Part 6. Propagation

Propagation and Planting of Containerized *Eucalyptus* Seedlings in Hawaii[1]

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Abstract: A container reforestation system has been researched and developed in Hawaii which results in consistently high survival and growth rates for eucalyptus seedlings. Mean survival of containerized saligna eucalyptus (Eucalyptus saligna Smith) seedlings is 90 percent with a standard deviation of 4. Because transplant shock is minimal, seedlings begin to grow quickly. Mean survival of bare-root saligna eucalyptus seedlings was only 56 percent with a standard deviation of 32, and about 70 percent of the seedlings suffered stem dieback. The containerized system includes the nursery, transport, and field phases of reforestation.

Eucalyptus seedlings are propagated and planted in Hawaii through a container reforestation system. The dibble-tube system, which was researched and developed by the Forest Service, U.S. Department of Agriculture, and the Hawaii Division of Forestry, has increased seedling survival and growth rates over those obtained with the old bare-root system (Walters 1981b, Walters and Horiuchi 1979).

The basis of the system is the Hawaii dibble tube (fig. 1)--a specially designed plant container of high-density polyethylene. Its size, about 5 inches deep and 1 1/8 inches in diameter at the top, represents a trade-off between biologic and economic considerations. The dibble tube is large enough for adequate seedling development but small enough for economical handling. The tube has four ridges on the inside that extend from top to bottom. These ridges prevent the lateral roots from spiraling within the container.

The tubes and their racks reduce the number of biological and mechanical variables involved in growing, transporting, and planting seedlings. The dimensional uniformity of the tubes and racks provides potentially the same rooting and aerial volume for each seedling and allows mechanization of nursery and planting operations.

This paper describes the specialized equipment and procedures used in Hawaii to propagate and plant containerized eucalyptus seedlings.

[1]Presented at the Workshop on Eucalyptus in California, June 14-16, 1983, Sacramento, California.

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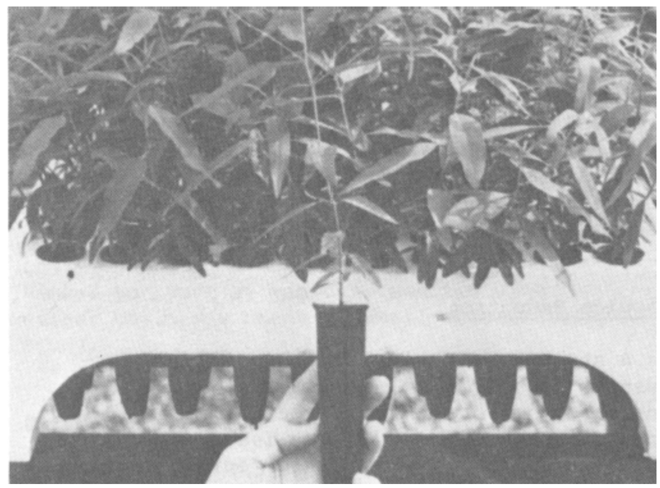

Figure 1--Eucalyptus saligna seedlings growing in the dibbling tubes. A rack holds 100 seedlings.

DIBBLE-TUBE SYSTEM

The dibble-tube system closely links the nursery, transport, and field phases of reforestation (fig. 2). Sufficient technology has been developed or borrowed to allow for a smooth progression from processing seed in the nursery to planting seedlings in the forest.

Nursery Phase

The nursery phase includes headhouse operations and seedling culture. The headhouse is divided into storage and work areas. Sufficient tubes, racks, rooting medium, and gravel (seed cover) are stored to produce about 500,000 seedlings. The work area is designed so that tubes are put into racks, cleaned, filled, seeded, covered, and transported to the seedling culture area in one continuous flow (fig. 3). Eight people can process 100,000 tubes per day.

Gen. Tech. Rep. PSW-69. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service; U.S. Department of Agriculture; 1983.

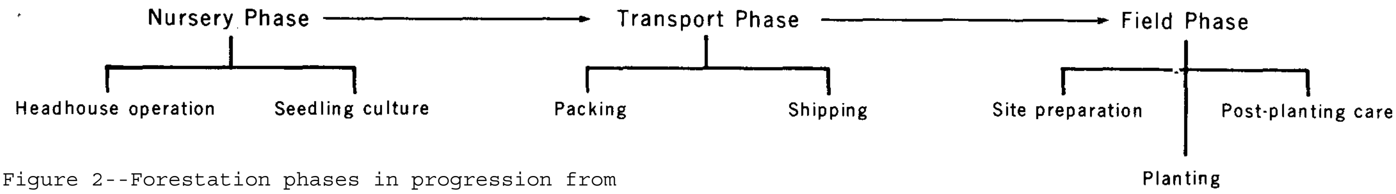

Figure 2--Forestation phases in progression from seed in the nursery to established tree in the forest.

