IS THE OSCILLOSCOPE TECHNIQUE SUITABLE FOR PREDICTING SURVIVAL OF PLANTING STOCK?

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Good physiological condition is an important prerequisite for survival and growth of seedlings after outplanting. However, no rapid and reliable method is available for determining the physiological quality of planting stock.

To detect dead plant tissue in stems and needles of conifers, Zaerr (4) applied a square-wave electrical signal to plant tissue, then observed the wave form on an oscilloscope screen. If the tissue was healthy, the trace remained nearly square or had a spike on the leading edge, whereas dead tissue yielded a sawtoothed track (fig. 1).

Using Zaerr's technique, Ferguson et al. (1) observed that the square wave passed essentially unchanged through healthy tissue during the late fall and winter, but was spiked during the rest of the year. Concluding that these changes corresponded to the level of activity or dormancy of nursery stock, Ferguson and his coworkers proposed degree of dormancy as an indicator of a seedling's physiological condition.

Although Ferguson et al. (1) did not show that the oscilloscope technique permits prediction of field survival of planting stock, apparently some foresters and nursery managers have mistakenly been using it for that purpose. Consequently, we tested the suitability of the oscilloscope technique for predicting seedling survival after planting.

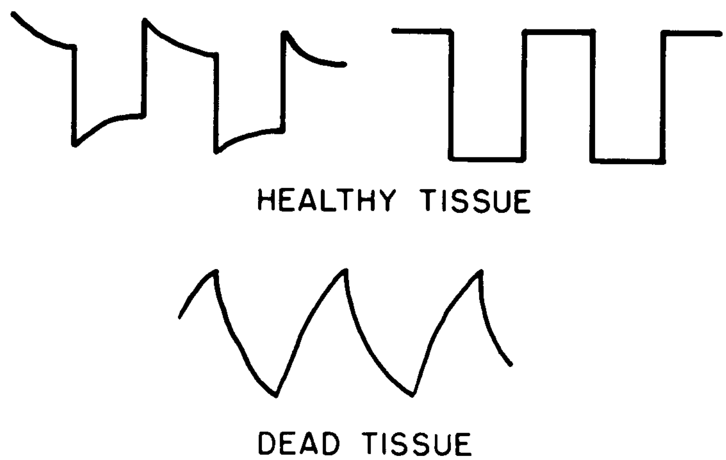

Figure 1.—*Patterns of oscilloscope traces indicating live and dead tissue.*

Materials and Methods

Two-year-old Douglas-fir seedlings were lifted from the same bed in a nursery (Forest Seedlings, Inc.) in Oregon's Willamette Valley on October 11, November 10, and December 8 of 1976, then in 1977 on January 4, February 8, and March 24. On each date, 72 seedlings uniform in root collar diameter and height were selected and divided into three lots of 24 trees each. The first lot was stored overnight at 3° C (37.4° F), whereas the second and third lots were stored for 4 to 8 weeks.

After the seedlings were removed from the cold storage room and allowed to equilibrate to room temperature (21° C, or 69.8° F), oscilloscope traces were recorded to measure electrical impedance (4). The electrode probe consisted of four stainless steel surgical pins approximately 1 cm apart and 0.6 mm in diameter below the tapering point (fig. 2). The probe was inserted in the terminal shoot near the terminal bud. A Wavetek Model 30 generator supplied a 4.5 V square-wave signal with 860 Hz frequency to the first pin of the probe. The output signal from the third pin was measured with a Tektronix Model 564 storage oscilloscope. The second and fourth pins were grounded.

The trace was photographed as it appeared within 1 minute after the square wave was applied to the stem tissue. Voltage was measured at three constant points of the trace (fig. 3) and designated high-frequency voltage (HFV), mid-frequency voltage (MFV), or low-frequency voltage (LFV). Ratios of these measurements were used to typify trace forms.

Then seedlings were planted in a randomized block design in cold frames near the Forest Research Laboratory of Oregon State University. After April 15, the cold frames were covered with a plastic roof during rainfall to increase moisture stress during the growing season.

