FOREST HEALTH FACT SHEET

EC 1615-E • January 2008

Swiss Needle Cast of Douglas-fir in Oregon

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What is it?

Swiss needle cast of Douglas-fir is a foliage disease caused by the fungus *Phaeocryptopus gaeumannii*. The disease is specific to Douglas-fir, affecting no other tree species.

It was discovered first in Douglas-fir plantations in Europe in the early 20th century, hence the name "Swiss" needle cast, but the pathogen is presumed to be native to the Pacific Northwest. In Oregon, *P. gaeumannii* is found throughout the range of Douglas-fir, where it usually is a reasonably harmless fungus within the leaves' interior.

Swiss needle cast disease typically is associated with Douglas-fir grown outside its native range, such as in Europe or New Zealand, or in Christmas tree plantations in the U.S. Midwest. However, Swiss needle cast can also occur in western Oregon, particularly on sites that get a lot of spring and/or summer rain and where mild winters favor the pathogen's growth and reproduction.

Swiss needle cast is also one of a number of important foliage diseases in Oregon Christmas tree plantations. Currently, Swiss needle cast is causing severe symptoms in the low-elevation, western flanks of the Coast Range in central and northern Oregon (Figure 1).

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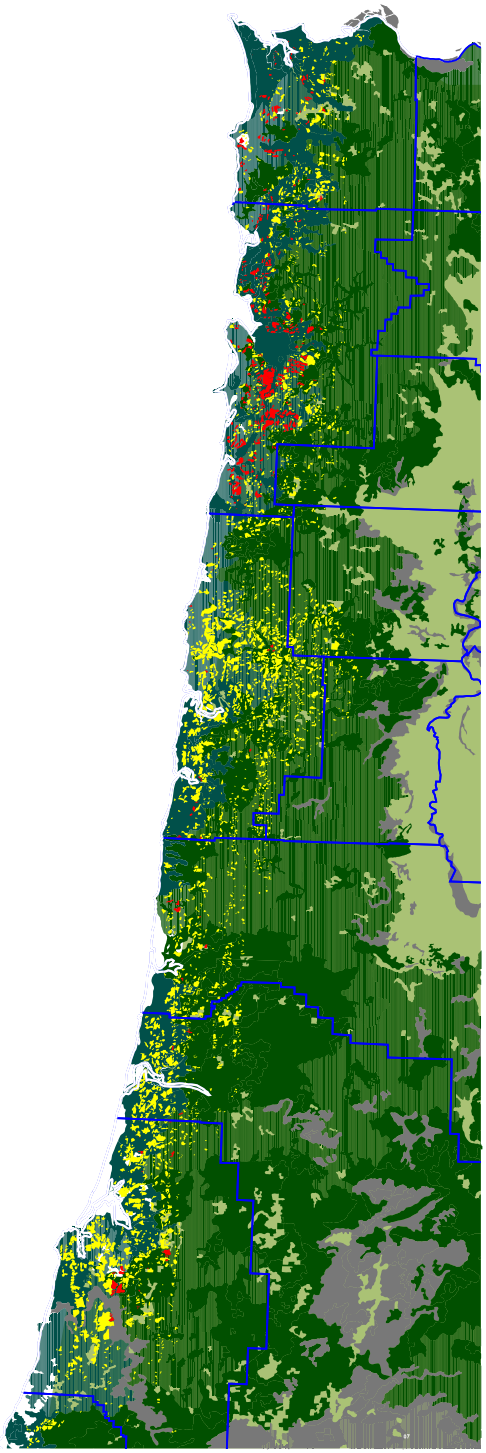

What does it do?

Swiss needle cast causes premature needle loss (casting), resulting in thin crowns (Figure 2); remaining foliage may be yellowish (chlorotic). Symptoms are most visible in late spring, just before bud break (May to early June). After bud break, the new foliage masks the yellowish foliage of previous years' growth.