Preparing Tubes and Rooting Medium

Tubes and racks are cleaned and chlorine-rinsed in a commercial dishwasher with a water-saving system at a rate of 8000 tubes per hour. A more automated dishwasher could increase the rate.

The rooting medium--a 2:1 by volume mix of sphagnum peat and vermiculite--is prepared in a self-cleaning soil mixer with 1-yd^3 capacity. Bales of peat and vermiculite are placed in the mixer and then their covers are slit and removed. This loading method reduces the dust problem. Mycorrhizae spores or mycelium are added if available. To ensure that each batch of medium has the same moisture content, a recycling timer allows a specified amount of water to be added during mixing from nozzles on the mixer lid. The mixed rooting medium falls through the bottom hatch of the mixer onto a conveyor, which carries the medium to a hopper over the tube-filling machine.

Three racks (300 tubes) are filled with rooting medium at one time in an automatic impact loader. The impact loader raises the racks then lets them drop; the sudden stop at the bottom forces the rooting medium into the tubes. Filled tubes are carried on a dead-roller conveyor to a simple revolving drum press, which compresses the medium to make room for seeds. The press can be adjusted for compaction to different depths, depending on the size of the seeds to be sown.

Sowing Seeds

Eucalyptus seed is cleaned using sieves and a blower, and then is pelletized by a commercial company. Pelletized seeds are about 1/16 inch in diameter and can be sown accurately and precisely with a simple manual seeder (Walters and Goo 1980).

The seeder consists of three plates with holes held by a frame (fig. 4) so that the holes in the top and bottom plates do not line up; the middle plate slides between the top and bottom plates. Seeds are put on the top plate. The middle plate is positioned so that the holes in

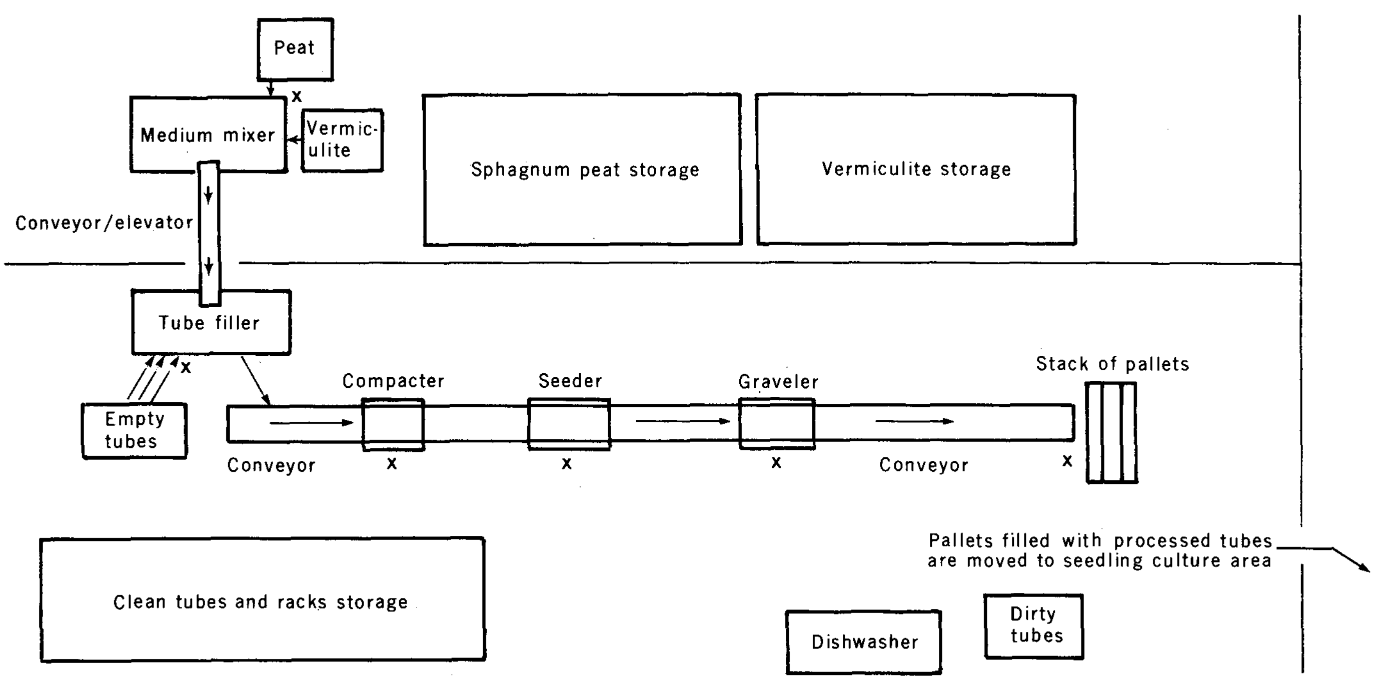

Figure 3--Layout of headhouse showing storage areas and processing equipment for tubes and racks.

