Electrolyte leakage method can give misleading results for the frost hardiness of roots

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Introduction

Assessment of frost hardiness of roots by relative electrolyte leakage (REL) method often fails. Why this happens? We aim to prove that the treatment of roots prior to and after freezing test seriously affects the results of conductivity measurements and therefore the frost hardiness assessment.

Material and Methods

The roots of containerised Norway spruce and Scots pine seedlings were sampled in January and May respectively. The roots were washed free of peat and cut to the tubes for the electrolyte leakage test either prior to or after controlled freeze-thaw treatments at different temperatures, respectively. The REL is defined as:

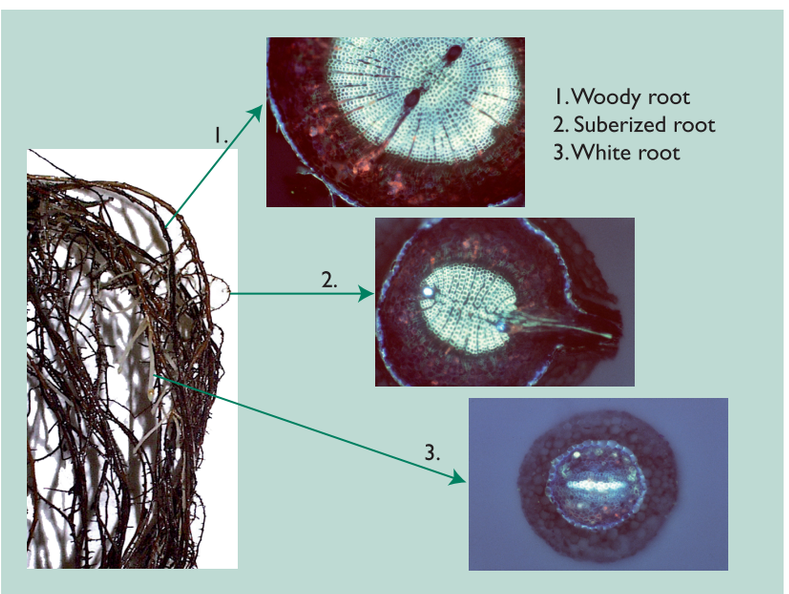
$$REL = \frac{C_1}{C_2} \quad \text{where}$$

C_1 = electrical conductivity of the incubation solution after freezing test and 22 h shaking

C_2 = electrical conductivity of the incubation solution after heat-kill and 22 h shaking

Results

- Electrolytes from the injured roots of Norway spruce leaked to the test tubes (Fig. 1) but from the Scots pine roots to the growing medium (Fig. 2) during the freeze-thaw treatment and/or to water used for the washing of the roots after thawing.
- If the roots are cut to the test tubes after the frost treatment, the low conductivity readings and consequent low REL values result in misleading estimate for frost hardiness.



Root structure of Norway spruce. Note the degeneration of Casparian band during the secondary thickening of the root.

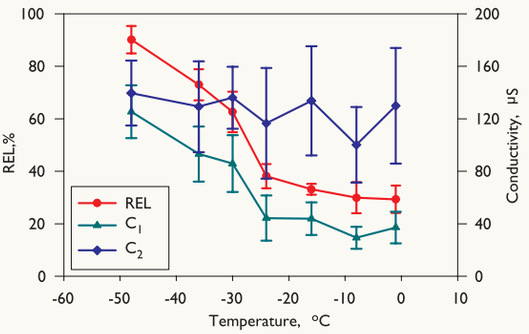


Figure 1. Electrical conductivity of the incubation solution for woody roots of Norway spruce after freezing tests and 22 h shaking (C_1) followed by heat-kill and 22 h shaking (C_2), and relative electrolyte leakage (REL) in a freezing test in midwinter. The root samples were cut to test tubes prior to the freezing test.

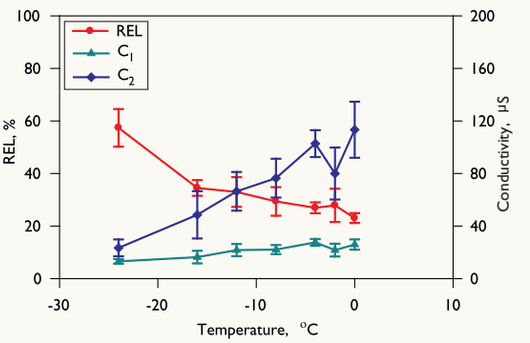


Figure 2. Electrical conductivity of the incubation solution for woody roots of Scots pine after freezing tests and 22 h shaking (C_1) followed by heat-kill and 22 h shaking (C_2), and relative electrolyte leakage (REL) in a freezing test in spring. The root samples were cut to test tubes after the whole-plant freezing test and soil thawing.

Conclusions

- The root samples should be washed out from the growing medium and set to the test tubes prior to the freezing treatment.
- If the roots are injured prior to the washing then the electrolytes may leak to the growing medium. This may limit usability of the REL method for measuring root vitality and frost hardiness.

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