PHYSIOLOGICAL CHANGES IN STORED PINE SEEDLINGS

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Physiological changes in Jeffrey pine seedlings, 1-1 stock, in storage at the Mt. Shasta Nursery were studied during the winter of 1957-58. Water content, enzyme activity, and food reserves in the form of starch were measured in stored and freshly lifted stock three times during the winter. The stored stock was lifted on October 24. Tests were conducted that day, 11 weeks later, and again 26 weeks after lifting. Fresh stock for comparison was lifted and tested each day a test was made on the stored stock. When laboratory tests were checked against field survival, the disappearance of starch in the stored seedlings appeared to be directly related to a decrease in field survival.[3] Field survival was not correlated with water content of the needles, or with enzyme activity in the roots and stems of the stored seedlings.

Plans were made to extend the study the following year. The food reserves of the stems and roots and the water deficiency as well as water content of the needles were to be determined. However, it was not possible to conduct the study until the winter of 1960-61. By this time nursery operations had been changed considerably. Stratified seed was being sown, wider spacing was being used in the seedling beds, and 2-0 stock, rather than 1-1, was being produced. The stored 2-0 stock was dug later in the fall. These changes in procedure allowed a longer growing season, less crowding in the beds, and elimination of the transplanting "shock." The results were larger seedlings and a shortening of the time that the seedlings were in storage. Increased survival for seedlings was being reported from the field plantings.

In the 1960-61 study, ponderosa pine seedlings were used. They were much larger than those previously tested, averaging 5 grams dry weight against 3 grams for the 1957-58 stock. Differences between Jeffrey and ponderosa pine at 2 years are not sufficient to account for the weight differences. If anything, Jeffrey pine seedlings are normally larger than ponderosa pine seedlings. Therefore, the increased dry weight must be credited to the growing procedures.

The starch tests showed that the seedlings under the present methods of growing, storing, and handling did not deplete their starch reserves during 42 months of storage, which is longer than the average storage period. Starch was present only in the roots of the stored stock, but in roots, stems, and buds of freshly dug stock (figs. 1 and 2). Both the previous and this study indicated that the starch in the roots was used last. No tests were conducted on reserve sugars. However, previous studies on pine pollen showed that the reserve sugar was depleted before the starch,[4] and it is logical to assume that the same relationship exists in the seedlings.

The water relations of the needles were checked by two methods: (1) The wet and dry weights of the needles were obtained. (2) The amount of water taken up by the fresh needles when they were soaked in distilled water for 24 hours was determined.

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2 In cooperation with the California Institute of Technology.

3 Lanquist. Karl B.. and J. Henry *Doll.* Effect of polyethylene and regular packing methods on ponderosa pine and Douglas-fir seedlings stored over winter. Tree Planters· Notes 42: 29-30. 1960.

4 Hellmers, Henry, and Leonard Machlis. Exogenous substrate utilization and fermentation by the pollen of Pinus ponderosa Plant Physiology 31 (4): 284-289. 1956.

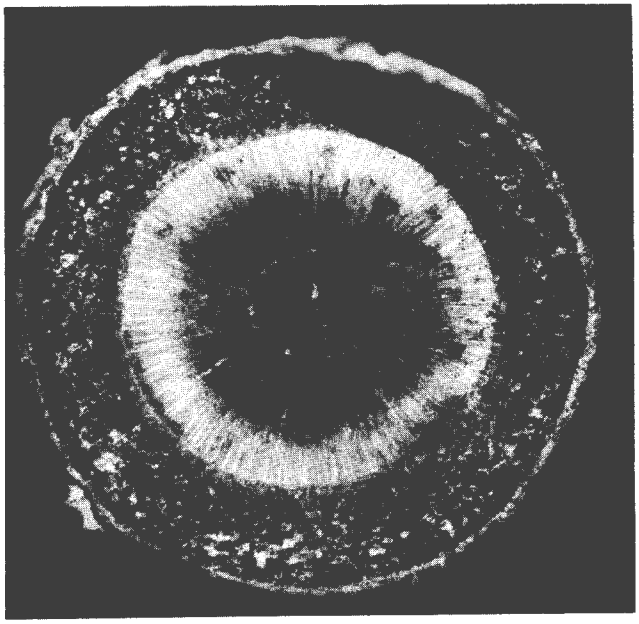

Figure 1.--Cross section of stem of freshly dug ponderosa pine seedling stained with I_2KI. The starch in the pith, xylem, and phloem stained dark.

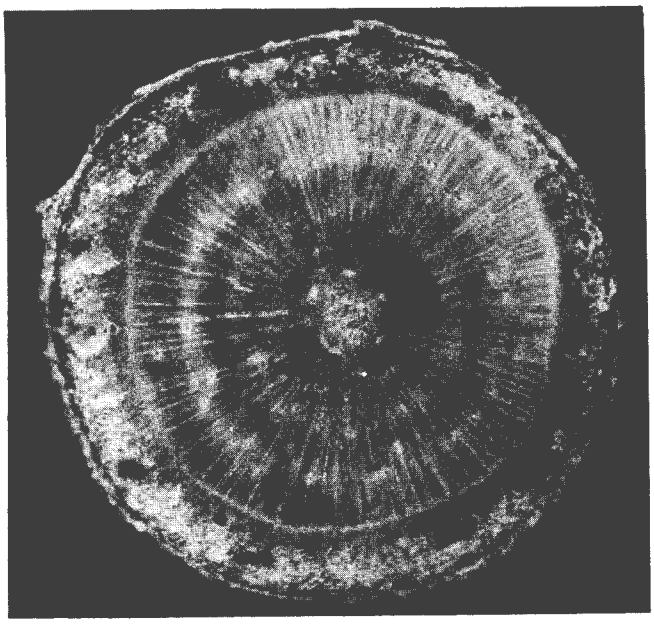

Figure 2.--Cross section of stem of stored (4½ months) ponderosa pine seedling stained with I_2KI. No starch was evident.

The stored stock had a higher water content and a lower water deficit than freshly dug stock by about 10 percent. The difference may be a reflection of lack of snow cover that winter; the ground was frozen, and the field stock was subjected to drying winds much of the time, while the stored stock had its roots in moist packing material and its tops protected from drying winds.

Enzyme activity in both stored and freshly dug material was indicated by the tetrazolium test for dehydrogenase, as in the 1957-58 study. As previously, the stored stock appeared to be less active than the freshly dug trees.

In summary, the problems of storing pine seedlings seem to have been substantially lessened by a combination of changes including growing larger plants, delaying the lifting time to allow an increase in development, and decreasing the storage time. The results of the studies reported here indicate that the starch content of seedlings could be a good indication of the physiological condition of the plants. A starch test would not, of course, show the results of other harmful conditions to which the trees may have been subjected, such as heating or drying. The starch disappears first from the top of the plant and then from the roots. Thus the location of the starch as well as the quantity of the starch could serve as a general indication of the condition of the planting stock. Starch is easily and rapidly stained with iodine solution so it could be checked very readily at the time of shipment or at the planting site if any question arises about the condition of the trees.