# Homemade Potting Mixes for Container Planting in the Pacific Islands

**Roger G. Skolmen and Donovan S. Goo**

*Research forester and forestry technician, USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Honolulu, HA*

*Locally available soil, sand, paper, and vegetative material were made up into potting mixes and compared with standard mixes of peat moss and vermiculite for suitability in growing* Eucalyptus saligna *Sm. and* Casuarina equisetifolia *L. ex J.R. & G. Forst. Mixtures of one part each of grass clippings, soil, and calcareous sand produced good plantable stock of both species. Mixtures containing waste paper,* Leucaena leucocephala *(Lam.) de Wit leaves, and sand and soil without organic material were generally found to be failures for growing* Eucalyptus*, but* Casuarina *grew better in some of these media than in the commonly used peat moss/vermiculite.* Tree Planters' Notes 37(4):12-16; 1986.

Tube-container tree nurseries are becoming popular in some islands of Micronesia. Ideal materials for potting mix in the containers are peat moss and vermiculite. Unfortunately, the shipment of such bulky materials to these islands is prohibitively expensive. Thinking it possible to find some readily available substitute materials on these islands, we tried several soil and vegetative materials of Hawaii that essentially correspond to those in Micronesia. We tested these planting mixes by growing *Eucalyptus saligna* and *Casuarina equisetifolia* L. ex ).R. & G. Forst, both of which grow on some islands in Micronesia.

Potting mixes for tube-shaped containers must have suitable characteristics. Most importantly, they must remain soft and deformable so that the seedling can be removed from its container once it is grown. Tubes filled with sand or soil cannot be deformed by squeezing once the roots have filled the original voids in the medium, preventing the plants from being removed without serious breakage. The material must also provide rapid drainage, have a pH in the range suitable for the plants to be grown, and have a high cation exchange capacity. Ideally, the material should also be lightweight so that racks of containers and seedlings can be moved and handled easily.

Most tropical Pacific Islands have abundant coral ($CaC0_3$) sand and soils formed from calcareous rock. Many also have soils formed from basic igneous rock. The Mariana Islands, in particular, have extensive stands of *Leucaena leucocephala* (Lam.) de Wit, a weedy shrub or small tree that has lately become popular for fuelwood plantings. These islands also have scattered grass lawns, often near nursery sites, and abundant waste paper. Therefore, we selected the following materials for our trial potting mixes: sand, soil, leaves, grass clippings, and small bits of paper.

## Methods

The materials selected for trial were beach sand, lowland soil, upland soil, *Leucaena* leaflets, lawn grass clippings, and confetti (to simulate finely cut waste paper). The beach sand, a mixture of shell and coral fragments, was essentially pure $CaC0_3$ with a pH of 8.4. It was washed to remove salt before use. The lowland soil was Waialua clay, an agricultural soil formed in place on an old coastline coral shelf with some igneous alluvium inclusions. The sample used had a pH of 6.2. The upland soil was Papaa clay, a reddish-brown oxisol formed on old basalt. The sample used had a pH of 4.4.

The sand and soils were fumigated with Dowfume (a restricted use fumigant requiring a licensed applicator) before mixing. The *Leucaena* leaflets, which are about 0.5 by 1 centimeter in size, were stripped from trees near the nursery and air dried. The grass clippings from a nearby Bermuda grass ('Sun Turf') lawn were used fresh. The confetti was circular bits of magazine paper about 0.5 centimeter in diameter. It had clay coating and ink typical of waste paper of this type.

The constituents were mixed by hand using parts by volume, each part consisting of a loosely packed 500-milliliter beaker. The potting mixes were placed in tube-shaped polyethylene containers of the size and shape developed for use in Hawaii (1). Two experiments were carried out at different seasons, each with the same control potting mix (2 parts peat moss, 1 part vermiculite), but with different treatments. Treatments were as follows:

*Experiment 1*
(cool season)

1. Peat moss (2 parts), vermiculite (1 part)—control
2. Leucaena leaves (2 parts), Waialua soil (1 part)
3. Leucaena leaves (2 parts), Papaa soil (1 part)
4. Leucaena leaves (2 parts), Waialua soil (1 part), beach sand (1 part)
5. Leucaena leaves (2 parts), Papaa soil (1 part), beach sand (1 part)
6. Confetti (2 parts), Waialua soil (1 part)

