One-Year Results of Species Trial on Guam

Timothy J. Krohn
Former Head, Forest Nursery and Management Sect., Forestry and Soils Resources Div., Guam Department of Agriculture, Agana, Guam

First year study results of growth and survival of 21 tree species and provenances of trees planted in Guam are given.

The upland volcanic clay soils of southern Guam no longer support forest vegetation. Because of annual grass fires (generally caused by careless people), fire tolerant grasses are the predominant vegetation. The tree *Casuarina equisetifolia* L. could grow extensively on these sites in the absence of fire. However, its leaves are very flammable, and the tree dies when the leaves are scorched.

It would benefit Guam to introduce fire-resistant tree species for growing on the upland volcanic clay soils. The species will have to withstand typhoons, tradewinds, fire, drought, waterlogged soils, heavy acidic soils, and nutrient deficiencies. The species field trials described in this report identify species that can be adapted to these sites 1 year after planting.

Methods

Twenty-one species and provenances (table 1) were planted in June 1978. The experiment is laid out in a complete randomized block design, consisting of 21 treatments (plots), replicated four times. Each plot contained 60 plants spaced 4 by 9 feet (1.2 by 2.7 m) in five 12-tree rows. The four replications were split evenly among two sites.

Each site was mowed, burned, plowed, and disked for site preparation. At the time of planting, 30 grams of 14-14-14 Osmocote were added to each planting hole.

The seedlings were all grown in no. 8 Styroblocks.

Total tree heights were measured to the nearest centimeter every 3 months, and mortality was recorded.

Location and Site Conditions

Guam is located at 13°25' N. latitude and 144°45' E. longitude in the western Pacific Ocean. Its climate is humid tropical with distinct rainy and dry seasons of nearly equal lengths. It receives 60 to 100 inches (1,500 to 2,500 mm) of rain per year, most of which falls between June and December. Tropical storms with winds up to 90 miles per hour (145 km/h) occur annually; super typhoons, 200+ miles per hour (322+ km/h), pass over Guam on the average of once every 13 years. The temperature ranges from 75° F to 95° F (24 to 35°C).

Grasses are the predominant vegetation. Natural soil slumping and motorcyles affect the microenvironment by causing bare soil and erosion. *Dicranopteris linearis* (Burm.) Underwood (Savannah fern) is often the first soil binding species to cover bare ground. The grasses *Dimeria chloridiformis* (Gaud.) K. Schum. & Lauterb., *Miscanthus floridulus* (Labill.) Warb. (Swordgrass), and *Pennisetum polystachyon* (L.) Schult. (foxtail), along with *D. linearis*, are the savannah community plant indicators and will grow in pure or mixed stands. All of the typical savannah indicators were found on the planting sites. It has been noticed over the past few years that foxtail has progressively covered more land (*1*). At the end of the first year of the trial, other than the planted trees, foxtail was the predominant vegetation on the trial sites.

The terrain of southern Guam is hilly, but the sites are located on slopes gradual enough to drive a tractor and plow. Site soils are acidic (pH 4.70 to 5.45) and low in nutrients (table 2).

One site is exposed to the winds coming off the ocean, but the other is somewhat protected from the wind. Both sites are located next to and north of Cross Island Road within the Cotal Conservation Area in the middle of southern Guam. The site elevation is 450 to 500 feet (137 to 152 m).

Table 1.—*Species and provenances tested*

Plot No.	Species	Lot no.	Elevation (m)	Origin		
				Lat.	Long.	Country
10	*Acacia confusa*	706		23° N.	21° E.	Taiwan
11	*A. confusa*	708		23° N.	21° E.	Taiwan
12	*A. confuses*	709		23° N.	21° E.	Taiwan
13	*A. confusa*	710		23° N.	21° E.	Taiwan
14	*Eucalyptus brassiana*	10,976	110	15°26' S.	144°12' E.	Queensland, Aus.
1	*E. brassiana*	10,972				Australia
2	*E. camaldulensis*	10,558	430	15°08' S.	126°30' E.	West Australia
3	*E. camaldulensis*	10,558	430	15°08' S.	126°30' E.	West Australia
15	*E. camaldutensis*	12,139	460	17°21' S.	144°58' E.	N. Queensland, Aus.
16	*E. citriodora*	12,379	600	17°00' S.	144°56' E.	N. Queensland, Aus.
17	*E. deglupta*	12,322		4°IO' S.	152°40' E.	Papua, New Guinea
4	*E. grandis*	10,695	900	17°16' S.	145°42' E.	Queensland, Aus.
18	*E. pellita*	11,956	150	15°30' S.	145°15' E.	N. Queensland, Aus.
5	*E. tereticornis*	10,954	140	15°40' S.	145°13' E.	Queensland, Aus.
19	*E. tereticornis*	11,953	100	15°28' S.	144°28' E.	N. Queensland, Aus.
20	*E. tessellaris*	7,493				Queensland, Aus.
21	*E. urophylla*	12,362	1,100	8°37' S.	125°38' E.	Timor
6	*Leucaena leucocephala*	K8		22° N.	157° W.	Hawaii
7	*Melaleuca leucadendron*			22° N.	157° W.	Hawaii
8	*Serianthes kenahirae*			7° N.	135° E.	Palau
9	*Swietenia macrophylla*	1,305	270	10° S.	160° E.	Solomon Islands