The trace form of seedlings stored only overnight served as the trace form at time of lifting for all three storage treatments of a given lifting date. Trace forms at time of lifting and at time of planting were tested as indicators of survival potential. We used regression analysis of means for 18 treatments (3 storage lengths x 6 lifting dates) to determine the relationship between trace ratios and survival. Chi-square analysis of individual data points was used to see if sorting seedlings by trace form at time of planting corresponded to performance potential—that is, likely to die, will survive but grow poorly, or will survive and grow well.

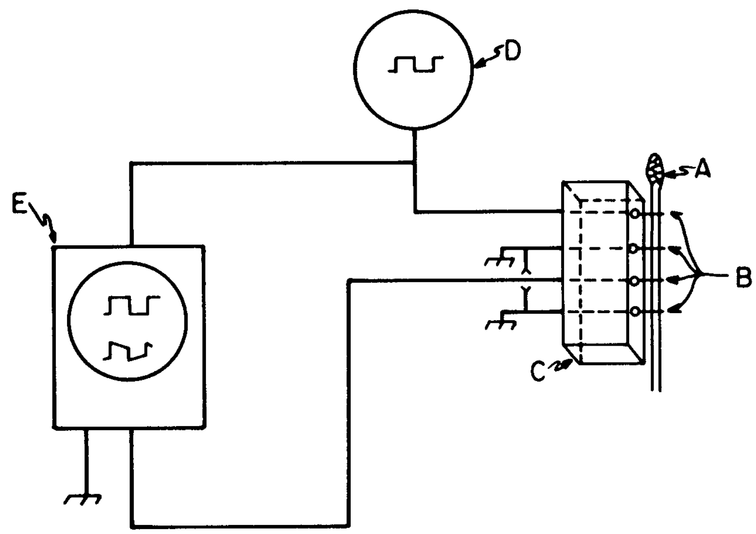

Figure 2.—*Schematic diagram of measuring circuit: (A) terminal shoot of seedling; (B) stainless steel electrode pins; (C) plastic block; (D) square wave generator; (E) dual trace oscilloscope.*

Results and Discussion

Trace form at time of lifting showed a distinct seasonal trend (fig. 4). Traces from seedlings lifted October 11 and March 24, then stored only one night, displayed definite spikes. Seedlings lifted October 11 and stored for 8 weeks had traces resembling the square traces of seedlings lifted in November, December, and January but stored only overnight. Conversely, lifting seedlings in March and storing them for 8 weeks caused the trace to peak considerably more than any other treatment.

Analysis of variance of each of the three voltage ratios assigned highly significant effects to both lifting date and storage period. Interaction of these two factors was also highly significant. Changes in the three ratios were nearly identical and, therefore, only the HFV/MFV ratio was used in regression analysis. The HFV/MFV ratio at time of lifting was significantly related ($r = -0.91$) to survival after 8 weeks of storage. Survival was low for seedlings lifted in October and March, then stored for 8 weeks (fig. 5). When lifted, these seedlings had peaked traces, resulting in a high HVF/MFV ratio (fig. 6). Seedlings from the remaining lifting dates, November through February, had nearly square traces and high survival regardless of the storage.

The difficulties of interpreting trace forms in regard to dormancy and survival are well illustrated by comparing the HFV/MFV for the October and March liftings. In October, seedlings are in deep dormancy, so the terminal shoot will not resume growth even under highly favorable conditions. In March, seedlings are ready to resume growth as soon as environmental conditions permit. At both times, however, oscilloscope readings showed a high HFV/MFV (fig. 6). Furthermore, survival was high for seedlings lifted in March or October, then planted immediately or after 4 weeks of storage (fig. 5).

Seedlings lifted in November had remarkably good survival considering their poor growth[1], so they may not have survived under conditions more severe than in the cold frames. In fact, survival probably was that good because predawn plant water potential never fell below -13.1 atmospheres during the summer of 1977[2]. Thus, a square trace form at time of lifting would not necessarily guarantee survival.

Regressions of the HFV/MFV ratio at time of planting were not significant for survival. Nor did chi-square analysis indicate that ability to predict survival was improved by grouping seedlings according to trace form at time of planting. Trace character apparently does not indicate vigor as such, and thus is poorly suited for predicting survival potential. This is not surprising considering that the probe is inserted into the lateral meristem which, unlike the apical meristem, does not have an endogenous dormancy cycle (2, 3).

