Broom Rusts of Spruce and Fir

Dense, pale, or dead-looking brooms

Pathogen—Fir broom rust is caused by the fungus *Melampsorella caryo-phyllacearum*. Spruce broom rust is caused by the fungus *Chrysomyxa arctostaphyli*.

Hosts—Many true fir species are susceptible to fir broom rust, including white fir and subalpine fir in the Rocky Mountain Region. Alternate hosts are chickweeds (*Cerastium* and *Stellaria* spp.) (fig. 1).

Spruce broom rust primarily affects Engelmann spruce and Colorado blue spruce in the Rocky Mountain Region. The primary alternate host is bearberry or kinnikinnick (*Arctostaphylos uva-ursi*) (fig. 2), but manzanitas (*Arctostaphylos* spp.) are occasional alternate hosts on the Uncompahgre National Forest.

Figure 1. Chickweed is the alternate host for fir broom rust. *Photo: Karan A. Rawlins, University of Georgia, Bugwood.org.*

Signs and Symptoms—These diseases are easily identified by the dense proliferation of branches (witches' brooms) on spruce and fir (fig. 3). Infected needles are chlorotic (pale), short, and thick and are shed each fall, making the broom appear dead over the winter, but new chlorotic foliage is produced within the broom each spring. Spermogonia form on the underside of needles between the cuticle and epidermis in the spring and have a strong, characteristic odor. Aecia appear in the summer. Brooms are most obvious at this time because the chlorotic foliage is covered with bright orange aecia, which contrast to adjacent healthy foliage (figs. 4-5). Witches' brooms commonly lead to cankers, dead tops and branches, broken tops and branches, and mortality. Rust brooms are sometimes confused with dwarf mistletoe brooms. However, rust brooms are denser, yellow, and lack mistletoe shoots. Dwarf mistletoes do not occur in true firs and spruce in the Rocky Mountain Region. Both pathogens cause a leaf spot and shoot blight on the alternate hosts.

Figure 2. The alternate host for spruce broom rust is kinnikinnick. *Photo: Dave Powell, USDA Forest Service, Bugwood.org.*

Disease Cycle—Both pathogens require an alternate host to complete their life cycles. Their life cycles are similar to one another and to other macrocyclic rust fungi, except *C. arctostaphyli* does not produce uredinia. Wind-blown spores (basidiospores) produced on the alternate host are needed to start new infections on trees. Infection occurs on newly emerging twig and bud tissue. Once a tree is infected, the fungus stimulates bud formation, leading to broom development. Spermogonia form on the underside of needles in the spring; their strong, fetid odor attracts insects that cross-fertilize the fungus. Bright yellow-orange pustules (aecia) of spores (aeciospores) rupture through the leaf surface in early summer. Aeciospores disseminate in the wind to infect the alternate host. Moist conditions are conducive to infection.

Impact—Broom rusts may cause stem cankers and deformations, growth loss, top-kill, and tree mortality. Trees weakened by broom rust may be more susceptible to other insects and diseases. A few brooms on a tree can result in more than 20% reduction in diameter and height growth. Rust brooms also serve as infection courts for decay fungi such as *Porodaedalea* (= *Phellinus*) *pini*.

Figure 3. Rust broom on Engelmann spruce after infected needles produced that year died. Note that the tree top has failed. *Photo: Kelly S. Burns, USDA Forest Service.*

Rust brooms are especially damaging when they occur near the stem. Stem breakage may occur at the point of infection, creating hazards in recreation areas. Portions of the San Juan and Rio Grande National

Figure 4. Close-up of infected spruce needles sporulating during summer. *Photo: William M. Ciesla, Forest Health Management International, Bugwood.org.*

Figure 5. Rust broom on subalpine fir sporulating in midsummer. *Photo: Susan K. Hagle, USDA Forest Service, Bugwood.org.*

Forests have high levels of infection (up to 23-29%) of spruce. Fir broom rust is also common on the San Juan National Forest, with some sites having 37-42% infection. However, average incidence in Colorado is 4.2% for spruce and 2.3% for fir.

The incidence of broom rust is associated with the distribution and abundance of hosts, microclimatic conditions, and host susceptibility. Mature stands are likely more susceptible simply because there is more susceptible target area, but damage is generally greater on small trees because their needles are so close to the main stem.

Management—Trees with stem cankers or brooms can be selectively removed during stand treatments. Pruning out broom rust infections may reduce the risk of stem breakage and maintain tree vigor. Trees with dead tops and adjacent dead brooms are often heavily decayed and should be considered hazardous in recreation areas. Consider the following management recommendations (ref. 2).

Tree removal priorities for commercial and precommercial entries:

- Remove trees with spike tops or broken tops while maintaining sufficient numbers of snags.
- Remove all infected trees that have symptoms of bark beetle attack, decay, and/or root disease.
- Remove trees with one or more bole cankers that girdle more than 33% of the stem circumference.
- Remove trees with one or more dead brooms and two or more live brooms within 1 ft (30 cm) of the main stem.
- Remove all infected trees while maintaining adequate stocking.

On developed sites:

- Remove all dead trees, hazardous trees, and hazardous branches.
- Maintain as many live trees as possible.

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