*Experiment 2*
(warm season)

7. Peat moss (2 parts), vermiculite (1 part)—control
8. Waialua soil (1 part), beach sand (1 part)
9. Papaa soil (1 part), beach sand (1 part)
10. Grass clippings (1 part), Waialua soil (1 part), beach sand (1 part)
11. Grass clippings (1 part), Papaa soil (1 part), beach sand (1 part)

We used 10 replications of each *Eucalyptus* treatment and five of each *Casuarina.* The tubes were completely randomized in one holding rack. The seedlings were grown on a greenhouse bench for 4 months.

During the growing period, seedlings were soaked once daily and fertilized twice weekly with 300 milliliters of a 1:1 mixture of Ortho 10-8-7 in water. The plants were started from a pinch of seed per tube and were thinned to one per tube when it became apparent that the seedling saved would survive. Germination tests were made of 30 seeds of each species on gravel-covered media of the same mixtures in the tubes.

Survival counts and height growth measurements were made monthly. At termination after 4 months' growth, seedlings were photographed, then removed from their containers using-to the extent possible--uniform hand squeezing and pulling procedures. The ease of removal from the tube, the retention of a tube shape by the root mass upon removal, and the compactness of the root mass were comparatively rated for acceptability for planting.

Then, the medium was washed from the roots, and the roots and tops of the plants were measured and weighed. Measurements consisted of total leaf area, total root area, and ovendry weights of tops and roots. The presence and amount of root nodules on *Casuarina* were also noted.

**Results and Discussion**

Treatments that included *Leucaena* leaves exhibited poor germination after only 3 weeks, more apparently among the *Eucalyptus* than the *Casuarina.* Germination tests were then started in sand alone and in the other media from experiment 1, with sand substituting for the control. In these tests, 30 seeds of each species were placed on each medium. Counts were made after 10, 20, and 30 days (table 1). These separate germination tests were made because a pinch of seed, rather than a known number, had been placed in the tubes.

In the second experiment, germination was satisfactory in tubes. Independent germination tests were therefore not made. However, of the five treatments

**Table 1**—*Germination percentage of* Eucalyptus saligna *and* Casuarina equisetifolia *sown on sand and other media*

| | | Germination percentage after sowing | | | | | |
|---|---|---|---|---|---|---|---|
| | | 10 days | | 20 days | | 30 days | |
| | Treatment | Euc. | Cas. | Euc. | Cas. | Euc. | Cas. |
| 1. | Sand | 37 | 27 | 43 | 33 | 43 | 33 |
| 2. | Leucaena + Waialua | 0 | 7 | 0 | 13 | 0 | 13 |
| 3. | Leucaena + Papaa | 0 | 3 | 0 | 3 | 0 | 3 |
| 4. | Leucaena + Waialua | 3 | 7 | 3 | 7 | 3 | 7 |
| 5. | Leucaena + Papaa | 3 | 10 | 3 | 20 | 3 | 23 |
| 6. | Paper + Waialua | 23 | 17 | 23 | 33 | 23 | 33 |

Euc. = *Eucalyptus saligna*; Cas. = *Casuarina equisetifolia*.

in the second test, the two *Eucalyptus* treatments with grass clippings required pricking in of seedlings from other tubes to 4 tubes out of 10 in each treatment in order to obtain 10 replications.

It was apparent that nondecomposed vegetative material reduced and retarded germination. *Leucaena* and grass retarded *Eucalyptus*; *Leucaena* alone retarded both Casuarina and *Eucalyptus*. The effect of *Leucaena is* believed to be caused by phenolic substances formed in the leaves in the early stages of decomposition. Kuo et al. (2) found that extracts of air-dried *Leucaena* leaves inhibited or suppressed radicle growth of several species. In our study, *Eucalyptus* was affected to a greater degree than *Casuarina*. Had we been aware initially of the problem with *Leucaena*, we would have composted the leaves to overcome the problem.

After growing for 4 months, the seedlings were removed from their containers. The tube was first squeezed to deform the root mass and free it from the container walls, then the plant and root mass were pulled out. We tried to do this in as similar a manner as possible for each seedling. The ease of removal and the retention of root mass form after removal were judged on the basis of acceptability for planting and probability of seedling survival. The percentage that was rated acceptable varied for the different treatments (table 2).

