
High soil temperatures have recently been associated with needle-tip die-back in Douglas-fir container nurseries. FRDA Report 035 details a FRDA study conducted under contract to the Canadian Forestry Service (CFS) by M.J. Peterson and S.E. Tuller to investigate the relationship between air and soil microclimate and the occurrence of the disease.

During the 1984 and 1985 growing seasons, approximately 20% of the Douglas-fir seedlings at the Canadian International Paper (CIP) new Canadian Pacific Forest Products (CPFP), container nursery in Saanichton, B.C. exhibited die-back symptoms. The die-back occurred in patches throughout the Douglas-fir seedlots. Each patch expanded from a few infected seedlings in the first two weeks after germination to 10-20 seedlings during the next two months. Losses have also occurred in private and British Columbia Ministry of Forests and Lands nurseries during the past five years. The main species affected by the disease in all nurseries was Douglas-fir.

Die-back symptoms have first been noticed when the seedlings are 1-2 cm tall. They include stunting, twisting and wilting of the shoot tips concurrent with die-back of the needles from the tips to the stems. Seedling roots also appear finer and more suberitized than normal.

Although the causal agent(s) of die-back are unknown, high ambient and media temperatures during germination appear to increase its incidence. Observations made by nursery personnel in 1985 found high temperatures to be associated with the disease.

The study involved three trials inside two greenhouses at the CIP (CPFP) nursery in Saanichton, B.C. The first trial was conducted in a polyethylene (HOOP) greenhouse from March 27 to May 14, 1986. Physical properties and soil temperatures were examined for 12 soil mix formulations used as part of CIP's die-back investigation. Each mix was categorized in terms of three factors:

1) peat source,
2) additives (vermiculite, perlite or none) and
3) presence or absence of slow-release fertilizer (Osmocote®).

In the second trial environmental parameters were recorded from May 21 to July 3. Measurements were taken in the HOOP greenhouse as well as a fiberglass-covered (MAIN) greenhouse.

The third trial was designed to investigate the effect of grit cover type on media temperature. It was conducted from July 15 to August 28. A CIP (CPFP) production media consisting of a 2/1 New Langley peat/vermiculite mix was used. No fertilizer was added. Half of the media examined were covered with forest sand, a commercial soil cover consisting of dark coloured, smooth sand grains, each averaging 3 mm in diameter. The other mix was covered with Granite grit. This cover is made of sharp, angular grains of crushed granite, each averaging 3 mm across at the widest point. The Granite grit is light gray, almost white, in colour.

The investigators found that soil temperatures, in container greenhouses, rapidly rise above ambient temperature early in the day during the succulent growth stage of conifer seedlings. The insulating quality of styrofoam helps preserve soil temperature at values higher than ambient. The result is soil temperatures that are above ambient air temperature for 18-20 hours per day. This study found that very high soil temperatures can occur in container greenhouses under standard management practices. High soil temperatures reached in the container greenhouse may contribute significantly to seedling mortality from phenomena such as Douglas-fir needle-tip dieback. High soil temperatures and subsequent lethal tissue temperatures may kill seedlings outright. In addition, constraints upon a seedling's ability to transpire, from increased soil water suction, may be induced by the same high temperatures that the seedlings are attempting to offset through increased transpiration. Results of this research suggest that control of high soil temperatures in container greenhouses may be achieved by the choice of peat, maintaining adequate moisture levels within containers and by using an appropriate grit cover.

Recommendations to greenhouse growers to reduce the risk of high soil temperature damage to conifer seedlings include:

- use a peat with good water absorption and retention characteristics;
- maintain moisture levels in containers as high as possible to reduce the risk of extreme soil temperatures while still minimizing the risk of damping-off fungi;
- avoid using a dark-colored grit cover (lighter granite-type grit will reflect more incoming solar radiation, thus promoting a
lower soil temperature); and

- use of the equation: Soil temperature = 1.4 x ambient (°C) - 5.8 °C provides an estimate of the soil temperature likely to be reached within 15 minutes. The rule-of-thumb: soil temperature = 1.25 ambient temperature, may also be used within the 30-40 °C air temperature range. If excessively high temperatures are predicted, compensating measures such as watering or using shade cloth should be implemented where possible.

Copies of this 43 page report, Die-back of container-grown Douglas-fir seedlings: Associated microclimate by M.J. Peterson and S.E. Tuller, are available while supplies last from:

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