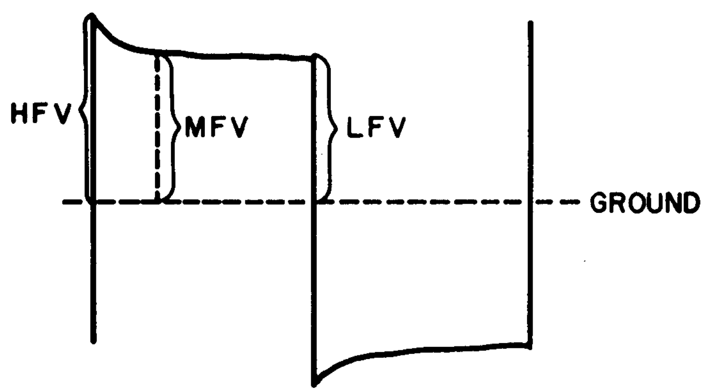

Figure 3.—*Measurement of voltages at three points on the oscilloscope trace. HFV is the greatest voltage in the first 0.039 msec of the trace; MFV is the voltage after 0.17 msec; and LFV is the volt-age at the trailing edge of the trace.*

[1]Askren, C.A., 1977. Evaluation of the oscilloscope technique for detection of dormancy and survival potential of coniferous seedlings. M.S. Thesis, Oregon State University, 101 p.

[2]Ibid.

