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Biological Requirements for Storing and Transporting Barerooted Scots Pine Transplants

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ABSTRACT

Storage and transport between lifting in the forest nursery and planting in the field can cause damage to tree transplants. Factors causing the damage were investigated in detail in a seven-year study at the University of Helsinki. Based on this work emphasis is recommended on the control of high temperatures. A simple method is proposed for conducting the temperature control in practice.

* The paper is largely based on work done at the University of Helsinki, Dept. of Silviculture.
1. Requirements for Reforestation Methods

Large-scale forest regeneration is operated under cost constraints. It is not always feasible to invest large amounts of resources to guarantee ideal silvicultural results. Indeed, one could argue that a perfect survival of tree transplants is a sign of failure; achieving the 100 per cent survival instead of a level of, say, 95 per cent has eventually been too expensive. Nonetheless, it is important to aim at a survival level of 80 to 95 per cent.

Transplant acquisition techniques should ideally be cheap to save expenses fast, to level out the peak work load and, yet, gentle to the plants. As a result, the costs would be moderate and the stock would start to grow, weather permitting, as soon as it has been planted out in the field and keep growing vigorously until the end of its growing period. This is the definition by Glerum and Mullin (1976) for a high quality stock.

This paper focuses on improving forest regeneration methods. A seven-year study was conducted at the Department of Silviculture, University of Helsinki on factors causing mortality within transplant acquisition from forest nursery into field. As a result, improvements are suggested to current techniques of storage and transport.

2. Study Results

In our study the biological requirements of the stock were first assessed and suggestions for techniques were then deduced based on these assessments. A picture was developed on the range of physical environments to which the plants are subjected. It was found that, in large scale reforestation, conditions of high temperature and high evaporative demand are difficult to eliminate. Rough treatment also occurs
in the form of shaking and dropping the plant containers. A series of 28 experiments were designed and conducted in order to screen the plants' responses to such potential environments. Different stress treatments were given to the plants before planting in the field. The response was measured two growing periods after planting in terms of growth and survival.*

The results indicated that Scots pine transplants are rather tolerant to shaking and dropping. Unfortunately, they are less tolerant to high temperatures and evaporation. Similar conclusions have been published by Lange & Lange (1960); v. Lüpke (1975) and Hallman et al. (1976); see also Rikala (1983). It was established, in particular, that the plant roots are about ten times more sensitive to evapotranspiration than the plant shoot.

Biological requirements as the guide one may conclude that shaking and dropping the plant containers is hardly disastrous, whereas high temperatures and drying out of the plants may well be. Watering the trees before planting as suggested by Yli-Vakkuri (1957) is only partially efficient, since even a temporal root damage generates long-term effects (Tranquillini, 1973). Improving techniques for transport and storage should focus on minimizing the risk for high temperatures and high evapotranspiration rates. In large scale reforestation this would have to be done in a simple and, yet, effective way: not only must the method be gentle; it must also be cheap and fast.

* Scientific report of the study will be available later this year.
Focusing on the control of high temperatures is the key proposal emerged in our study. High temperatures strongly enhance plant respiration which consumes carbohydrate reserves of the plant (Puttonen, 1980). The reserves are needed for a quick start of growth. But also evapotranspiration depends strongly on temperature. In high temperatures, even though relative humidity were high, there occurs substantial evapotranspiration (Gates, 1980; p. 310). Controlling the high temperatures during transport and storage, hence, provides the strategy for controlling two important factors generating plant mortality.

3. Indicator Band

For barerooted planting stock there appears to be a simple way to arrange the temperature control. Convenient temperature indicators are available for detecting any given threshold temperatures. The indicators are based on irreversible chemical reactions; colour of the indicator changes permanently at an indicator-specific threshold temperature. This kind of an indicator could be attached into the band which is used for binding plants together.

The method would be cheap and fast. The indicators are easily made available, and the band is used already in most plant acquisition programs. Additional phases of work would not be needed. The “readings” of the indicator could be read at any instance of time before planting. In practise this could be done when the plants are removed from the containers for planting. If it were observed that the plant temperature has exceeded the threshold level, there would be a chance to replace the stock with a fresh one. Having the temperature information one could
also track the transportation path backwards, and find out where the
damage actually did occur. In this way one would have a new way to con-
tinuously improve the methods for transport and storage. The opportun-
ity of controlling the temperatures would also motivate the people
involved in transplant acquisition to preclude the environments which
might bring about risks.

Some drawbacks of the proposed method have been identified. It is
not certain whether the indicators can be made available at an accept-
able price. Attaching the indicator into the band may be technically not
simple. If, for example, a threshold temperature of \( \sim 42 \) °C is selected,
the storage of the indicator band may itself cause trouble: the chemical
reaction is irreversible and once the colour is converted, the indicator
becomes useless for monitoring further. It remains to be seen whether
technical development will overcome these difficulties. If so it must finally
be confirmed in large scale practice that the benefits of the indicator
band outweigh the costs of implementing the new device.

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