an additional 50 million cubic feet. Together, the mortality and growth losses are equal to 10%-15% of the annual net growth of California conifers. These losses can vary considerably from year to year, depending upon favorable or unfavorable environmental conditions for the host.

Where Are Dwarf Mistletoes Found?

In California, dwarf mistletoes are found on all members of the pine family except torrey pine and bigcone Douglas-fir. Their hosts include pine, true fir, Douglas-fir, hemlock, and larch. In the western states there are about 22 million acres of commercial forest land infested with 16 species of dwarf mistletoes on 19 conifer species. The highest concentrations of dwarf mistletoes are found around Durango, Mexico and near Mt. Shasta, in northern California.

How Do They Affect Their Host?

As an obligate parasite, dwarf mistletoe cannot live apart from its host. It must obtain its food, water, and minerals from its host. As the number of mistletoe plants increase in a host tree, the demand for food, water and essential elements also increases. In most conifers, infected branches respond to the parasite by producing a dense proliferation of foliage called witches brooms. These brooms place considerable demand on the tree's ability to maintain uninfected branches. In periods of water stress, such as during droughts, or in over stocked stands, available soil water can become insufficient to meet the needs of both host and parasite. Under these circumstances, some dwarf mistletoe infested trees are attacked by bark beetles, further stressing or killing the tree.

What Is Their Life Cycle?

Seeds are explosively discharged in the fall. They are coated with a sticky substance, **viscin**, that helps them stick to needles and other plant surfaces they may contact. Once the seeds are moistened by rain, the viscin becomes slippery, allowing the seed to slide downward from its original location. The viscin eventually dries to "glue" the seed in place for the winter and provides support for the radicle (root), which, upon germination, penetrates the host. This process of slipping and gluing can be repeated several times before the seed becomes lodged or falls off. Successful infection can occur when the seed eventually lodges near the base of a needle, or on the thin bark of young twigs.

Germination takes place in late winter or early spring by the production of a radicle that forms a holdfast when meeting an obstruction. Infection results from the mechanical forcing of a wedge of parasite tissue into the host. Once successful penetration has occurred, a branching root-like **endophytic system** consisting of "sinkers" and "longitudinal strands" (haustorium) develops in the host tissue. Sinkers become oriented into host xylem to act as absorbing organs for the uptake of water, minerals, and nutrients. Longitudinal strands allow lateral growth of the parasite and provide distant sites for sinker development.

Several years may pass during the "incubation" period before a noticeable swelling on the host branch occurs. After initial shoot appearance, it takes one or two years for flowering to occur. Flowering takes place in the spring or fall and fruit production occurs five months to almost two years later. The timing of both flower and fruit production is dependent upon the species of dwarf mistletoe. Aerial shoots may continue to flower for several years before they are shed. Insects,

especially bees, ants, flies, thrips and perhaps spiders, are the principal disseminators of pollen. Wind pollination occurs, and may be very effective with some species and in some locations.

Two distinct growth forms can be found in the dwarf mistletoes: the *localized* infection, which is usually a single plant arising from a swollen area on a branch; and the less common *systemic* infection, in which the aerial shoots of a single mistletoe plant appear throughout an infected branch, including the branch tips and buds. After several years growth the latter type of infection usually gives rise to witches brooms. Systemic infections are considered to be an evolutionarily advanced characteristic. Ponderosa pine dwarf mistletoe (*A. compylopodum*) is an example of a mistletoe that causes only localized infections, while Douglas-fir dwarf mistletoe (*A. douglasii*) can cause both localized and systemic infections.

What Affects Spread of Dwarf Mistletoe?

Average rate of spread of dwarf mistletoe in a forest situation can vary considerably from stand to stand. Spread of 1-2 feet per year has been noted for some stands. Once the parasite becomes established in a host tree, buildup within the tree can begin. The intensity of buildup depends on whether it is a preferred host and on branch density. Most mistletoes have a single preferred host, but may occasionally be able to infect less desirable hosts. Densely foliated trees tend to "shield" themselves from upward movement of seeds shot from within the lower crown. Fast growing trees may "outrun" the upward spread from the lower crown.

There is a wide range of susceptibility among individuals of any one tree species. In ponderosa pine, for example, complete resistance is known, but rare. Conversely, some ponderosa pine are extremely susceptible to infection while others exhibit intermediate susceptibility.

How Are Dwarf Mistletoes Controlled?

Forest characteristics such as site quality, stand composition, density, and structure affect dwarf mistletoe impact. Host/parasite interactions that affect impact include host distribution and susceptibility, rate of spread (within and among hosts), and environmental conditions. Stand impact can be controlled by management practices with the degree of control dictated by management objectives. Assessment of stand/parasite conditions together with management objectives can provide a "prescription" for disease management in the stand. Silvicultural control practices include stand conversion, selection harvesting, and selective pruning of lightly infested trees in high value stands.

Early control attempts were aimed at eradication of the pest through tree removal and/or tree pruning. Pruning out mistletoe infections is unreliable because new infections and small plants may be missed. Eradication of dwarf mistletoe from a stand is not usually cost effective. The long life cycle and short distance of spread means that parasite movement and population buildup are slow. Roads and plantings of non-susceptible species can effectively create a barrier against spread. During the last thirty years, control strategies have shifted from pest eradication to **stand management** strategies that reduce impact.

Selection for host resistance has been underway for many years. Resistance mechanisms are not well understood, but two general kinds, physiological and mechanical, are known. Physiological resistance has been observed in ponderosa pine. For example, in one instance, a hypersensitive reaction occurs in which the host cells surrounding the penetrating radicle die. Since dwarf mistletoes are obligate parasites they can not survive unless they are surrounded by living host tissue. Mechanical kinds of resistance may take several different forms. Droopy needles on some pines intercept dwarf mistletoe seeds and cause the seed to slide off the end of the needle rather than into the needle fascicle. Thick bark on the twigs of some pines inhibits radicle penetration.

Considerable research has been done in an effort to identify **biological control** measures. Numerous insects graze on dwarf mistletoe plants. Occasionally, they inflict severe damage to aerial shoots. However, these insects are probably not dependable biological control agents. Three fungi, widespread in nature, are reportedly parasitic on dwarf mistletoe. These fungi have been extensively studied and have demonstrated their effectiveness under the proper conditions. Once introduced into an infested stand, however, these fungi have not become established. This has reduced interest in their use.

Chemical control of dwarf mistletoe has been studied since the early 1950's. Herbicides and hormones have been the most commonly tested chemicals. The close physiological ties between dwarf mistletoes and their hosts precludes the use of most systemic chemicals.

Further Reading

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