Comparison of Quick- and Slow-Release Fertilizers in Young Plantings of Eucalyptus Species[1]

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Eucalyptus saligna and E. grand is seedlings fertilized twice per year over a 2-year period with a soluble fertilizer (12-24-12) were taller and had greater diameters than those given one application per year of this quick-release fertilizer or one application per year of the slow-release fertilizers Osmocote, Nitrogano, or Agriform.

Fertilization is required for maximum biomass production in short-rotation, intensively cultured eucalyptus forests in Hawaii (5). Along the Hamakua Coast of Hawaii Island, rainfall exceeds 5,000 millimeters annually and leaching of nutrients may be a problem in forest establishment and maintenance.

Slow-release fertilizers have been shown to stimulate the growth of trees, especially on nutrient-deficient sites (1, 2, 4, 7). Meskimen (4) demonstrated the beneficial effect of slow-release fertilizer tablets on the establishment and growth of *Eucalyptus camaldulensis* on sandy soils in Florida. Walters (7) found that the slow-release fertilizer Osmocote significantly increased the early growth of Australian toon and Queensland-maple seedlings on the strongly acidic forest soils of Hawaii Island. No previous work has been published concerning the effect of slow-release fertilizers on the early growth of eucalyptus in Hawaii.

It was thought that slow-release fertilizers might be beneficial for eucalyptus growth in high rainfall areas because of decreased leaching of soluble nutrients. Slow-release fertilizers make small concentrations of nutrients available over a long period of time (6), thus decreasing the amount of nutrients susceptible to leaching at one particular time.

This paper reports on two tests that were installed to compare tree growth and application costs associated with three slow-release fertilizers and a soluble fertilizer applied at two dosages in a short-rotation eucalyptus plantation.

Materials and Methods

Eucalyptus saligna Sm. and *E. grandis* hill ex Maiden. seedlings were outplanted in January 1980 at the Kamae site, located 24 kilometers to the northwest of Hilo, Hawaii. The elevation at Kamae is 480 meters and the average annual rainfall exceeds 5,000 millimeters. The test site is located in a poorly drained area that had formerly been in sugarcane production.

The soil belongs to the Akaka silty clay loam series (Thixotropic Isomesic Typic Hydrandept) and slopes range from 10 to 20 percent. Thirty soil samples were sent to Brewer Analytical Laboratory for determination of pH, total N, and sulfuric acid extractable P and ammonium acetate extractable K, Ca, and Mg. Color in the extracted P solution was developed by the phosphomolybdate method (3), and concentration was determined using a Klett-Summerson photoelectric colorimeter. Potassium was analyzed with a Beckman model D-U flame spectrophotometer, while other elements were analyzed with a Perkin-Elmer model 303 atomic absorption spectrophotometer. Results were averaged and compiled in table 1.

The site was disk-harrowed, then sprayed twice with glyphosate at 2.2 kilograms per hectare of active ingredients per application before outplanting. Tubed E. saligna and *E. grandis* seedlings, which averaged 30 centimeters in height, were outplanted at a 0.75- by 3.0-meter spacing. The plot size was 7.5 by 27.0 meters with 90 trees per plot.

The following five fertilizer treatments were placed in holes 15 to 20 centimeters away from the trees and covered with soil. Based on preliminary results from a eucalyptus N-P fertilizer trial at Akaka in Hawaii (5), fertilizer rates were calculated to give 12.6 grams of N per tree per application.

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1. Soluble DC-153 fertilizer[2] (12-24-12) applied at planting and 12 months later (101 grams/tree per application).
2. Soluble DC-153 fertilizer (12-24-12) applied at planting and 6, 1 2, and 18 months later (101 grams/tree per application).
3. Slow-release Osmocote[3] (14-14-14) applied at planting and Osmocote (13.5-1 3.5-13.5) applied at 12 months (90 grams/tree per application).
4. Slow-release Agriform[4] tablets (20-10-5) applied at planting and 1 2 months later (three 21-gram tablets/tree per application).
5. Slow-release Nitrogano 5 (3-4-2.5) applied at planting and 12 months later (420 grams/tree per application).

The two experiments were laid out in a randomized complete block design with five treatments and four replicates of *E. saligna* in one test and five treatments and four replicates of *E. grandis* in a second test. Measurements of height of the inner 40 trees in a plot were taken at 3, 6, 9, 12, 18, and 24 months after outplanting. Diameter at breast height was measured at 18 and 24 months after outplanting. Analysis of variance was carried out to determine the significance of the treatment effect, and means were statistically separated by Duncan's multiple range test.