Table 2.—*Soil analyses, Cotal Conservation Area*

	Exposed		Protected		
	Site 1	Site 2	Site 3	Site 4	Site 5
PH	5.45	4.80	4.90	4.70	5.10
Percent organic matter	3.47	1.73	3.12	2.08	2.43
P p/m	.65	.78	.78	.65	.65
K p/m	160	75	130	50	115
Na p/m	54.88	58.80	54.88	39.20	54.88
Ca p/m	600	700	1,600	400	680
Mg p/m	1,200	720	1,860	460	1,760

Results

The analysis of variance shows that both treatments and replications are significantly different from the null hypotheses that there are no differences among species, provenances, and sites (table 3). Duncan's multiple range test indicates which treatments are significantly different from each other (table 4). The ranges show that the treatments can be broken apart into four sets having members that are completely significantly different from members of other sets. The four groups are:

1. *Eucalyptus camaldulensis* Merrill. 12,139; 344 cm

2. *E. camaldulensis* 10,558; 269 to 299 cm
   E. tereticornis Sm. 11,953
   E. camaldulensis 10,558

3. *E. brassiana T.S.* Blake 10,976; 140 to

220 cm
E. brassiana 10,972
E. tereticornis 10,954
E. urophylla T.S. Blake 12,362
E. deglupta Blume 12,322
Leucaena leucocephala (Lam.) deWitt K8
E. pellita F. Muell. 11,956 *E. citriodora* Hook 12,379

4. *E. grandis Hill* ex Maiden 10,695; 63 to 111 cm
Serianthes kenahirae Fosb.
Acacia confusa Merrill. 706
A. confusa 708
Swietenia macrophylla King 1,305
A. confusa 710
A. confusa 709
Melaleuca leucadendron L.
E. tessellaris 7,493

Duncan's multiple range test for replications, in contrast to the analysis of variance, does not show any significant difference between replication means. This contrast appears due to the low number (4) of replications in the experiment. However, it does show that the protected site means occur in the upper third of the insignificant range, while the exposed site means occur in the lower fifth of the insignificant range (table 5).

Table 3.—*Analysis of variance*

Source	SS	df	MS	f
Replication	42,785	3	14,261	* *
Treatments	541,207	20	27,060	* *
Error	73,165	60	1,219	
Total	657,157	83		

* * .01 level of significance.

Table 4.—*Duncan's multiple range test and percent mortality treatments*

Species	Lot no.	Plot means	Sig. ranges	Percent mortality
Eucalyptus camaldulensis	12,139	344.43		1.7
E. camaldulensis	10,558	298.80		4.2
E. tereticornis	11,953	285.58		4.2
E. camaldulensis	10,558	268.92		0.0
E. brassiana	10,976	220.21		0.0
E. brassiana	10,972	213.97		0.8
E. tereticornis	10,954	203.21		3.3
E. urophylla	12,362	185.54		23.3
E. deglupta	12,322	181.71		10.8
Leucaena leucocephala	K8	170.04		0.0
E. pellita	11,956	159.25		17.5
E. citriodora	12,379	140.54		54.2
E. grandis	10,695	110.78		48.3
Serianthes kenahirae		102.94		4.2
Acacia confusa	706	96.21		3.3
A. confusa	708	95.74		0.8
S. macrophylla	1,305	92.92		4.2
A. confusa	710	92.25		6.7
A. confusa	709	91.84		0.8
Melaleuca leucadendron		69.61		35.8
E. tessellaris	7,493	63.23		27.5

Table 5. –*Replications*

Site no. and location	Rep. mean	Sig. range
3 protected	198.22	
4 protected	176.21	
2 exposed	146.85	
1 exposed	143.05	

Discussion

Several other factors should be noted before deciding which species and provenances are worthwhile for further study.

