Swiss needle-cast of Douglas fir

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Causal organism


Fig. 1 - Douglas fir needles infected by *Phaeocryptopus gaeumannii*. Fungal fruiting bodies are emergent from stomata on lower needle surfaces.

Type of injury

Associated with premature defoliation and subsequent reduction in tree growth.

Diagnostic features

Two parallel bands of tiny (about 0.4 mm), black, spherical fruiting bodies, coincident with the stomata, on the lower surfaces of living needles (Fig. 1).
Mature fruiting bodies are more densely distributed, and therefore more easily seen, on older needles.

Premature defoliation of older needles. Infected trees usually do not retain needles for more than 3 years. Heavily infected trees may be chlorotic.

**Note**: Other fungi which occur on Douglas fir needles and may be confused with *P. gaeumannii* are:

i. *Rhizosphaera kalkhoffii* and *R. pini*, recognised by their brown fruiting bodies on dead portions of needles. (See Forest Pathology in New Zealand, No. 13).

ii. *Clypeolum* sp. and *Clypeolinopsis* sp., distinguished by their flattened, shield-shaped fruiting bodies which are not associated with stomata.

**Hosts**

The main host is the widely planted Douglas fir (*Pseudotsuga menziesii*). *Pseudotsuga macrocarpa*, a tree not used for afforestation in New Zealand, is also susceptible to infection.

**Distribution**

*Phaeocryptopus gaeumannii* was first found on Douglas fir in New Zealand in 1959. Its distribution at that time was limited to a radius of about 100 km around Taupo. In the South Island it was first found near Nelson in 1969, and reached Southland in 1977. *P. gaeumannii* is now distributed throughout most of the country.

**Economic importance**

Infection severity is high in many Douglas fir plantations in New Zealand, especially where winters are relatively warm (i.e. where the long term average June temperature is above 5.0°C). This includes most of the North Island, except for central, high elevation sites, and lower elevation, coastal areas in the South Island. Foliage retention of Douglas fir decreased following the
introduction of *P. gaeumannii*, more so in the North Island (predictions between 40 and 70%) than in the South Island (between 70 and 100%). An analysis of historical records showed that there was a 32% cumulative reduction in volume growth increment after *P. gaeumannii* reached different forests as it spread through the country. This decrease was greater in the North Island (35%) than in the South Island (23%). The effect of this decline has been partly offset by subsequent selection from superior Douglas fir sources for new planting. The disease has had negligible effect on cooler, more elevated, inland South Island sites where daily minimum October temperatures average below 3.2°C.

**Disease development**

Spores are released between September and January, with peak production occurring in October and November, coincident with the flushing period of the host. Maximum infection occurs within the first 4-6 weeks of flush. Fruiting body initials first appear in April, and the fructifications mature the following spring. New fruiting bodies are produced annually and so are more densely distributed on older needles. The fungus continues to grow within infected needles until they are shed prematurely (Fig. 2). Older foliage can also become infected, but at much reduced levels. Infection is favoured by the comparatively wet spring/early summer period found in most of New Zealand.
Fig. 2 - Grafted cuttings of Douglas fir from 22-year-old trees. The plant on the right is infected by *P. gaeumannii* and is prematurely casting 2-year-old foliage. The plant on the left is uninfected.

**Control**

**Genetic selection:** No trees or seedlots resistant to infection by *P. gaeumannii* have yet been found under New Zealand conditions. However, trees originating from different sources in the native Douglas fir range exhibit a varying degree of chlorosis and needle cast symptoms when heavily infected (Fig. 3). Variation in needle retention is also noticeable among infected trees of the same seedlot. Trials are currently in progress to develop further improved Douglas fir planting stock for commercial use. Selection criteria include enhanced needle retention and acceptable growth despite the presence of infection.

Fig. 3 - Variation in tree size and degree of chlorosis in 12-year-old trees heavily infected by *P. gaeumannii*. Smaller, yellower trees to the right of the white peg are grown from an inland Californian seedlot, those to the left from an Oregon seedlot.
Site selection: Douglas fir is least affected by the disease on cooler, higher altitude, inland sites, especially in the South Island (Fig. 4).

Fig. 4 – Map of New Zealand showing the predicted loss in volume growth after the arrival of *P. gaeumannii* in forests in different regions.
Fungicides: *Phaeocryptopus gaeumannii* can be controlled in seedlings and very young trees by protectant spraying with cuprous oxide or copper oxychloride (50W, 0.25 g/litre). A surfactant such as Multifilm X-77 should be used with the fungicide. Two applications should be made, the first about 3 weeks after bud burst and the second approximately 6 weeks later. It is important to spray foliage thoroughly to run-off point to achieve satisfactory control. Copper fungicides need to be used carefully as they can cause foliage burning. Overseas, the disease has been controlled by two aerial applications of chlorothalonil. Chemical control is probably uneconomic except for short-term, high-value crops such as nursery stock or Christmas trees.

Silviculture: It has been found that thinning in heavily diseased, central North Island plantations does not reduce infection severity or increase stand growth. Nevertheless, current advice is to thin early, in order to reduce competition and increase the crown depth so as to maintain vigour and piece size on residual trees.

**BIBLIOGRAPHY**


