Douglas-fir Dieback[1]

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Abstract.--Dieback of container Douglas-fir germinants is caused by a minor root pathogen. The incidence and severity of dieback are strongly influenced by (1) germinant susceptibility to the pathogen, highest the first few weeks after germination, and by (2) the growing environment, particularly moisture content, temperature and pH of the growing mix.

INTRODUCTION

For the past five years, nursery growers have observed a growth problem, termed needle dieback, in container-grown Douglas--fir seedlings. Dieback occurs in patches throughout Douglas-fir seedlots and may result in cull losses of 0-25% depending upon the nursery, sowing date and year. Dieback symptoms including stunted shoot growth, needle chlorosis, and dieback of needles from the tips to the bases. These symptoms are first noticed when the seedlings are a few centimetres tall. The root systems of dieback seedlings appear normal, exhibiting none of the external symptoms associated with root diseases.

This poster summarizes the results of Douglasfir dieback research funded by the Canada-British Columbia Forest Resource Development Agreement. For more information, a file report is available from Dr. J. Sutherland, Pacific Forestry Centre, Canadian Forestry Service, Victoria, B.C., Canada.

RESULTS

Douglas-fir dieback is caused by a minor root pathogen. However, the incidence and severity of dieback damage depends on the growing environment and the susceptibility of Douglas-fir germinants to the pathogen (fig. 1).

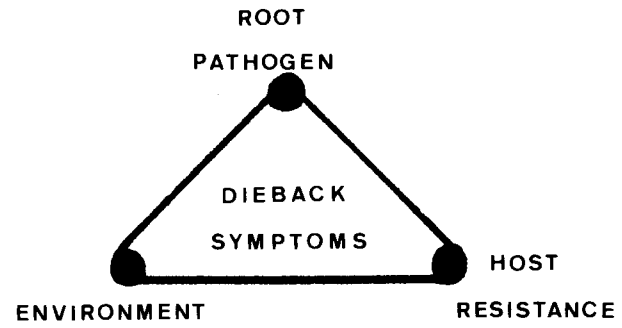

Figure 1.--Douglas-fir dieback as a minor root pathogen x host x environment interaction.

Minor Root Pathogen

A minor root pathogen, probably *Pythium ultimum3,* causes dieback in Douglas-fir germinants. This conclusion is based on the following observations.

(1) Autoclaving growing medium or drenching it with a systemic fungicide, fosetyl aluminum, eliminates or significantly reduces the incidence of dieback.

(2) Pythium has been isolated consistently from surface-sterilized roots of dieback seedlings.

(3) Pythium oospores isolated from dieback seedling roots were cultured and used to inoculate sterile Douglas-fir seeds sown into autoclaved peat:vermiculite (PV) growing mix. Pythium-inoculated seedlings developed dieback symptoms. No dieback symptoms developed on control seedlings which were inoculated with heat-killed Pythium cultures. Microscopic examination of *Pythium* oospores isolated from inoculated dieback seedlings showed that they were similar to those of the original inoculum cultures.

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[3]Identified by Dr. H. Hartmann, M.B. Research and Development, Sidney, B.C., Canada.

(4) There are numerous reports of subclinical damage caused by a variety of *PythiuM* species (Hodges 1985, Horshman 1986, Kobriger and Hagedorn 1984). Subclinical damage is characterized by stunting and growth losses in plants which have normal-appearing roots with no external symptoms of root rot.

Minor root pathogens, such as *Pythium*, are generally restricted to juvenile root tissues such as root hairs, root tips or cortical cells (Salt 1979). In Douglas-fir germinants, *Pythium* seriously reduces root hair development (figs. 2 and 3). Damage to root hairs is easily overlooked and may be of a temporary nature because root hairs may live only a few hours, days or weeks (Kramer and Kozlowski 1979). However, root hairs can comprise 50% of the total root surface area of a seedling (Kozlowski and Scholtes 1948) and therefore, contribute significantly to water and nutrient absorption.

Environment and Host Susceptibility

The degree of damage caused by minor root pathogens typically depends on the growing environment and host plant vigor (Salt 1979). Seedling age, growing mix temperature, moisture content and acidity (pH) are important factors influencing the incidence of Douglas-fir dieback in container nurseries.

Seedling Age

Percent germination is not affected by the presence of the dieback pathogen. Dieback symptoms appear two to three weeks after germination. Susceptibility to dieback decreases as seedlings age. One-week-old germinants transplanted into growing medium containing the dieback pathogen are very susceptible to the disease; 80-90% will exhibit dieback symptoms.

In contrast, eight-week--old seedlings transplanted into growing mix containing the dieback pathogen do not develop dieback symptoms.

Figure 2.--Micrographs of root hair development in a healthy Douglas-fir germinant.

Figure 3.--Micrographs of root hair development in a dieback Douglas-fir germinant.