Figure 1 (at left).—*Aerial surveys in 2007 of coastal Oregon reveal visible signs of Swiss needle cast disease. Areas in yellow are moderately affected, and those in red are severely affected. Map: Oregon Department of Forestry.*

Figure 2 (above).—*Douglas-fir with symptoms of Swiss needle cast. Note the thin crown, yellowish color, and general overall peaked look. A tree like this may not die, but its reduced growth will put it at a competitive disadvantage. Photo: Alan Kanaskie, Oregon Department of Forestry.*

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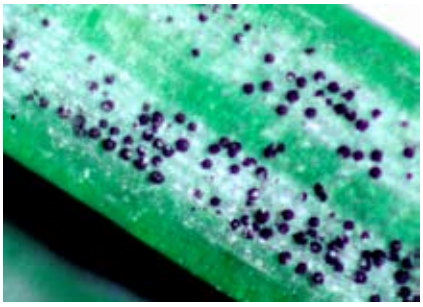

Figure 3.—*At top, Swiss needle cast fungi look like rows of little black dots on the needle's underside. Below, a close-up of reproductive structures (pseudothecia) clogging air pores. Photos: Alan Kanaskie, Oregon Department of Forestry.*

Diagnosis can be made by examining the undersides of the oldest needles for small black dots called pseudothecia—fruiting bodies of the pathogen—which plug the air pores (stomates); see Figure 3. These can be seen best with a 10X hand lens; but if the disease is severe, they can be seen with the naked eye.

Swiss needle cast rarely kills trees but can reduce tree growth rates (Figure 4).

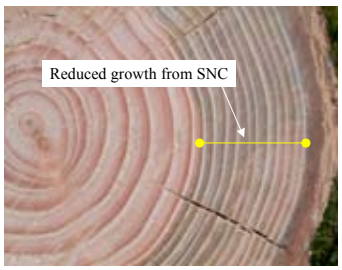

Figure 4.—*A cross section of infected Douglas-fir shows how Swiss needle cast reduced tree growth. Photo: Alan Kanaskie, Oregon Department of Forestry.*

Growth losses due to disease can vary depending on disease severity. Studies in the zone of the Oregon Swiss needle cast epidemic have shown average losses are between 20 and 55 percent of normal annual growth. Growth reduction due to disease can eliminate the competitive advantage of the planted Douglas-fir, allowing other naturally seeded tree species to outgrow the Douglas-fir (Figure 5).

Biology and spread of the fungus

Phaeocryptopus gaeumannii is a microfungus in the group of fungi that reproduce sexually by a type of spore called an ascospore. These spores are produced within the fruiting bodies, or pseudothecia, that appear as small black dots on the undersides of needles.

In May and June, when new foliage emerges, ascospores mature and are released, and they are dispersed by wind-blown rain. Ascospore release and infection are aided by surface moisture, light rain, and dew. Infection occurs only on newly emerged foliage in the spring during or shortly after needle flush.

The spore is deposited on the needle, germinates, and grows on the needle surface until it finds a suitable air pore to grow into. *P. gaeumannii* lives within the needle, but it produces spores at the entrance to the air pores (stomates) on the underside of the needle. This clogs the air pore, and the leaf can neither take in carbon dioxide nor allow water and oxygen out.

It appears that the fungus does no other harm to the plant; e.g., it does not kill cells within the needle or feed on them. However, clogging the needles' air pores starves the tree of carbon, and that reduces growth.

The ascospores are very susceptible to drying. Weather has to be reasonably wet for successful infection. Mild, moist spring and early summer weather is most conducive to foliage infection. Since only the newly emerged leaf is infected, the amount of inoculum (abundance of ascospores) and the weather during the spring infection period strongly affect the amount of infection that will be in a cohort of foliage for its life. Hence, after several years of weather favorable for infection, the entire tree crown can be heavily infected by *P. gaeumannii*.