Results and Discussion

Levels of extractable P, K, Ca, and Mg in the soil were found to be low at this site (table 1). Preliminary results from a eucalyptus N-P fertilizer trial located 4 kilometers to the southeast of the Kamae site on soils belonging to the same soil series showed that the primary limiting nutrient was N and there was no significant growth response to Pat 12 months after outplanting (5). Based on these preliminary results, it was decided to apply soluble and slow-release fertilizers at a constant rate of N per application.

The annual rainfall recorded at the Honohina mauka weather station located 3 kilometers to the north of the Kamae plantings was 5,625 millimeters for 1980 and 3,282 millimeters for 1981. The first fertilizer treatments were applied at the time of outplanting in January 1980. In March 1980, more than 2,000 millimeters of rain fell along the Hamakua Coast during a major rainstorm. This rainstorm presumably increased fertilizer loss by leaching soluble nutrients below the rootzone of the seedlings. Fertilizer loss in the surface runoff was somewhat minimized by the subsurface applications of the fertilizers.

At 3 months after outplanting, there were no significant differences between fertilizer treatments in height of the *E. saligna* or *E. grandis* seedlings (figs. 1 and 2). By 6 months after outplanting, the

[2] DC-153 is composed of urea, treble superphosphate, and muriate of potash.

[3] Osmocote is a product of Sierra Chemical Co., Milpitas, Calif. Osmocote 14-14-14 is a 3- to 4-month-release fertilizer, while Osmocote 13.5-13.5-13.5 is a 6- to 7-month-release fertilizer.

[4] Agriform is a product of Sierra Chemical Co. In addition to N, P, and K, it contains 2.6 percent Ca, 1.6 percent S, and 0.35 percent Fe.

[5] Nitrogano is a product of Wilbur-Ellis Co., Los Angeles, Calif. It is derived from activated dried chicken manure and, in addition to N, P, and K, contains 5 percent Ca, 0.75 percent Mg, 0.35 percent Fe, and 50.0 percent organic matter.

Table 1—*Soil pH, total N, and 0.02-N sulfuric acid extractable P and 1-N ammonium acetate extractable K, Ca, and Mg averaged from 30 sites at Kamae, Hawaii*

Depth	pH	N	P	K	Ca	Mg
				P/m		
0 to 15 cm	5.0	6,845	18	52	64	37
45 to 60 cm	5.1	4,701	10	43	40	13

