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Sirococcus Shoot Blight

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Sirococcus shoot blight, caused by the fungus *Sirococcus strobilinus* Preuss, affects conifers in the Northern United States and southern Canada. The fungus infects the new shoots; diseased seedlings and saplings are especially affected.

In the United States, sirococcus shoot blight has become increasingly widespread since the early 1970's. When favorable conditions for infection have occurred, the incidence of tree mortality and shoot death has risen steadily in several areas. Tree mortality in some Wisconsin red pine plantations, for example, increased from 19 to 67 percent from 1972 to 1976.

In the United States, the pathogen has been found in the Northwest, in Alaska and California, in the Lake States, and in the Northeast.

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Hosts

The major tree or shoot mortality caused by *Sirococcus* occurs with red pine in the Lake States, Jeffrey pine in northern California, and western hemlock in southeastern Alaska. But *Sirococcus* has been reported on many other species of conifers. In addition to red pine (*Pinus resinosa* Ait.), Jeffrey pine (*P. jeffreyi* Grev. & Balf.), and western hemlock (*Tsuga heterophylla* (Raf.) Sarg.), hosts include Colorado blue spruce (*Picea pungens* Engelm.), red spruce (*P. rubens* Sarg.), Sitka spruce (*P. sitchensis* (Bong.) Carr.), mountain hemlock (*Tsuga mertensiana* (Bong.) Carr.), Coulter pine (*Pinus coulteri* D. Don), sugar pine (*P. lambertiana* Dougl.), lodgepole pine (*P. contorta* Dougl.), ponderosa pine

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(*P. ponderosa* Dougl. ex Laws.), and jack pine (*P. banksiana* Lamb.)

Damage and Symptoms

Sirococcus shoot blight commonly kills nursery seedlings and forest seedlings and saplings growing under or near infected overstory trees (fig. 1). A single infection is likely to kill a seedling; it takes multiple infections to kill a sapling. Trees that do not die often become misshapen. On older trees, the lower branches are often killed as a result of multiple infections.

The fungus causes shoot dieback and stem and branch cankers on the current year's growth. The needles on the infected shoot turn yellow and brown at the base; then entire needles die and turn brown. On most species, the shoots will often curl (fig. 2). On red pine, young, elongating shoots will curl (fig. 3); fully elongated needles tend to droop (fig. 4 and cover). As the fungus spreads into the shoot tissue, it causes a canker. Cankers on some species are purplish. A small drop of resin, or pitch, is often exuded at the base of infected needles. The tissue underneath the bark is resinous.

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Figure 1—*Red pine with infected overstory and understory.*

Disease Cycle

Young needles are infected; and then the fungus grows into the elongating shoots, where cankers form. The fungus spreads within the succulent shoot tissue, but rarely into older wood. Growth is restricted in the cankered areas, causing the shoot tip to curl over and form a crook. (See figs. 2 and 3.)

Small, black fruiting bodies, or pycnidia, form on the dead needles and shoots (figs. 5 and 6). These fruiting bodies produce large numbers of slender, transparent spores, or conidia (fig. 7). The conidia are spread to nearby hosts by water drops, which splash from rain or irrigation systems. When the humidity is high, the temperatures are mild, and the light is low, the conidia germinate and infect host trees. In some conifer species, the fungus may occur on cone scales and be seedborne. When the pathogen is seedborne, it causes damage to nursery and containerized seedlings.

In the Lake States and the Northeast, major spore release and infection of new growth on red and jack pine occur in May and June. Symptoms such as pitch droplets, browning at the base of needles, chlorosis, shoot curling, shoot death, and needle droop occur in late June, July, and August. The fungus overwinters in these dead shoots and mature spores are produced and

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Figure 2—*Western hemlock with curled shoots symptomatic of sirococcus shoot blight infection.*

disseminated during rainy weather the following May and June, completing the life cycle. A sexual stage of the fungus has not been found.

Cultural Controls

The cultural controls discussed here are specific to red pine, Jeffrey pine, and western hemlock, but can be used for other host species where appropriate.