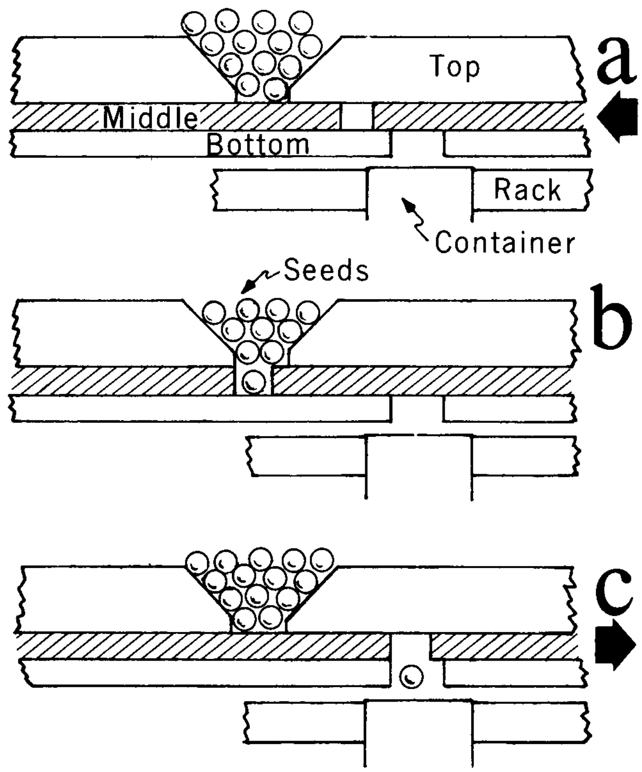

Figure 4--How the manual seeder works: (A) A hole in the top plate is filled with seeds; (B) the middle plate is moved so the hole in it lines up with the hole in the top plate, and a seed drops into the hole; and (C) a seed falls into the container as the middle plate is moved so the hole in it lines up with the hole in the bottom plate.

it line up with the holes in the top plate, and seeds fall into the holes in the middle plate. Then the middle plate is moved so that the holes in it line up with the holes in the bottom plate, and the seeds fall through into tubes. A number of seeds can be sown in each tube by moving the middle plate back and forth as many times as the number of seeds desired per tube, as determined on the basis of germination tests.

Seeds are covered with a 5-millimeter layer of crushed basalt by a device similar to the manual seeder (Walters 1981a). Gravel prevents the seeds from being washed away during irrigation and prevents the buildup of moss and algae on the top of the soil.

Transfer of Tubes and Racks to Seedling Culture Area

A stack of specially designed pallets is placed at the end of the conveyor. When a rack of tubes is complete, it is placed on a pallet. When the pallet is filled with 12 racks (1200 tubes), a forklift picks up the load and moves it to the plant shelter. The next pallet in the stack is there to receive more racks. In the plant shelter, a pallet is set on four cement blocks so that it forms a bench top.

Seedling Culture

In the plant shelter, pallets are supported several feet off the ground to prevent disease organisms from being splashed up to the roots, to provide air space so air pruning of the root systems occurs, and to provide a convenient height for workers to weed and thin the seedlings. During germination and early seedling growth, light intensity is kept at about 50 percent sunlight with plastic screens. An overhead irrigation system applies water daily. When the seedlings have several true leaves, nutrients are applied twice a week through the irrigation system at a rate of 75 to 100 parts per million (nitrogen basis) of a 12.5-25-25 commerical [sic] formulation. Pesticides are applied as necessary.

After about 6 weeks or when the seedlings are several inches tall, they are moved outside. There, only watering and feeding can be controlled. Water is applied daily through impact irrigation heads. The system provides about 120 percent overlap, which is necessary because of the frequent winds that often reach 20 mi/h at the nursery site. Nutrients are injected through the irrigation system twice a week. The nutrient solution initially is about 75 parts per million (nitrogen basis) of 20-20-20. After several weeks, the concentration is increased to 250 parts per million (nitrogen basis). When seedlings are about 10 inches tall, the formulation and rate are changed to 75 parts per million (nitrogen basis) of 12.5-25-25.

Transport Phase

When seedlings are 12 to 14 inches tall, they are shipped to the field for planting. The roots and rooting medium form a mass that holds together during handling. In the packing area seedlings are removed from the tubes and packed horizontally in wax-lined cardboard boxes so the roots face toward the box ends and the tops overlap. Box flaps are held closed with string instead of staples or tape. These boxes, even when stacked on pallets, protect the 200 seedlings inside and fulfill government regulations for shipping plant material between islands. Pallets of boxed seedlings are transported to the planting site by trucks, or to other islands by air freight.

