Measurement of Frost-hardiness in Douglas Fir at Three Nurseries by an Electrical Method

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Abstract

Frost-hardiness changes in three Douglas fir provenances at each of three nurseries were followed from September, 1968, to April, 1969, by measuring electrical impedance of stems. Nursery had a greater effect on hardiness than provenance, with seedlings at one nursery reaching the same level of hardiness two weeks earlier than those at another nursery. Detection of these hardiness differences shows the practical value of the impedance method for measuring frost-hardiness.

Résumé

De l'emploi de l'impédance électrique comme méthode en pépinières pour mesurer la résistance au gel de semis de Sapin de Douglas

De septembre 1968 à avril 1969, on a observé les variations de la résistance au gel de trois provenances de plants de Sapin de Douglas, à trois pépinières, en mesurant l'impédance électrique sur les tiges. La pépinière produisit plus d'effets sur la robustesse que la provenance; les semis d'une pépinière atteignirent le même niveau de robustesse deux semaines plus tôt que ceux d'une autre. La détection de ces différences de robustesse démontre la valeur pratique de la méthode d'impédance pour mesurer la résistance au gel.

Suitability of conifer nursery stock for planting-out depends on several factors such as size, general state of dormancy, and frost-hardiness. Degree of frost-hardiness is particularly important if seedlings are to be planted at high elevation. Electrical methods have been developed for measurement of frost-hardiness in woody plants (Wilner et al. 1960), and it has been shown that stem impedance is well correlated with frost-hardiness in Douglas fir seedlings (van den Driessche 1969). Work described here was done to determine the practicality of the impedance method, and to see what effect provenance and nursery had on frost-hardiness changes in Douglas fir seedlings.

Methods

Three 2-0 Douglas fir provenances, representing high, medium, and low elevation sources, were selected at Koksilah, Green Timbers, and Chilliwack nurseries. Only the high elevation provenance (Thurston) was the same at all nurseries. One bed

of each provenance was divided into two blocks. Five seedlings were lifted from each block at 14-day intervals from mid-September to early December, 1968, and from late January to late April, 1969. Seedlings were placed in plastic lined paper bags and immediately despatched to the laboratory. The average time elapsing between lifting and measurement was 3 days, and the maximum 7 days. At the laboratory plants were subjected to 16 hours at -9.5°C , and then allowed to reach room temperature (25°C), before two stem impedance measurements were made above the root collar using equipment previously described (van den Driessche et al. 1968). Results were treated by analysis of variance omitting January data because deep snow prevented lifting of Chilliwack samples during this month.

Results and Discussion

After early October 2-0 Douglas fir plants at Chilliwack were apparently more frost-hardy than plants at Green Timbers or Koksilah, since Chilliwack plants showed higher impedance values which indicate greater frost-hardiness (Fig. 1). The difference between Chilliwack and the other two nurseries was most pronounced during November. In fact the same degree of hardiness was achieved about two weeks earlier at Chilliwack than at Koksilah or Green Timbers. At Koksilah plants did not become quite as frost-hardy during the winter

Fig. 1. Effect of nurseries (above) and provenance at Green Timbers nursery (below) on stem impedance. Higher stem impedance values indicate greater frost hardiness.

as plants at the other two nurseries, and they also lost hardiness earlier in spring.

Provenances did not show significant differences in frost-hardiness. At Green Timbers, however, the data suggested slightly earlier loss of hardiness in the high elevation provenance during spring (Fig. 1.). At Chilliwack there was an indication that the low elevation provenance hardened slightly earlier, and the high elevation provenance slightly later, than the medium elevation provenance during fall.

Earlier development of frost-hardiness at Chilliwack might be expected because this nursery is in a more severe climate than the other two. However, it also has a sandier soil. Weather records from adjacent stations suggest temperature differences did not account for the earlier loss of frost-hardiness at Koksilah than at Green Timbers in spring. For

example, the mean monthly minima for the first four months of 1969, appropriate for Koksilah, were 19.2, 27.5, 31.6, 38.1° F, and corresponding values for Green Timbers were 22.4, 32.0, 35.9, and 41.4° F.

These results show that stem impedance measurement is a practical way of comparing frost-hardiness in conifer seedlings. Apparently development of hardiness in 2-0 Douglas fir is considerably affected by nursery. It is not clear whether climate or some other factor, such as soil, causes the nursery effect. Once the factor is identified, however, time of hardening could be influenced by suitable nursery location.

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