Growing Mix Temperature and Moisture

Moisture stress and high root-zone temperatures appeared to influence the incidence and severity of dieback in container nurseries. In order to determine the effects of growing mix temperature and moisture on dieback incidence, Douglas-fir germinants were transplanted into sterilized PV or sterilized PV inoculated with the dieback pathogen. The germinants were grown at two root-zone temperatures (20 and 30°C) and at three levels of moisture stress: (1) none [moisture content (MC) of medium 575%], (2) light (MC of medium 375%), and (3) moderate (MC of medium 140%).

Three weeks after germination, all seedlings grown in the sterilized PV with no inoculum appeared healthy. In the sterilized PV containing the dieback pathogen, the incidence of dieback increased with growing mix temperature and moisture stress (figs. 4 and 5). Root-zone temperature also affected the severity of dieback symptoms. At 2000, dieback seedlings were stunted and had needle dieback; at 30°C, most dieback seedlings died.

Growing Mix pH

Douglas-fir seed was sown into 3:1 mixtures of peat:vermiculite adjusted with dolt cite lime to initial pH values of 4.0, 5.0, or 6.0. During the six week experiment, pH rose 0.8 to 1.0 units in each mix. All mixes contained micronutrients. The development of dieback symptoms was strongly influenced by the initial pH of the growing mix. Mean dieback incidences (three replicates) for pH 4.0, 5.0 and 6.0 were 94%, 10% and 4%, respectively.

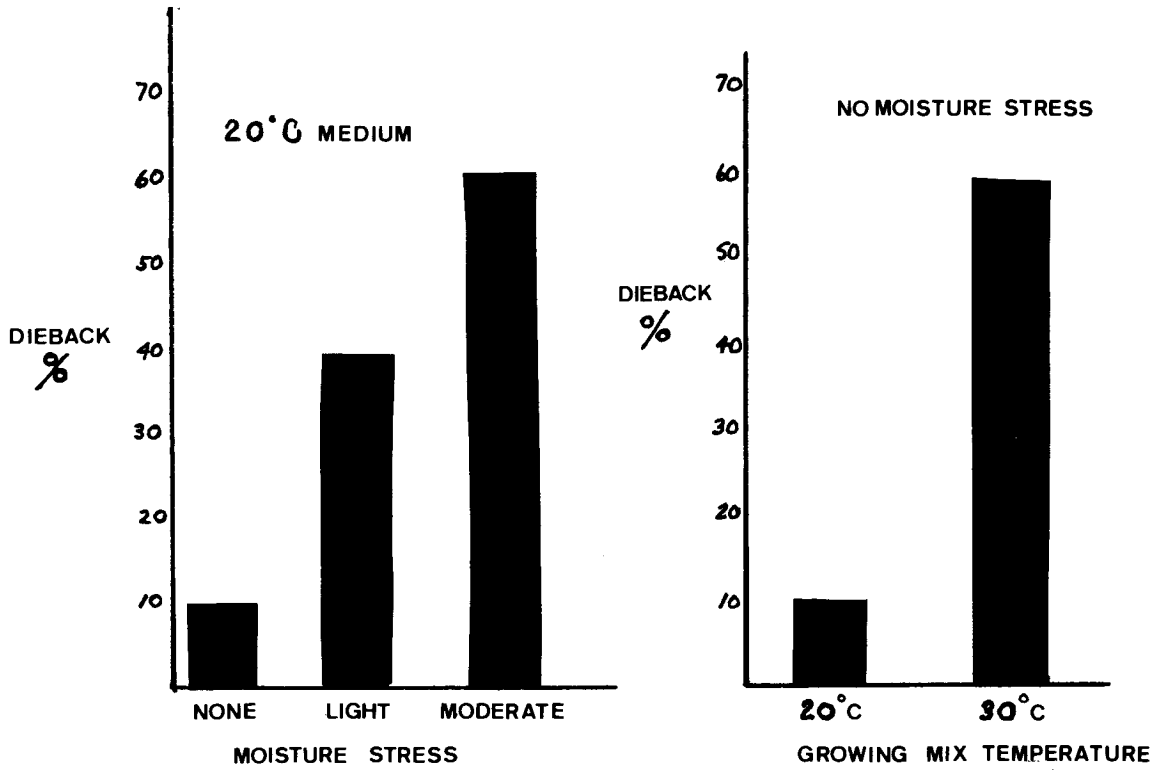

Figure 4.--Effects of growing mix temperature and moisture content on the incidence of Douglas-fir dieback.

In B.C. nurseries, a growing mix pH of 4.0 is not unusual during the first few weeks after sowing[4]. Low pH is associated with low calcium availability. Either of these factors may increase dieback incidence by (1) decreasing host vigor, or (2) decreasing bacterial competition for nutrients. Elad and Chet (1987) reported that the presence of bacteria along the roots of susceptible host plants reduced the establishment of *Pythium* along the roots; the bacteria appear to compete successfully with *Pythium* for nutrients. Low availability of calcium may also favor the germination of *Pythium* spores (Kao and Ko 1986, Qian and Johnson 1987).

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