Field Phase

Planting sites are generally prepared by clearing or crushing weeds and slash with a bulldozer.

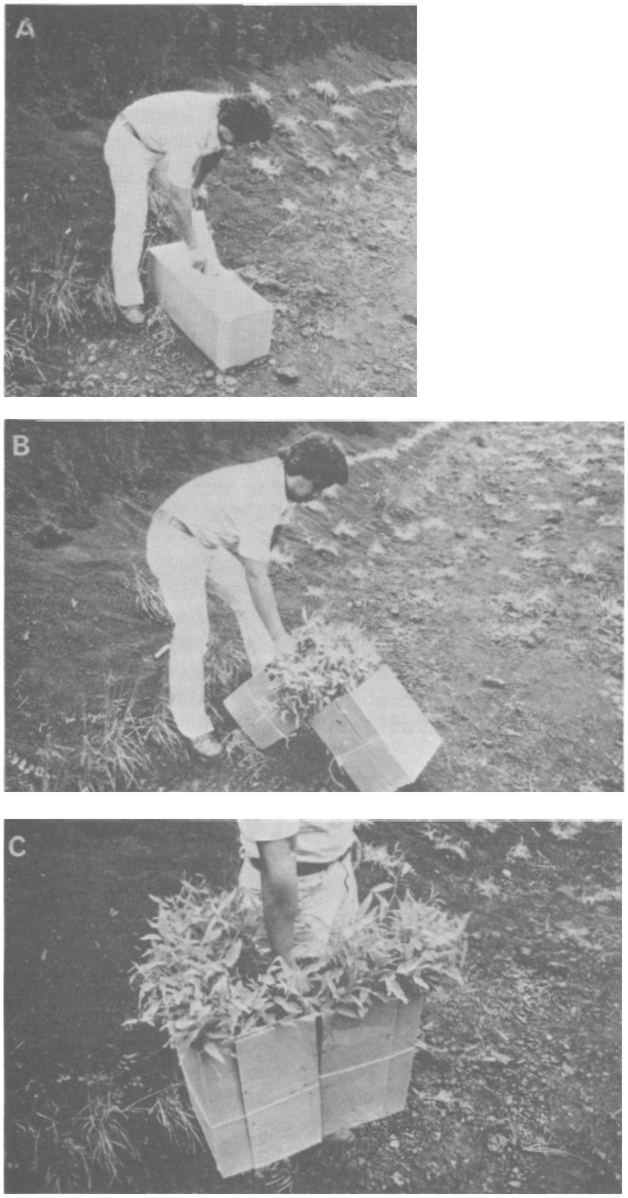

Figure 5--A seedling packing box is easily converted to a carrying box. This is done by: (A) cutting along lines marked on three sides and (B) folding ends together. A precut handhold (C) makes the box simple to carry. When the box is empty, it is flattened and shipped back to the nursery. The cut section is taped for reuse.

Packing boxes are quickly converted to carrying boxes by making several cuts and folding the box (fig. 5) (Walters 1978, Walters and Goo 1978). Packing seedlings in one end of the box before packing the other end will allow the tops to separate easily when the box is cut and folded into a carrying box in the field. When the box is empty, the strings are cut allowing the box to be flattened. Boxes are shipped back to the nursery. When the box is needed again, the cut section is taped and the box is reused.

Seedlings can be planted by hand or by machine. For hand planting, a dibble is used to make planting holes the same size and shape as the seedling root mass. A worker places the root mass into the hole and presses it down to ensure maximum contact between roots and soil, then puts soil over the root system. Dibble planting works well in clay soils and in lava rocklands. Using this method, one worker can plant 750 to 1000 seedlings in 8 hours. In the same time, a single-row planting machine on a clay or loam soil can plant 3000 to 7000 seedlings, depending on spacing and terrain.

Forest plantings are not irrigated, but are commonly fertilized with 1 to 2 ounces of 10-30-10 fertilizer at the time of planting. The fertilizer is poured into a hole made about 3 inches from the seedling root system. The fertilizer stimulates growth enough to reduce the need for weeding (Walters 1982).

SEEDLING SURVIVAL AND GROWTH

Sufficient biological data have been collected to allow seedlings to be grown in the nursery that have a high survival and growth potential in the field. Mean survival for forestry plantings of containerized saligna eucalyptus is 90 percent with a standard deviation of about 4. Under the old bare-root system, mean survival was 56 percent with a standard deviation of 32, and about 70 percent of the seedlings suffered stem dieback. When stem dieback was severe, 3 months or more were often required for the seedling to attain its original height. Under the new system, seedlings grow quickly because transplant shock is minimal.

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