ENGINEERING THE CONTAINER -- Panel Discussion

Sixth of Nine Papers

DESIGN CONSIDERATIONS FOR THE RL SINGLE CELL SYSTEM1/

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Abstract.--Injection-molded plastic tubes were selected for raising the type of seedlings required for the Weyerhaeuser Company's forest regeneration programs. Size and configuration were determined by seedling-size specifications, plantation characteristics, and weight. With singulated containers, it is possible to ship only plantable trees. Root systems remain undisturbed until the moment of planting. During greenhouse culture, air is vertically circulated through the seedling crop for disease control and energy economies.

INTRODUCTION

The objective of any seedling production operation is to provide to the regeneration forester planting stock which will exhibit maximum survival and growth in the given planting-site environment. With this in mind, it is possible to describe the ideal seedling in terms of its morphology and its physiological state. Deviations from the biologically ideal seedling are concessions to logistics, economic restraints, availability of materials, and mechanical limitations.

While the orchardist or landscaper can handle large trees, the foot-borne tree-planter must have stock small enough to carry in substantial quantities over rough terrain. Thus, concessions are made to the limitations of the planting operation. The number of seedlings to be planted between restock points, their weight and volume, the types of planting equipment available, and the mobility on the planting site are among the considerations which influence the maximum size of the planting stock. The ability to prosper in competition with other vegetation, to withstand frost and drought, and to resist the assaults of other organisms influence minimum-size specifications.

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These factors are highly variable even within an individual ownership. When differing regeneration philosophies and objectives are added, it is obvious that no single seedling container will be universally acceptable. Selection of a particular container and cultural method does not imply an indorsement to those with a different set of criteria.

DESIGN CRITERIA

Seedling Specifications

Selection of a container for the Weyerhaeuser containerized seedling program started with specifications for the seedling to be produced. Two species were of primary interest; Douglas fir and ponderosa pine. The target specifications established for container-produced stock for these species were:

	Douglas fir	Ponderosa Pine
Height (inches)	6.0 (min.)	4.0 (min.)
Stem Dia. (inches)	0.1 (min.)	0.1 (min.)
Shoot/Root Ratio (dry wt)	2:1 (max.)	2:1 (max.)

In addition, fall out-planting stock must be freeze-hardy. Spring-planting stock must be freeze-hardy and preconditioned at low temperature to permit bud burst after out-planting.

Container Specifications

Progeny-test seedlings raised in containers with an 8 cu.in. root volume at 39 seedlings per sq.ft. density significantly exceeded minimum specifications. Tests with Douglas fir seedlings in 2.5 cu.in. containers at 93 seedlings per sq.ft. showed that the target could be achieved with controlled growing conditions. Ponderosa pine seedlings needed a greater root volume than Douglas fir to achieve sufficient root surface area and length to perform well in the porous soil of south-central Oregon.

Other factors which were considered to be important were that:

Root systems remain intact and undisturbed up to the moment of planting.

Root systems are unimpeded after planting.

Only plantable seedlings be sent to the plantation sites.

The root "plug" has a regular and uniform shape.

Root spiraling within the container be discouraged.

Three hundred containerized seedlings, watered to field capacity of the growing media, weigh less than 40 lbs.

Based on these criteria, a container was designed which was intended for both Douglas fir and ponderosa pine. Basically, each container was a slightly tapered tube, 5 inches long with 3 cu.in. volume and longitudinal internal ribs. A wire-mesh holder with about 90 openings per sq.ft. was proposed. However, it was not possible to obtain the tooling to manufacture this container in time for the sowing of the 1973 crop.

Mr. Raymond Leach of the Leach Nurseries in Aurora, Oregon had independently designed a slightly smaller container. Since commitments for the tooling and the molding of the Leach container had already been made, it was selected for sowing several million seedlings in 1973. In 1974, a longer version was added for raising pine and over-wintered Douglas-fir seedlings.

THE LEACH ("RL") SEEDLING CONTAINERS

Seedling Tubes

The RL seedling tubes are of two sizes (fig. 1) with the following characteristics:

	"Fir" Tube	"Pine" Tube
Length	4.75 in.	6.38 in.
Top Diam. (nominal)	1.00 "	1.00 "
Volume	3.0 in^3	4.0 in^3
Weight/M	14 lbs.	20.5 lbs.