The pH of the peat moss-vermiculite mix was quite different between the two experiments (table 2). The reason is unknown because we did not check the pH of the ingredients of the second batch before combining them. Although the first, more-acid peat moss-vermiculite mix was suitable for both species, the second, less-acid batch was not at all suitable for growing *Casuarina.*

All five plants in this second control treatment nodulated well but were significantly lower in dry weight than the plants in the other treatments. The peat moss-vermiculite mix also produced lightweight *Casuarina* plants in the first (cool season) experiment, suggesting that this much-used mix is not well-suited for the species. Both species grew much larger in the second experiment, which was carried out in late summer and fall during very favorable warm weather.

*Leucaena* leaflets greatly raised the pH of the soils and sand-soil mixes to which they were added. Their addition had an ameliorative effect apparently about equal to that of the pure calcium carbonate sand. Both *Eucalyptus* and *Casuarina* had germinated satisfactorily in this sand.

Poor survival of three of the four *Eucalyptus* treatments containing *Leucaena* leaflets may have influenced statistical comparisons with the control. The plant roots had not grown sufficiently in these mixtures of

**Table 2**—*Survival, condition, and growth of* Eucalyptus saligna *and* Casuarina equisetifolia *seedlings after 4 months in the potting mixes tested*[1]

| Treatment | Initial pH | % Survival | % Acceptable | Height at 4 months (cm) | Leaf area ($cm^2$) | Dry weight (g) |
|---|---|---|---|---|---|---|
| *Eucalyptus saligna* | | | | | | |
| Experiment 1 | | | | | | |
| 1. Peat + vermiculite | 5.4 | 100 | 100 | 13.0 a | 41.7 a | 0.57 a |
| 2. Leucaena + Waialua | 6.3 | 30 | 33 | 8.4 a | 34.6 a | .44 ab |
| 3. Leucaena + Papaa | 6.0 | 20 | 50 | 8.9 ab | 46.8 a | .54 ab |
| 4. Leucaena + Waialua + sand | 7.3 | 30 | 67 | 10.6 a | 46.6 a | .60 a |
| 5. Leucaena + Papaa + sand | 7.2 | 90 | 78 | 12.6 a | 58.0 a | .69 a |
| 6. Paper + Waialua | 6.5 | 100 | 0 | 3.2 b | 1.3 b | .05 b |
| Experiment 2 | | | | | | |
| 7. Peat + vermiculite | 6.3 | 100 | 100 | 25.7 x | 95.1 x | 1.82 x |
| 8. Sand + Waialua | 6.5 | 100 | 60 | 20.2 x | 62.7 x | 1.42 x |
| 9. Sand + Papaa | 6.2 | 100 | 100 | 24.4 x | 73.4 x | 1.68 x |
| 10. Grass + Waialua + sand | 6.9 | 100 | 90 | 26.4 x | 95.2 x | 1.81 x |
| 11. Grass + Papaa + sand | 6.5 | 100 | 80 | 19.8 x | 76.0 x | 1.39 x |
| *Casuarina equisetifolia* | | | | | | |
| Experiment 1 | | | | | | |
| 1. Peat + vermiculite | 5.4 | 100 | 100 | 14.2 a | 8.4 a | 0.23 a |
| 2. Leucaena + Waialua | 6.3 | 60 | 67 | 9.7 a | 7.1 a | .20 a |
| 3. Leucaena + Papaa | 6.0 | 80 | 50 | 15.6 a | 13.7 a | .44 a |
| 4. Leucaena + Waialua + sand | 7.3 | 100 | 100 | 18.8 a | 15.1 a | .41 a |
| 5. Leucaena + Papaa + sand | 7.2 | 60 | 100 | 16.9 a | 14.8 a | .37 a |
| 6. Paper + Waialua | 6.5 | 0 | — | — | — | — |
| Experiment 2 | | | | | | |
| 7. Peat + vermiculite | 6.3 | 100 | 60 | 19.1 x | 15.6 x | .36 x |
| 8. Sand + Waialua | 6.5 | 100 | 80 | 30.0 y | 42.1 y | 1.02 y |
| 9. Sand + Papaa | 6.2 | 100 | 80 | 27.7 xy | 37.9 xy | 1.02 y |
| 10. Grass + Waialua + sand | 6.9 | 100 | 100 | 33.5 y | 54.3 y | 1.39 y |
| 11. Grass + Papaa + sand | 6.5 | 100 | 100 | 31.0 y | 49.7 y | 1.19 y |