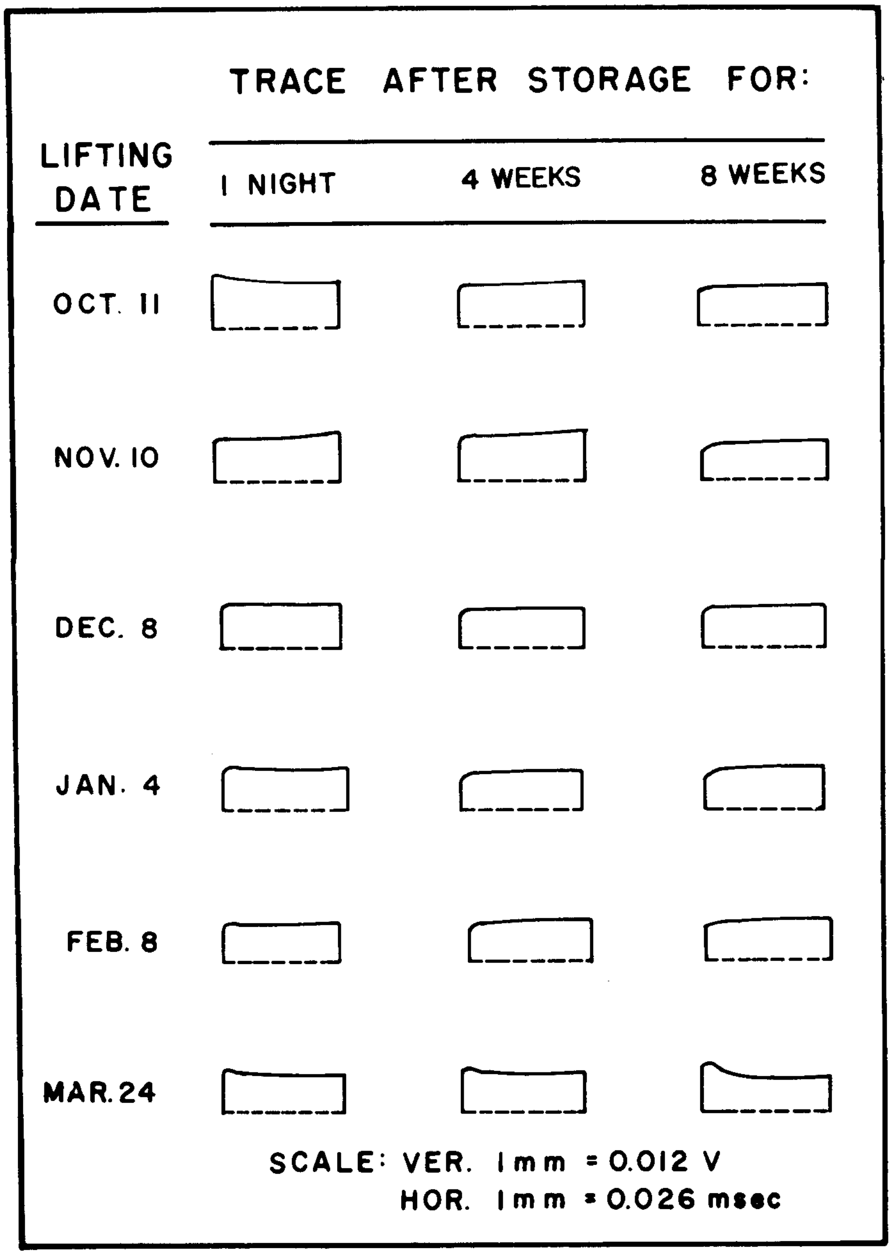

Figure 4.—*Traces of 2-0 Douglas-fir seedlings for 18 combinations of lifting date and storage.*

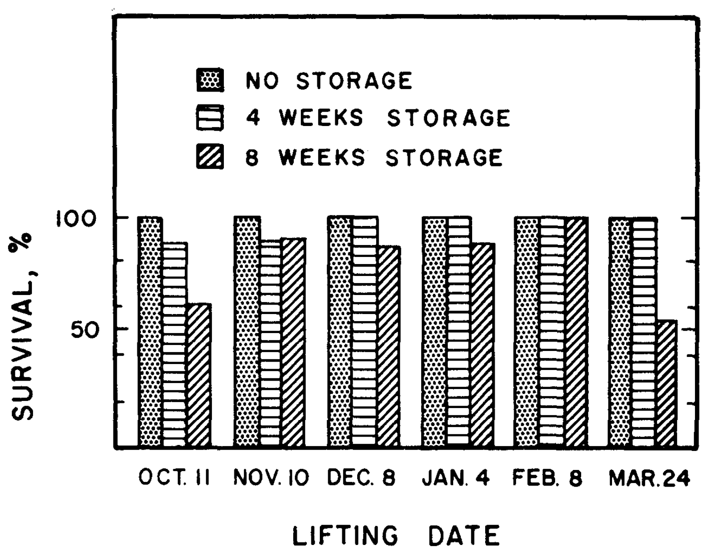

Figure 5.—*Seedling survival for different lifting dates and length of storage.*

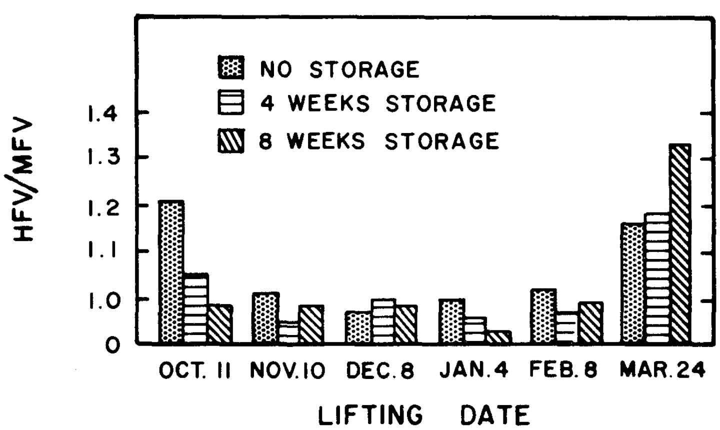

Figure 6.—*Ratio of HFV/MFV at different lifting dates and storage periods.*

Conclusions

The oscilloscope technique offers little promise as a tool for predicting survival potential of bareroot seedlings of Douglas-fir and, probably, other western coniferous species. Although a peaked trace in fall or spring indicates poor survival for stored planting stock, a square signal does not guarantee survival of stored seedlings on severe sites. Conversely, a peaked signal does not imply that seedlings planted shortly after lifting will do poorly.

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