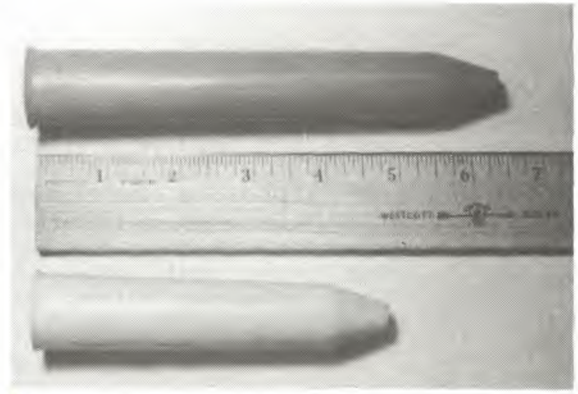

Figure 1.--The RL single cell seedling containers.

The tubes are made of injection-molded polyethylene. Each tube contains internal longitudinal ribs (fig. 2). The ribs effectively retard the root-spiraling tendency of some species--particularly pine.

Figure 2.--Internal, 0.06" high ribs in the "fir" (left) and "pine" RL cells.

Holder Tray

Two hundred seedling tubes are held in an injection-molded polystyrene tray. The tray is approximately 24 inches long, 12 inches wide, and 6 7/8 inches high (fig. 3). The tube holes are 1.2 inches on-center, resulting in the growing density of

100 seedlings per sq.ft. Each hole is countersunk in such a way that the tops of the seedling tubes are flush with the top of the holder tray.

Astroid-shaped openings between the tube holes total 24.2 sq.in. per tray or about 8.4% of the tray area. These openings are an important part of the environmental control system for the greenhouses as will be discussed later.

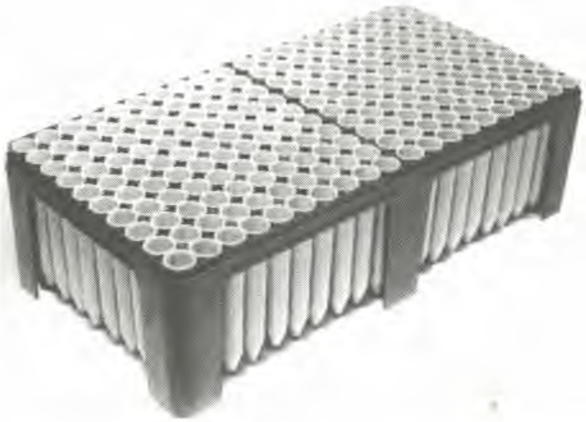

Figure 3.--RL seedling tray with two-hundred pine tubes. Astroid-shaped ventilation holes are visible between tubes.

The Container as Part of A Total Operation

In addition to meeting the criteria mentioned earlier, any container must be compatible with the selected means of preparing, culturing, shipping, and planting the crop. Some of the procedures described below can be used with any type of seedling container. Others are unique to the RL tube and holder tray.

Stock Preparation

Trays of tubes are filled with a 1:1 by volume mixture of sphagnum peat and vermiculite at 50-60% moisture content. The media is depressed about 3/8 inch with a conical or hemispherical mandrel to facilitate centering the seed. Each tube is sown, a tray at a time, with one or more seeds. Crushed-quartz grit is applied to cover the seed. The seeded tray is then conveyed to the greenhouse and set in place.

The Culturing Environment

The trays are supported by cedar 4x4 timbers (fig. 4). When a growing bed is filled, the tops of the trays form a diaphragm over an air space 18 feet wide by 174 feet long. Four 12" diameter perforated plastic tubes deliver warm or cool air below the bed (fig. 4). In the present installations air is supplied at a rate of one cubic foot per minute per square foot of bed area. Air flows upward through each astroid-shaped opening at a velocity of about 12 feet per minute. Future installations will increase this flow rate several fold.

