CONTAINERIZED SEEDLING PRODUCTION FOR FOREST REGENERATION IN THE PACIFIC NORTHWEST

James M. Sedore

ABSTRACT: The containerized seedling continues to be a valuable regeneration option during this time of economic stress. Recent developments in plug-1 culture and seedling storage are described.

INTRODUCTION

As you know, these are hard times for the timber industry. The lack of timber harvesting has reduced the demand for regeneration seedlings. Seedling orders have been reduced for two years at our operations, and we see no indication of any impending leap to the previous levels. Greenhouse operations throughout the Northwest have had to respond to this change, and the response has been varied. One operation has been almost totally mothballed; another is planning to consolidate two facilities into one; another is operating at less than 40 percent capacity and is looking to move and build a smaller, more efficient operation. Another operation has diversified and is growing vegetables in some of their greenhouses. It has been a time to prioritize and to reevaluate the value and role of the container program after little more than a decade since its birth. Although some operations have gone by the wayside, the containerized seedling has retained a place in the regeneration effort.

It is obvious that the conditions under which we work in the Pacific Northwest differ significantly from the conditions in the intermountain states, especially the region of the Southwest. I hope that by sharing what we are doing in the Northwest, you might get an idea or two that you can apply at your operations.

GREENHOUSES

The average production facility in the Northwest produces from two to four million seedlings per year, although two facilities produce over eight million per year. Private timber companies own and operate the largest container complexes for their own forest regeneration needs. They also compete for public regeneration contracts. The greenhouse layouts and designs differ based on the state-of-the-art at the time the greenhouses were built. The most popular greenhouse design at this time calls for a fiberglass roof with roll up sidewalls. Common regimes call for heating the greenhouse to 20 C., through May and minimal heating from October through January. Passive cooling through roof vents or active cooling with exhaust fans and evaporative coolers occurs during the hotter hours of June through September.

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Therefore, the structure must facilitate both heating and cooling to provide proper growing conditions throughout the year.

ENERGY

Fuel represents up to 15 percent of the cost of our seedlings. Several operations have made significant reductions in their fuel bills by sowing later and by switching from diesel oil to natural gas. Natural gas is the most popular fuel source in the Northwest because of large supplies from Canada. Solar collection may be used more in the future, but the cost to collect and use the limited solar radiation we receive does not compete with gas at this time. A recent greenhouse energy conservation technique is being used by The Bureau of Land Management at Colton, Oregon. The BLM uses infra-red heating in one of their two greenhouses. They report a 30 percent energy savings over their forced-air system. They also believe that the quality of their stock has not diminished.

BENCHES AND CONTAINER TYPES

Bench layouts vary from broad growing troughs, wooden 2" X 4" saw horses, iron flat bars, aluminum T-bars, and aisle eliminating bench tops. The most popular container type is the Styroblock in either the 2A or the 4A size. Commonly seedlings grown in a 2A are transplanted to become plug-1's, and 4A's, are shipped directly to the forest. Other containers have been used such a Leech tubes for genetic stock or Spencer-Lemaire books for Thuja, but the most common container type is the Styroblock.

SOWING AND FERTILIZING

Most of us sow with some type of vacuum sower which picks up one seed per hole from a tray of seed. The seed then falls into the cell when the vacuum is broken. It is most common to multiple sow to ensure a germinant in each cell and then to thin. Soluble fertilizers are mixed according to each grower's preference and injected into the watering system. Fertilizer regimes *vary* according to species, time of year, and nutrient status as indicated by foliar and soil analysis. Most growers contract their soil and foliar analysis with a private consultant. As is common with many plants, the growth curve of most conifer species that we grow is a sigmoid curve. Growth starts slowly, gradually increases in rate, and finally tapers off in the fall. To produce a quality seedling, it is necessary to find the balance between overfeeding, which produces succulent, top heavy seedlings and underfeeding which produces a stunted, starved seedling.

PLUG-1's

If sown in a bareroot seedbed, many of our seedlings such as Abies, Tsuga, and Thuja do not grow quickly the if rst few years. Commonly we grow these seedlings for one year in the greenhouse and then transplant them at the nursery. These seedlings may be transplanted either in the summer (August, in our area) or in the spring. We call these seedlings Plug-1's. In the nursery transplant bed, they can develop into large enough seedlings to withstand deer and elk browsing or vegetative competition. The shoot of a Plug-1 Tsuga is similar to a 2-1 Tsuga, but the roots of a Plug-1 are mop-like which can more easily support the shoot. The hemlock transplant bed does not have to be shaded or misted as the seed bed requires, and each crop uses valuable nursery bed space for only one year rather than three.

PLUG CULTURE

Back at the greenhouse, seedlings destined to go directly to the forest are kept unshaded and exposed to broader and broader temperature ranges. If you keep temperatures and fertility levels high, you produce a large, succulent shoot at the expense of an adequate root system and caliper. Seedlings, grown in this way, leave the greenhouse unprepared for the vigors of the forest and are commonly frozen back, desiccated or pushed to the ground by the first snow. Our goal is to produce a seedling with a large caliper and good buds, tall enough to compete with surrounding vegetation and with enough roots to support the shoot.

