STUDIES OF WATER STRESS IN BARE-ROOTED 2+1 DOUGLAS FIR USING THE SCHOLANDER PRESSURE BOMB

by

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My agreement with the program committee was to spend 20 minutes today discussing our initial work at the Forestry Research Center on water relations of bare-rooted 2+1 Douglas fir stock. Current interest in the subject stems from (1) the well-known importance of water to the successful field establishment of coniferous seedlings (Hermann, 1967); (2) the advent of the Scholander pressure bomb which greatly facilitates such studies; and (3) the establishment of three new forest nurseries by our Company to support regeneration in the High Yield Forest program.

These studies began this past winter at Weyerhaeuser's Washington Nursery about 20 miles from Centralia in western Washington. The work is part of an investigation into seedling vigor designed to provide guidelines to Company nurserymen for the production of stock with high field performance potential.

The Scholander pressure bomb may be unfamiliar to some in the audience though in the past few years it has gained widespread use in forestry research. Dr. P. F. Scholander and his group at the University of California developed the principle for the instrument about three years ago (Scholander, et al., 1965). Waring and Cleary (1967) at Oregon State University took the principle and developed the pressure bomb which we now use in our studies.

The instrument provides a simple and direct way to measure water potential in plants, formerly a theoretical concept limited to complicated laboratory determinations. The details of water potential are somewhat involved; a good non-technical synonym is water stress. It is not a measure of the amount of water in a plant; rather, it describes the energy status or availability of water within the plant. It is true, however, that water stress correlates to some degree with the amount of water in the plant.

There are several additional advantages to the Scholander pressure bomb: it is portable; determinations are rapid and virtually non-destructive to most plants; a momentary reading of a key factor in plant vigor is possible; the instrument is simple requiring only a tank of compressed nitrogen gas as an energy source. The slides demonstrate its use.

One of the first questions we asked was how rapidly do bare-rooted seedlings develop a water stress and from where do they lose water. Sample seedlings were placed on screens in a hood at 23 °C, at 33% relative humidity and at 1000 ft. candles of light up to two hours. In the hood, seedlings received four treatments -- either:

1. Shoots and roots exposed;

2. Shoots covered with moist burlap and roots exposed;

3. Shoots exposed and roots covered with moist burlap; or

4. Both shoots and roots covered.

Every three minutes in each treatment we determined the water stress of a seedling.

Under treatment one, water stresses of both shoots and roots quickly began to build and became more severe with time up to two hours. Treatment two showed that water stresses remained much lower during the two hours indicating that water loss is mainly through the shoots -- not surprising when we stop to think about it for needles are the plant parts which normally give up water through transpiration. Treatment three resembles the way seedlings are commonly handled from lifting to planting, i.e., with only the roots covered. This does keep root stress conditions down compared to those in treatment one, but the shoot stresses are quite erratic -- some high, some low. In treatment four, however, when both shoots and roots are covered with moist burlap, water stress fails to develop in either shoots or roots during the two hours. The recommendation to our nurserymen was to keep both shoots and roots of bare-rooted stock covered during times conducive to evaporation of water from seedling shoots (transpiration) e.g. warm temperatures, low humidities either inside or outside the packing room.

The next questions are: do some seedlings arrive at the planting site in a stress condition and what does this mean in terms of field performance? We only have a start on these answers. However, early indications show that under some lifting, packing and storage conditions at the nursery, seedlings can arrive in the field under water stress. Fortunately most stock from the Weyerhaeuser Washington Nursery last winter did not, but those that did, grew significantly less in height this season than their counterparts without stress. Plans are to continue the studies during the next planting season to fully understand the incidence and significance of water stress in bare-rooted Douglas fir seedlings.

References

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