During its first year, Acacia confusa grew close to the ground (fig. 1). In previous plantings, *A. confusa* did not achieve any significant height growth until into the second year. During the first year, the branches and stem lay on the ground so that tree height may be 0.25 meter and crown radius may be 1.00 meter.[1]

Eucalyptus brassiana showed impressive growth. However, the leaves began to show nutrient deficiencies; some trees had distinctly bronze leaf color. The two provenances were very close in average height.

Eucalyptus camaldulensis showed a large variation in height among provenances; yet, it was the most impressive in height growth and overall vigor.

Eucalyptus citriodora had the highest first year mortality (54%), which could have been due to planting undersized seedlings. Many of these seedlings lost part of their roots when pulled from the Styroblock cavity. This species showed fair height growth for the first 9 months, but increased rapidly in height between 9 and 12 months, coinciding with the driest part of the dry season and the first month of the rainy season. It was infected with a leaf roller caterpillar (*Stcepsisrates ejectana* Walker) during the first 3 months.

Eucalyptus deglupta flowered at 11 months of age or 9 months from outplanting (fig. 2). Those trees on the wetter, protected site flowered and seeded earlier and more heavily than those trees on the drier, exposed site.

Eucalyptus grandis distinctly preferred the protected site. Its height growth and survival on the protected site were nearly double those trees on the exposed site. It had the second highest mortality (48%).

Eucalyptus pellita had average height growth.

Eucalyptus tereticornis showed above average height growth and a wide variation between provenances.

Eucalyptus tessellaris showed the poorest growth of all the species planted. It was very heavily infested with a leaf skeletonizer throughout the whole year.

Eucalyptus urophylla showed above average growth and vigor. At 3 months after planting, a leaf roller caterpillar (S. ejectana) had rolled about 90 percent

Figure 1.—*Acacia confusa at 1 year of age is beginning to show height growth.*

Figure 2.—*Eucalyptus deglupta at 1 year of age. These trees are the tallest of this species and are located on the wetter site.*

[1] A. confusa was measured from the stem base to the tip of the longest and highest branch/stem.

of the juvenile leaves. The species seemingly has outgrown susceptibility to this insect (fig. 3).

Figure 3.—*Young* E. urophylla *was highly infested with leaf rollers, but outgrew the infestation.*

Leucaena leucocephala (super tangan-tangan) grows best on limestone- or coral-derived soils (fig. 4). It grew very well during the rainy season; but during the dry season it suffered and scale insects attacked it. Also, during the dry season about 80 percent of the trees in one replication were broken off at waist height probably by Marianas deer (*Cervus mariannus* Desmarest).

Melaleuca leucadendron had the second poorest height growth and third highest mortality rate (36%). It was also heavily infected with *S. ejectana*.

Figure 4.—*Some of the* Leucaena leucocephala. Overall, *it does not grow as well on clay soils as on limestone soils.*

Serianthes *kenahirae* had below average growth, but because of its healthy uninfected leaves and apparent vigor, it should receive further consideration.

Swietenia macrophylla should also receive further consideration in light of its healthy leaves. This provenance had below average height growth, which may make it more wind firm than faster growing provenances of this species.

Conclusions

The 14 species planted at Cotal Conservation Area can be separated into four groups according to their performance at 1 year of age. These groups are:

Very high	*High*
E. brassiana	*E. deglupta*
E. camaldulensis	*E. pellita*
E. tereticornis	*E. urophylla*
	Serianthes kenahirae
	Swietenia macroph ylla

Medium	*Low*
Acacia confusa	*E. grandis*
E. citriodora	*E. tessellaris*
	L. leucocephala
	Melaleuca leucaden dron

Those trees that had good height growth, healthy leaves, and good overall vigor should be selected for further study. Whereas, those trees susceptible to leaf roller caterpillars, leaf skeletonizers, scale insects, nutrient deficiencies, and poor height growth should be avoided.

Further study, 5 to 10 years after planting, may determine which species, if any, of this initial selection may produce a viable forest cover on the volcanic soils of southern Guam.

Literature Cited

1. Moore, P.H., and McMakin, P.D. 1979. *Plants of Guam.* 186 p. College of Agriculture and Life Sciences, University of Guam.