Figure 5.—*Infected Douglas-fir, with yellowish needles, is being outcompeted by western hemlock, near Tillamook.*

Alternatively, dry spring weather can lead to little infection. The anomalies of

Figure 6.—*Age classes of Douglas-fir needles on a healthy branch. Douglas-fir has determinate growth, so each age class is distinct. Illustration: Nancy Babayco.*

annual weather patterns control much of the visual expression of the disease. Typically, low-elevation, moist valley bottoms in the Cascades and Willamette Valley tend to have drier spring weather than the western Coast Range, and Douglas-fir plantations in those locations may have sporadic symptoms. The disease tends to be more consistently severe along the western slope of the central and northern Oregon Coast Range. Sites that have a southerly aspect, low elevation, and higher moisture condensation on foliage are the worst.

P. gaeumannii black fruiting bodies are common on 4- or 5-year-old needles of healthy Douglas-fir trees, where they contribute to loss of older needles. The most severe symptoms of Swiss needle cast are on trees in which the fungal fruiting bodies are abundant on 1- and 2-year-old foliage, which results in early needle loss.

The Swiss needle cast epidemic in Oregon is limited geographically and does not appear to be expanding. However, the total area affected is about 1 million acres, and the average growth reduction is about 25 percent.

Prior to the 1940s, the area was dominated by a mix of western hemlock, Douglas-fir, Sitka spruce, western redcedar, and red alder. But whereas Douglas-fir made up less than 20 percent of the forest 60 years, it has become the dominant species, and most plantations are young.

The most likely cause of the epidemic is the combination of mild winters, wet and fog-laden springs and early summers that allow leaf infection, the presence of abundant, young, even-age hosts, and rich soils that produce succulent, nitrogen-rich foliage which might aid in fungal growth. Everything favors the fungus!

How do I know if I have a problem?

Even though Swiss needle cast is present, you most likely do not have a problem as long as your trees retain about 3 years of foliage. We normally don't detect reduced growth until the tree retains less than that.

Figure 6 shows how cohorts of needles are arranged on a Douglas-fir branchlet. Count the cohorts, beginning with the newest or current-year cohort.

A simple way to confirm the number of years of foliage retention in your tree is to use binoculars to look at the mid-crown area on the sunny side (south, usually) of the tree and count the foliage cohorts. It is best to count several different branches and to use laterals rather than the apical leader of the branch. Take an average of several counts in this area of the tree.

Again, you don't have a current problem with Swiss needle cast if your tree carries about 3 or more years of foliage, even if you can find black dots on the undersides of older needles.

What are we doing about the epidemic on the Oregon coast?

In 1996, after the epidemic in the Oregon Coast Range became apparent, Oregon State University and forest landowners (state, federal, and private) came together to form the Swiss Needle Cast Cooperative. This cooperative has spearheaded research into the epidemic's cause and how to manage it.

In addition, the members of the Northwest Tree Improvement Cooperative are working to find SNC-tolerant Douglas-fir families through traditional tree breeding.

The cooperative currently is focusing on melding our increasingly sophisticated understanding of the spatial distribution of disease severity, weather models, forestry practices, growth models of Douglas-fir under different disease scenarios, and soils. Spatial models may be able to predict disease severity at the scale of the plantation. In the future, these models could be linked to growth models that take into account disease severity, and allow the forester to estimate impacts to Douglas-fir growth for a specific site.

Figure 7.—*At top, a branch showing effects of Swiss needle cast; only 1 year of foliage is present. Below, a healthy branch, which has retained older needles. Photos: Alan Kanaskie, Oregon Department of Forestry.*

Fungicides are effective against the disease but impractical for use over such a vast area. Normal silvicultural practices that encourage tree growth, such as thinning, are encouraged, although nitrogen fertilization is not. Managing for mixed species may help offset any losses from Swiss needle cast of Douglas-fir; in some zones where the disease is severe, Douglas-fir should not be grown.

For more information

Swiss Needle Cast Cooperative
http://www.cof.orst.edu/coops/sncc/index.htm

Oregon Department of Forestry, Forest Health
http://egov.oregon.gov/ODF/PRIVATE_FORESTS/fh.shtml

USFS PNW Region, Forest Health Protection
http://www.fs.fed.us/r6/nr/fid/index.shtml