Techniques for inducing budset vary by species. It is common for Pseudotsuga to be leeched, moisture stressed, and then fed a low nitrogen, high phosphorus and potassium fertilizer in September to form large, mature buds for winter planting. However, Tsuga appears to respond best to full light exposure in July and a balanced fertilizer each time the seedling requires moisture. Shading has become less and less popular among Northwest growers. Although many of our trees will grow well under shade, when these seedlings are removed from a shaded house and planted in a nursery or clear-cut reforestation site, the seedlings drop their foliage and must struggle to break bud and begin growing. To avoid this we attempt to grow the seedlings without shade.

SEEDLING STORAGE

We have all struggled with the problem of holding seedlings at lower elevations for late planting at higher elevations. All too often the seedlings break bud in the shelterhouse before the planting site is ready or accessible. Moving these succulent seedlings in the spring from a warm, protected nursery to some cold, harsh site is a frustrating experience for both the nurseryman and the forester. Growers in the Northwest have several different approaches to the problem of seedling storage and I'll share several of these approaches with you.

The Washington State Department of Natural Resources moves their seedlings out of the greenhouse into shelterhouses in June. Here they remain until packaged for field planting which traditionally begins the first week of January. At our location, we feel that this is the time when the seedlings are fully dormant. The seedlings are sprayed thoroughly with a foliar fungicide to reduce damage from storage molds and one week later the seedlings are packaged and stored at 2°C in poly-lined boxes. The seedlings are kept at this temperature during transport and until the day of planting. All seedlings stored this way should be planted by June. Seedlings to be spring transplanted in the nursery as plug-1's may be stored in this way or kept in the shelterhouse. Container stock is transplanted in mid-March, and plug transplanting is completed by early April, two weeks before bud burst of Pseudotsuga in our area. Seedlings are therefore stored above freezing for 1 to 20 weeks. Storage molds have not been a major problem in our program although we lose a few trees each year. Many nurseries use this method of cooler storage for coastal and low elevation seedlings.

The Weyerhaeuser Company freezes most of their high elevation container stock at 1 to 2%. The seedlings are packaged in January and February after having received 400 to 600 hours of exposure to temperatures below 4°C. Thawing takes from one to two weeks in a shaded warehouse at 4 to 15 °C, before the seedlings are shipped to the planting site. Seedlings are planted shortly after thawing. For more information, contact Steve Hee at Weyerhaeuser Regeneration Center in Rochester, Washington.

The Industrial Forestry Association is a group of timber companies who share a nursery system for the reforestation of their individual lands. IFA does freezer-store container seedlings on request according to vulnerability criteria. There are three vulnerability criteria: (1) coastal seed sources, (2) seedlots which have had a history of winter damage in the nursery and (3) seedlots that are likely to suffer significantly from storage molds. Late in the fall, frost hardiness testing is begun. The lethal temperature for 50 percent LT is established by means of controlled freezing tests. If the seedlings have achieved a set LT, they are considered liftable and storable. Seedlings may be stored frozen for six months. Large quantities may be thawed en masse at 4 °C, but this takes up to six weeks. Small quantities may be thawed in a matter of days at 15 °C. Pseudotsuga, Picea and Abies do not appear to have any problem with this treatment although Tsuga roots are sometimes damaged. For more information, contact Sally Johnson at the IFA

Nursery in Toledo, Washington.

The British Columbia Forest Service also freezer stores many of their seedlings, especially interior seedlots and seedlots that they suspect will suffer significantly from disease problems in storage. When possible, they also make frost hardiness tests. This has indicated to them that, at their interior, harsh environment nurseries, they can begin storing in October but must wait until mid-December at their coastal nurseries. They report successful storage of interior Picea, Pinus, and Abies at -2 °C. Other seedlings can also freezer stored but Tsuga appears to be the most sensitive. In trials at the nursery, the roots of seedlings frozen six months do not elongate for 20 days after planting. Bud burst does not occur until 28 days after planting. Their freezer storage length may vary from two to eight months and they are doing research into the sugar and starch balance in six month freezer stored seedlings. For more information, contact Jim Sweeton at the Surrey Nursery in Surrey, British Columbia.

As you can see, both cooler and freezer storage are an important part of our regeneration programs. However, we have not yet worked out a uniform program. I hope that you'll join us in developing this technology.

CONTAINER REUSE

After extracting the seedlings from the containers, the containers are washed and refilled for use in the next sowing. Blocks can be reused many times.

THE FUTURE

During this time of economic stress in the regeneration business, it is significant to note that the value of the containerized seedling has withstood cost/benefit analysis. As the demand for seedlings increases and funds become available, I expect to see more improvements in the containerized program. I look for improvement first in the fertilizer regimes. I anticipate that we will find that each species has a different optimum fertilizer, light, and temperature regime. In fact, I expect to find differences within species native to different climatic zones. Through meetings like these, we can share information but we must continue to try new ideas and document them. Also, we must support, encourage, and participate in research directed at unlocking this information. We must work systematically at producing a quality plant at affordable prices which, not only survives, but flourishes when it is placed in its final growing site.

In: Murphy, Patrick M., compiler. The challenge of producing native plants for the Intermountain area: proceedings: Intermountain Nurseryman's Association 1983 conference; 1983 August 8-11; Las Vegas, NV. General Technical Report INT-168. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1984. 96 p.