SEEDLING CONTAINERS FOR REFORESTATION IN HAWAII 1/

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Abstract.--For reforestation work in Hawaii, three techniques of growing seedlings in a container and then field-planting them have been tried. The Walters' Bullet was unsatisfactory. The BC/CFS Styroblock was satisfactory in a test of four hardwood species planted on four different soils. The Hawaii Dibbling Tube shows the most promise.

Foresters working to reforest mountainous tropical islands have special problems. They must plant a variety of species. And they must contend with a broad range of climatic, biotic, and edaphic conditions. The reforestation techniques they select must be adaptable to the species and conditions--and be economical for widespread nursery and field application.

To produce seedlings, the Hawaii Division of Forestry has for many decades relied on cans, bags, and flats. These methods have become too expensive even though field survival was generally high. In an attempt to cut costs, the Division switched to bare-root planting in 1962. Bare-root planting has helped reduce seedling production and transportation costs, but rate of survival of field plantings often is unacceptably low. Therefore Division foresters have become interested in container-grown seedlings for reforestation.

In 1972, the Institute of Pacific Islands Forestry began evaluating a number of containers for their efficiency in the nursery, in transporting seedlings, and in field planting. In addition, they are rated on their ability to produce biologically sound seedlings--seedlings that will survive and grow immediately after planting.

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Many containers now available have been evaluated. If a container seems to meet the criteria, we contact the manufacturer or others who are knowledgeable. We also review the literature. Then if a technique shows promise, we grow seedlings in the container and make field plantings. Thus far, we have grown seedlings in only three types: an early version of the Walters' Bullet; the BC/CFS Styroblock; and a new container called the Hawaii Dibbling Tube.

Our work with the 4 1/2 inch Walters' Bullet was disappointing. Seedlings grew rapidly in the bullets, but we had difficulty in removing the bullets from the holder because roots grew into adjacent bullets. The problem occurred because the planting medium fell between the bullets during loading (our loading method was the same as that used in Canada, where the technique is used). Planting bullet seedlings with the planting "gun" proved difficult in typical Hawaii forest soils. These soils have medium to high clay content or high rock content, both of which resisted bullet penetration. Only about 20 percent of the seedlings were planted successfully. All seedlings eventually died, apparently because of moisture shortage even though showers fell intermittently during the weeks after planting. The bullet encases all but a small portion of the roots. Therefore direct contact between the surrounding soil and seedling root mass is minimal. Apparently, moisture lost from the planting medium by the transpiring seedling cannot be replaced fast enough by the soil to keep the seedling alive. We do not plan to test the old-style bullet any further. Perhaps some of the new-style bullets will prove more adaptable.

In contrast to the Walter's Bullets, the BC/CFS Styroblock has produced enrouraging results for each of the four species and soils we have tested. Seedlings of koa (Acacia koa), saligna eucalyptus (Eucalyptus saligna), Australian toon (Toona australis), and Queensland-maple (Flindersia brayleyana) were grown in Styroblocks with techniques similar to those used in Canada (Matthews 1971). After 4 months, seedlings of koa, saligna eucalyptus, and Australian toon--all grown in Styroblock "2" (2.4-cubic inch cavity)--were judged ready for outplanting. Queensland-maple, grown in the larger Styroblock "8" cavities (7.6 cubic inches), required about 6 months. At the time of outplanting the styro-plug seedlings of each species were reasonably uniform in size:

	Stem height	Stem diameter	Top/root ratio
	- - (Inches) - -		
Species:			
Koa	10	0.09	1.0
Saligna euc.	10	0.09	2.0
Australian toon	7	0.09	0.8
Queensland-maple	10	0.10	2.0

We used a dibble to plant 150 seedlings of each species. We planted "2" size styro-plugs at a rate of 150 per hour; the "8" size styro-plugs, at a rate of 100 per hour. Perhaps as we gain experience, our planting rates will match the 360 seedlings ("2" size) per hour rate of the Canadians (Vyse, et al. 1971).

Seedling survival, vigor, and stem dieback were checked 3 months after planting. Seedling survival rate exceeded 95 percent for all species. More than 90 percent had high vigor. None of the seedlings died back. The results obtained with saligna eucalyptus were particularly encouraging because seedlings of this species always suffer severe dieback and generally have high mortality when planted bare-root. Survival rates of only 30 percent are not uncommon in Hawaii. Planting shock is generally great; sometimes as many as 85 percent dieback. As koa is more difficult to establish bare-root in field plantings than saligna eucalyptus, our results with koa were encouraging. Queensland-maple and Australian toon are easier to establish than saligna eucalyptus, so the good results were not unexpected.

We determined that preparation of planting holes in different soil types--clay, volcanic ash, organic, and lava rockland--was both easier and faster using the dibble than a mattock.

We are also growing seedlings of Norfolk-Island-pine (Araucaria heterophylla) mamani (Sophora chrysophylla), ironwood (Casuarina glauca), and 'ohi'a-lehua (Metrosideros collina) in Styroblocks. Seedling stem and root development look favorable for each species.

The Styroblock technique has limitations. Procurement cost, including shipping, is high. Also, blank cavities or unacceptable seedlings cannot be readily sorted in the nursery. Seedlings must be removed from the container and repacked for most economical transport. This repacking reduces shipping volume, but exposes the roots to damage and allows them to grow into a shape different than the dibble.

The Hawaii Dibbling Tube (fig. 1) is an outgrowth of available containers, principally the Walters' Bullet, the BC/CFS Styroblock, and the Weyerhauser Tube. Produced in Hawaii, it appears to have the same advantages as the Styroblock, but not the limitations. The tubes are individual containers that fit into a rack--96 to a rack. Spacing is 64 seedlings per square foot. The Dibbling Tube, made of high density polyethylene, measures 5 inches deep and 1-1/3 inch inside top diameter. The volume is about 3.4 cubic inches. In cross section, it is similar to the Styroblock cavity. The four ridges, extending from top to bottom on the cavity walls eliminate root spiralling. When the seedlings are ready for outplanting, each Dibbling Tube with its seedling is removed from the rack. Seedlings are then packed tightly in a waxed lined box and shipped to the planting site. They are planted after the Dibbling Tubes are removed from the roots. The empty tubes are returned to the nursery, sterilized, and reused.

We are now growing our first lot of seedlings in the Dibbling Tubes. They are developing similarly to those grown in Styro-blocks. Thus similar field planting results are expected. Although the Dibbling Tube shows considerable promise for use in Hawaii, it may be modified--if improvements can be identified.

Containers of one configuration or another, are in Hawaii to stay. They provide the best approaches for meeting the require-ments for reforestation--biologically sound plants and efficiency in the nursery, in

Figure 1.-- Norfolk-Island pine (*Araucaria heterophylla*) seedlings growing in Hawaii Dibbling Tubes. The aluminum rack holds 96 tubes (upper). The Dibbling Tube with its seedling is removed from the rack and shipped to the planting area. The Dibbling Tube is then removed from the seedling root mass and the seedling is planted using a dibble.

transport, and in the field. Among the containers now available, the Dibbling Tube has come closest to meeting these criteria for Hawaii.

LITERATURE CITED

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