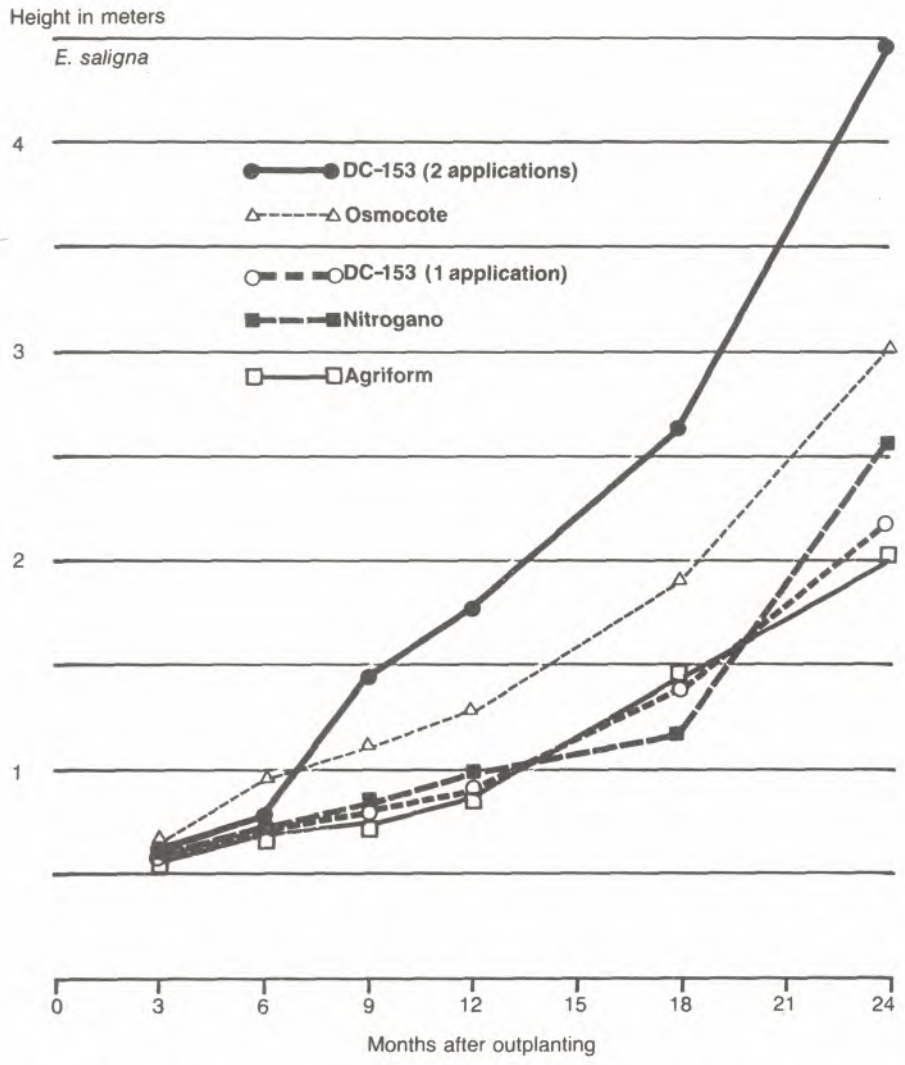

Figure 1—*The effect of various slow- and quick-release fertilizers on height growth of* E. saligna *over a 24-month period.*

eucalyptus trees fertilized with Osmocote were significantly taller than those given all other treatments (figs. 1 and 2), indicating the greater effectiveness of Osmocote fertilizer, particularly after heavy rains.

The eucalyptus trees that received a second application of soluble DC-153 fertilizer at 6 months after outplanting were significantly taller at 9 months than those given all other treatments (figs. 1 and 2). This second application at 6 months appeared to be critical since growth of the fertilized trees sharply increased between 6 and 9 months (figs. 1 and 2). Soluble nutrient loss in these plots was probably accelerated by the rainstorm in March, resulting in soil nutrient deficiencies by 6 months.

Eucalyptus trees receiving soluble DC-153 fertilizer at 6-month intervals generally outperformed all other treatments from 9 through 24 months after outplanting (figs. 1 and 2). At 24 months after outplanting, *E. saligna* trees given the double dosage of DC-153 fertilizer were significantly taller and had significantly greater diameters than those given all other treatments (table 2). At 24 months after outplanting, *E. grandis* trees given the double dosage of DC-153 fertilizer were significantly taller and had significantly greater diameters than those given all other treatments except for Osmocote (table 2).

Among the fertilizer treatments given once per year, eucalyptus trees fertilized with Osmocote were the tallest from 6 through 24 months after outplanting (figs. 1 and 2). At 24 months after outplanting, Osmocote-fertilized *E. saligna* trees were significantly taller than those given a single application per year of the other fertilizers, except for Nitrogano (table 2). In the case of *E. grandis,* the height of Osmocote-fertilized trees was significantly greater than those given Agriform (table 2).