Cultural controls for red pine—The best control for red pine is to avoid two-story or uneven-aged stands in areas where *Sirococcus* is a potentially serious problem. (See fig. 1.)

Removing infected overstory and understory trees (or infected shoots, if understory trees are small enough) can significantly reduce or prevent infection of the remaining healthy understory trees. The removal of infected overstory trees eliminates a major inoculum source and the shade necessary for infection.

Red pine seedlings should not be planted under or adjacent to infected trees. The minimum width of the buffer zone should be twice the height of infected trees. This buffer zone can be left unplanted or managed for deciduous species or immune or resistant conifers, such as white spruce, black spruce, balsam fir, or larch. As a precaution, newly established red pine plantations should be checked 5 years after planting to make sure the fungus has not spread into the plantations. If the fungus is present, appropriate control measures should be carried out to insure that major inoculum sources are eliminated.

Where there are small pockets of infected overstory and understory trees in an otherwise healthy plantation, the infected overstory trees should be removed. The infected understory trees should also be removed or the infected shoots should be pruned and destroyed.

Microclimatic conditions favorable for infection create hazard sites when *Sirococcus* is present in the area.

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Figure 3—*Red pine with curled shoot.*

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Figure 4—*Red pine with drooping needles.*

Humid, shady planting sites, such as small forest openings (diameter less than height of surrounding trees), shaded sites north and west of a stand of tall trees, and steep north or west slopes, are potential hazard areas and should not be planted with red pine.

Scattered, large overstory red pine

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Figure 5—*Small, black fruiting bodies on a Jeffrey pine seedling.*

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Figure 6—*Closeup of black fruiting bodies at base of red pine needle, magnified approximately 30 times.*

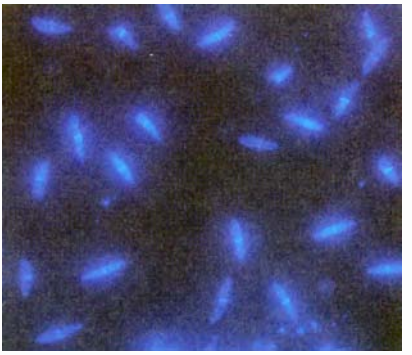

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Figure 7—*The two-celled* Sirococcus *spores are spindle shaped and approximately 3 by 15 microns in size. The spores were labeled with a fluorescent brightener under ultraviolet light for this photograph.*

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Figure 8—*Infected Jeffrey pine nursery seedlings.*

should not be left during logging in *Sirococcus* hazard areas, particularly if the site is to be planted to red pine.

If removal of infected overstory red pine is impractical, the area should be managed for resistant or immune conifers or deciduous species. Before choosing an alternate species for planting, make sure other important diseases and insects of the chosen species are not prevalent in the area.

Cultural controls for Jeffrey pine—Most of the damage to this species occurs in nurseries (fig. 8). The fungus lives saprophytically on the scales of spruce cones, where it produces spores. When blown into the nursery, these spores infect pine seedlings. It is helpful to remove sources of inoculum from around the nursery and infected seedlings within nurserybeds before they have a chance to produce spores and infect adjacent seedlings.

Cultural controls for western hemlock—Thinning dense stands of hemlock and spruce will alleviate the moist, dark conditions conducive to infection. Spruce and dominant hemlock should be favored during thinning. Roguing infected seedlings in nurseries will reduce inoculum levels and infection.

Fungicidal Control

Sirococcus can be controlled in nurseries by properly timed fungicidal sprays. The timing of sprays will vary depending upon the geographic area, but fungicides should be applied just before and during the peak spore dispersal and infection periods. Chlorothalonil is effective for this purpose. Following label instructions, first apply spray to seedlings with newly emerging shoots and needles, and then spray at 3- to 4-week intervals until needles are fully developed. Spray more often during prolonged rainy periods and when shoots are rapidly elongating.

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Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment, if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

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