HIDDEN CHANGES IN DOUGLAS-FIR SEEDLINGS SUGGEST TIMING OF NURSERY OPERATIONS

by

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Best timing for fertilizing, root pruning, lifting, transplanting, and other nursery operations is necessary to maximize seedling quality. Improved timing depends on better information about seedling growth. This is the idea for a seedling biography which Jim Trappe introduced at the Nurserymen's meeting in 1964. Full results of the study 1/ mentioned by Jim summarized here have been submitted for publication in Forest Science.

The study focused on two main questions: First, when do Douglas-fir seedlings grow at Wind River Nursery:-- height growth is readily seen, but growth by stems and roots is more difficult to observe. Second, when and in what forms do food reserves accumulate in seedling tops and roots. As they grow, seedlings use carbohydrates, fats, and proteins for energy and structural material. When the photosynthetic machinery to make these materials is inadequate or shut down, the seedling must call upon its reserves. Knowing if and when these materials accumulate and when they are used most rapidly helps pinpoint proper timing for lifting and storage. Such information may be the key to increased seedling vigor.

Study of 2-0 Douglas-fir seedlings started in October 1962 and continued through their third growing season. Beds of seedlings sampled represented two seed sources, one from west and one from east of the Cascade Range. Every 2 weeks, seedlings were dug from a new set of three randomly chosen plots located in beds of each source. Some seedlings from each plot were analyzed for sugars, starch, fats, and protein. Other seedlings were measured for stem diameter, bud or shoot length, percent of active (white) root tips, and length of the longest white root tip.

Seedling roots made the earliest visible growth in the spring. Root activity was high in late March, then markedly decreased by the time buds broke (fig. 1). A second period of high root activity occurred after mid-June and extended through August. Diameter growth started rapidly about mid-March, slowed during May and June, became more rapid again in July, August, and September, and apparently continued through October. Shoot growth started about mid-April in 1963 and was rapid until mid-June. All seedlings set bud in late June, but seedlings of the west-side source burst bud again, and their shoots grew until mid-September.

1/ Thanks are due personnel of the Wind River Nursery, Gifford Pinchot National Forest, for active support and assistance, and to Region 6 of the U. S. Forest Service for financial aid which made possible a study of this size and scope.

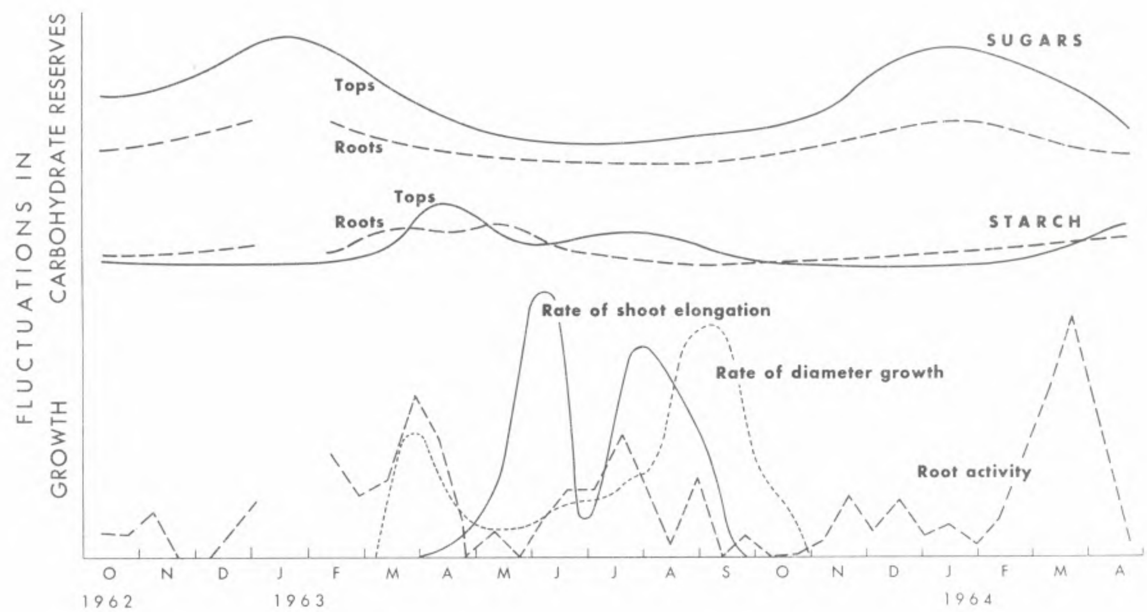

Figure 1. - -Fluctuation in carbohydrate reserves and growth of Douglas-fir seedlings at the Wind River Nursery -- a generalized illustation.

The root activity, shoot elongation, and diameter growth curves all have steep or flat intervals, illustrating that rates of growth fluctuated during the season and suggesting that the timing of these rate fluctuations be examined. Peak rates of growth occur in successive order: roots, diameter, shoots, then roots, shoots, and finally diameter again. A distinct alteration in timing of maximum growth rate by different parts of the seedling is suggested, and, of course, a slower rate of growth continues between peak periods.

Little seasonal change was found in food reserves of fat and protein, but sugars in both roots and tops increased dramatically, starting about November after growth stopped. A maximum was reached by January, and this high level was maintained through February. In March, sugars converted into starch, and the concentration of carbohydrates was then used up in spring growth. Unlike broadleaf trees, there was little or no increase of carbohydrates in Douglas-fir seedlings during the sunnier.

Seedlings of both seed sources behaved quite similarly, which appears to simplify the nurseryman's job.

In examining the growth and food reserve curves, it is easy to interpret from them suggestions for the timing of nursery operations. Fortunately, many of these suggestions parallel current Wind River Nursery procedures:

1. Lifting seedlings as late as possible in the fall allows time for diameter growth to stop and, also, for a buildup of carbohydrate reserves. High carbohydrate reserves may partially explain results of several studies where maximum survival was obtained when seedlings were lifted in midwinter.

2. Seedlings lifted when carbohydrate reserves peak would contain maximum energy supplies for use during storage.

3. If seedlings are lifted before carbohydrate reserves decrease in the spring, energy material would be conserved to support root growth at the planting site rather than in the nursery bed Tender, new roots are largely lost in lifting and outplanting. When this happens, the seedling has a lowered level of reserves to support growth of replacement roots. Stock is rarely lifted or moved after bud burst as experience has shown it survives poorly. This experience may be less related to bud burst itself than to the fact that root activity is low preceding and following bud burst.

4. Fertilization might produce maximum results if done early in the spring during the period of maximum root activity preceding shoot growth, and then repeated in late June before the second period of rapid shoot growth.

5. If the goal. is maximum new root production, root pruning might best be done in mid-May before the summer peak of root activity.

6. When we learn more about desirable seedling "balance," some change in relative amount of root and top growth might possibly be realized by adjusting timing of fertilization or root pruning, or both.

The rather clear-cut picture obtained in this study may possibly be unique to Douglas-fir in one particular season at Wind River Nursery. However, it seems likely that the general pattern prevails more widely.

Snow, wet soil, manpower availability, and other considerations will dictate how closely a nurseryman can achieve optimum timing. Nonetheless, having a goal and an estimate of its importance will help the nurseryman set priorities.