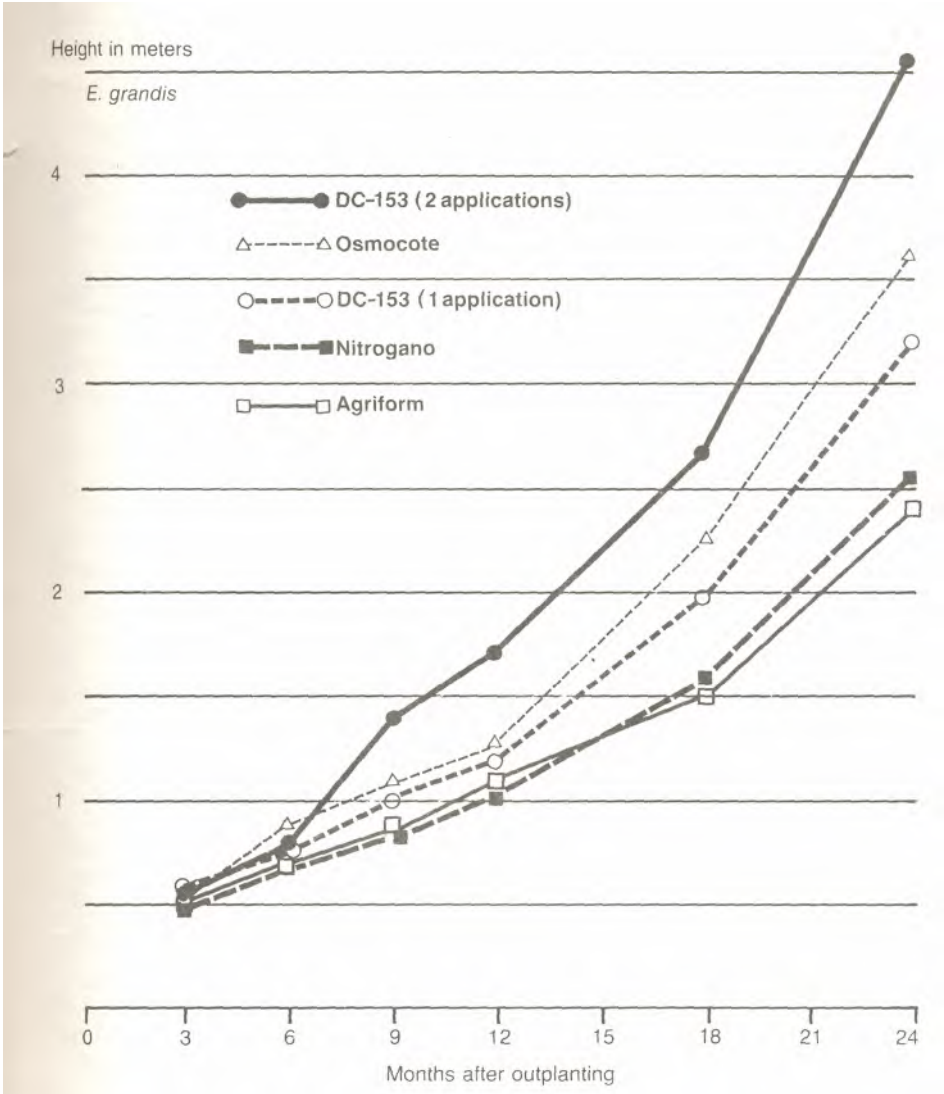

Figure 2—*The effect of various slow- and quick-release fertilizers on height growth of E. grandis over a 24-month period.*

At 24 months after outplanting, *E. saligna* trees fertilized with Osmocote had significantly greater diameters than those given a single application per year of all other fertilizers (table 2). In the case of *E. grandis,* trees fertilized with Osmocote had significantly greater diameters than those given a single application per year of any other fertilizer, except for DC-153 (table 2). The greater effectiveness of Osmocote, relative to all other fertilizers applied once per year, could be because of its temperature-dependent release of nutrients (6), which would reduce the soluble nutrient concentration available for leaching.

Fertilization costs were calculated to include both materials and labor (table 2). The least expensive fertilizer treatment was the single application per year of soluble DC-153, while the most expensive treatment was Agriform (table 2).

The double application per year of soluble DC-153 fertilizer (12-24-1 2) resulted in the best growth of *E. saligna* and *E. grandis* compared to all other treatments at 2 years after outplanting (figs. 1 and 2, table 2). The second best growth of eucalyptus trees at 2 years after outplanting was found in Osmocote-fertilized plots (table 2). The cost of a double application per year of soluble DC-153, however, was less than the single application per year of Osmocote fertilizer (table 2).

Conclusions

The double application per year of soluble DC-153 fertilizer (12-24-12) produced the greatest growth of *E. saligna* and *E. grandis* compared to all other treatments at 2 years after outplanting. Slow-release fertilizers, such as Agriform, Nitrogano, and Osmocote, were more expensive than the double

Table 2—*The effect of various slow- and quick-release fertilizers on height and diameter at breast height (d.b.h.) of* E. grandis *and* E. saligna *at 24 months after outplanting and the associated costs of the fertilizer treatments*

Fertilizer treatment	*E. grandis*[1]		*E. saligna*		Costs per year per hectare		
	Height	D.b.h.	Height	D.b.h.	Labor[2]	Materials[3]	Total
	M	*Cm*	*M*	*Cm*	---------- *Dollars* ----------		
DC-153 (1 application)	3.2bc	2.3bc	2.2cd	1.3cd	95	160	255
DC-153 (2 applications)	4.6a	3.7a	4.5a	3.7a	190	321	511
Osmocote	3.6ab	2.7ab	3.0b	2.3b	95	494	589
Agriform	2.4c	1.4c	2.0d	1.1d	95	776	871
Nitrogano	2.6bc	1.6c	2.6bc	1.6c	95	427	522

[1]Means in a column followed by the same letter are not significantly different at the 95-percent probability level as determined by Duncan's multiple range test.
[2]Labor costs were calculated at $35 per day of labor with 2.7 days of labor needed to apply fertilizer per hectare.
[3]Material costs were based on bulk order rates. DC-153 cost $0.37 per kilogram. Osmocote 14-14-14 or 13.5-13.5-13.5 cost $1.28 per kilogram. Agriform cost $2.86 per kilogram. Nitrogano cost $0.24 per kilogram.

application per year of soluble DC-153.

The growth of the *E. grandis* given one application per year of soluble DC-153 fertilizer did not significantly differ from that of trees given slow-release fertilizers. In the case of *E. saligna*, only Osmocote-fertilized trees among those given slow-release fertilizers grew significantly more than trees given a single application of DC-153. The cost of the single application per year of DC-153 was less than half that of any slow-release fertilizer.

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