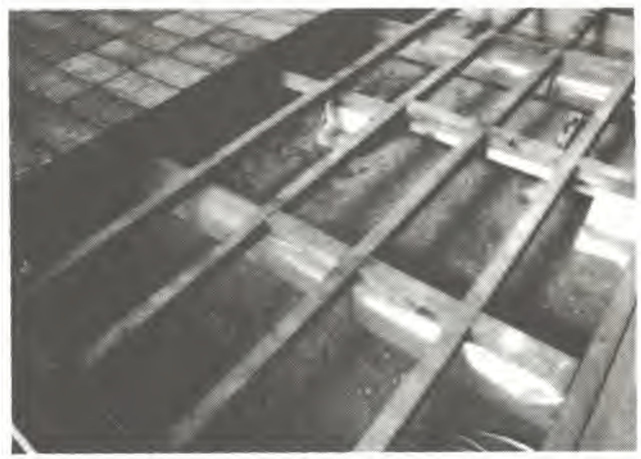

Figure 4.--Cedar 4x4 supports for seedling trays. Perforated, 12 inches diameter, plastic, air-delivery tubes are suspended below the beds at center and upper right.

A prime reason for this method of air distribution is to significantly reduce energy requirements by concentrating environmental control in the immediate vicinity of the seedlings rather than heating or cooling the whole greenhouse space. Another reason is to discourage infection by fungal diseases. Once crown closure occurs (generally in 8 to 12 weeks) it is difficult to adequately ventilate the root-collar zone with conventional greenhouse air distribution systems. Under these conditions, the incidence of botrytis infection, especially during hardening-off at cool temperatures, is high. The through-crop ventilation, possible with the RL tray, is intended to provide the means to dry the lower portions of the seedlings and discourage pathogenic fungii.

Irrigation, nutrient feeding, and stock maintenance functions are performed from electrically-driven gantries that span two 18-foot beds.

Black-out curtains provide a means for shortening the photo period as an aid in forcing bud set for fall out-planting.

Presently, the stock is kept in the greenhouses until ready to pack and ship to regeneration plantations. During this time, the singulated container makes it possible to extract tubes that contain no seedling or a "runt" and replace it with a tube containing a well developed seedling from oversown stock of the same seed-lot. Full use of the available greenhouse space is thus achieved.

Packing, Shipping, and Planting

Trays of dormant seedlings are removed from the growing beds as orders are received. Periodically, the remaining lots are consolidated and unused bed space covered with poly film to maintain proper ventilation rates through the trays.

The seedling tubes are removed from the trays, culled and bundled into groups of ten (fig. 5). Thirty bundles are packed into a poly bag inside of a waxed, corrugated shipping container. The shipping containers are palletized and shipped within a day or two to the planting site.

Figure 5.--Ten ponderosa pine seedlings bundled for packing. A rubber band holds the cells together.

Specially designed planter belts carry up to 300 seedlings. When fully watered, 300 seedlings weigh from 30 to 40 lbs. A variety of planting dibbles, with and without scalping blades, are used for hand planting. The seedling "plug" is extracted from the tube just prior to insertion in the planting hole.

Empty tubes are returned to the greenhouse nursery where they are reloaded into the holder trays. After cycling through a commercial dishwasher, the tubes and trays are ready for another cycle.

The first operational plantations with seedlings grown in RL containers were planted in the winter and spring of 1973/1974. As yet, field survival and growth data is not available. Because the root mass remains undisturbed up to the time of planting, they are expected to show superior performance to bare-root and some other types of container-grown seedlings.

SUMMARY

The RL single cell system, together with a compatible environment control system, is expected to fulfill the biological objective of providing seedlings with a high level of field survival and growth. Singulated growing tubes permit shipping only plantable seedlings without disturbing the integrity of the root system.

Extracting the seedling from the tube prior to planting is a bothersome operation. Until a biologically or mechanically degradable container is found to replace the present RL tube, this operation is necessary to achieve unimpeded root development after planting. The cumbersome logistics of recycling the tubes would also be eliminated by using plantable containers.

While not the ideal container system, the RL tube and tray presently comes closest to meeting the needs of the Weyerhaeuser regeneration programs. Further, it is a system that is highly adaptable to changes in materials and operations. Thus, the RL tube system is viewed as a base for developing an increasingly efficient containerized seedling operation.