[1]Means followed by the same letter in the same species and experiment do not differ significantly at the 5 percent level.

leaves and soil to hold the root mass together, so even the survivors were judged unacceptable for planting. The addition of sand improved the *Leucaena*-soil mixes for use with Eucalyptus, but the plants were hard to remove from the tubes, particularly those with the stickier Waialua soil. Only 3 of 10 plants survived in the *Leucaena-Waialua*-sand mixture, while 9 of 10 did in the mixture with Papaa soil.

As mentioned, germination was reduced by the presence of *Leucaena* leaves and to a lesser extent by grass. It was possible to lift extra seedlings from those tubes containing grass treatments and transplant them into tubes where none germinated, after which they grew well. In *Eucalyptus* and *Casuarina* treatments with poor survival, the losses occurred after germination and resembled damping off. We believe that the poor germination and subsequent mortality could have been avoided had we used decomposed, rather than air-dried, leaves because *Leucaena* leaves are often used in Hawaii for compost without problems of phytotoxicity.

The mix of small bits of paper and Waialua soil was a complete failure with both species. The paper impeded drainage. The medium was always completely saturated, and root growth could not occur except at the surface, where oxygen was available. It is possible that either the ink or the coating on the paper was toxic, but it appeared obvious to us that poor drainage was the primary cause of poor growth because germination of the *Eucalyptus* was unaffected. The roots were too small to hold the mix together when pulled from the tubes.

In the first experiment, the only acceptable *Eucalyptus* treatment other than the control was number 5, *Leucaena* + Papaa + sand, and even that treatment had two failures during removal of plants from the tubes when the medium fell apart.

The results were somewhat better with *Casuarina* (table 2). Both *Leucaena* + soil + sand treatments produced acceptable plants with plantable root systems, although poor survival of treatment 5 indicates that treatment 4 might be the better choice of the two. Curiously, the roots of these two treatments grew in the center of the tubes rather than along the tube walls as they normally do in peat moss + vermiculite.

In the second experiment, all four trial mixes produced acceptable growth in both species (table 2). For *Casuarina,* all trial mixes were much better than the peat moss-vermiculite control, with the grass-soil-sand mixes promoting significantly better height, leaf area, and weight. The sand-soil mixes were very hard and difficult to deform once the roots had filled the tubes, causing plants to break on removal. This was very pronounced with *Eucalyptus* in the sand-Waialua soil mix, but it was possible to obtain complete plants from the sand-Papaa soil mix with considerable extra effort. Because of this difficulty of removal, we consider the grass-soil-sand mixes to be the only ones really acceptable among those tried. Nodulation of *Casuarina*, present to some extent in all treatments, was equally complete in the control and the two grass-soil-sand treatments.

## Conclusions

An apparently acceptable potting mix can be made of local materials available on most of the Pacific Islands. Based on the results of this study, we suggest composting any fresh organic material to allow at least partial decomposition before use. Fresh or air-dried *Leucaena* leaves should be avoided. In fact, we suggest avoiding the fresh leaves of any plant that has a sparse or absent understory, which indicates possible allelopathy, a survival mechanism common to many plants.

Mixtures of sand, soil, and grass clippings were acceptable as potting mixes for *Eucalyptus saligna*, and were actually preferable to the peat moss-vermiculite mix commonly used in nurseries in Hawaii for *Casuarina*. Survival and growth in the sand, soil, and grass mix would likely have been better if composted grass had been used.

## Literature Cited

1. Walters, G.A. Why Hawaii is changing to the dibble-tube system of forestation. Journal of Forestry 79 (11):743-745; 1981.
2. Kuo, Y.L.; Chou, C.H.; Hu, T.W. Allelopathic potential of *Leucaena leucocephala. Leucaena* Res. Rep. 3:65. Waimanoalo, HI: Nitrogen Fixing Tree Association; 1982.