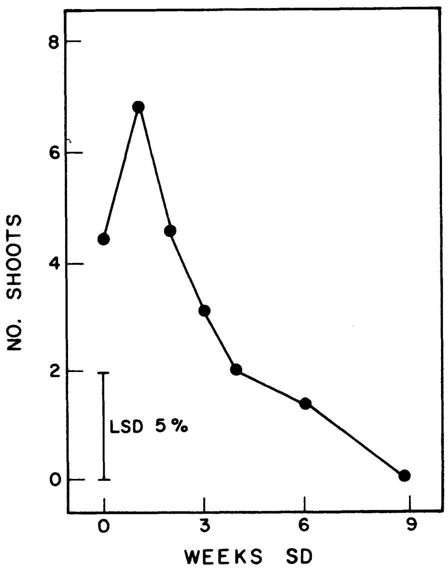

Fig. 2. Effect of 1 to 9 weeks of SD on shoot development of leaf cuttings of 'Aphrodite Pink'. All cuttings received LD after the SD treatment. Mother plants received SD.

came the beneficial effect of the SD mother plant LD cutting treatment (Fig. 3).

Propagation of these cultivars by leaf cuttings was optimized by applying SD to the mother plants for 3 to 4 weeks prior to taking cuttings. Mother plants should be maintained at relatively cool temp (15.6°C). After cuttings are made, they should be kept under LD, although 'Aphrodite Pink' cuttings benefit from one additional week of SD. In this way, both cultivars will develop the desired shoot initiation after 9 weeks, although 'Aphrodite Pink' is still subject to seasonal variation (2).

Table 1. Effect of mother plant temp on shoot formation in leaf cuttings of 'Aphrodite Pink' begonia.

Mother plant temp (°C)	Leaf cuttings forming shoots (%) Week 7	8	9	10	12
15.6	3.5	19.8	28.0	37.1	52.6
21.1	0.0	6.0	13.8	22.4	39.7
26.7	0.0	2.2	5.6	7.7	26.7
LSD 5% = 16.4					

Table 2. Effect of mother plant temp on shoot formation in leaf cuttings of 'Schwabenland Red' begonia.

Mother plant temp (°C)	No shoots per leaf cutting Week 7	8	9	10
15.6	2.7	4.4	4.8	5.9
21.1	2.4	4.1	4.5	5.4
26.7	1.3	3.2	3.9	4.6
LSD 5%	0.8	0.8	1.1	1.2

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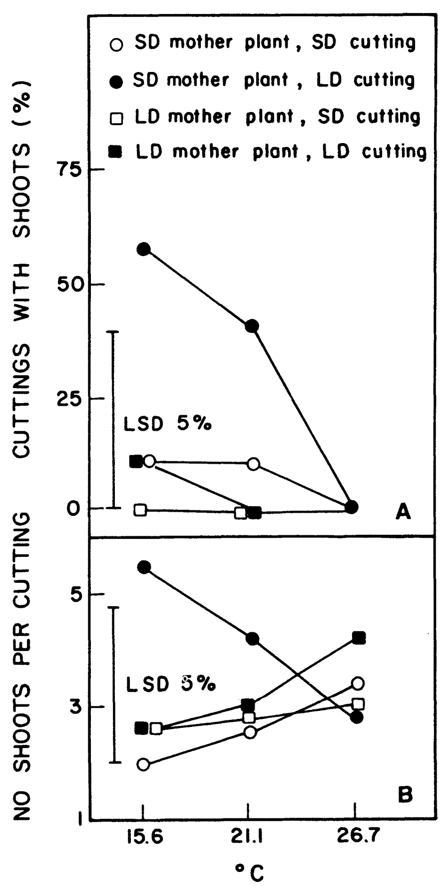

Fig. 3. Effect of mother plant temp and photoperiodic treatment on shoot development by leaf cuttings. (A) Percentage of cuttings with shoots, 'Aphrodite Pink'. (B) Mean no. of shoots per cutting, 'Schwabenland Red'.

HortScience 11(4):379–381. 1976.

Response of 'Sunturf' Bermudagrass to Slow-release Nitrogen Sources under Greenhouse Conditions[1]

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Additional index words. nitrogen fertilization, *Cynodon magenisii*

Abstract. **Slow-release N sources (sewage sludge, Agriform, Osmocote, sulfur-coated urea (SCU) and isobutylidene diurea (IBDU)) and a soluble N source (ammonium sulfate) were applied to soil at the rates of 224 and 448 kg N/ha before planting bermudagrass (*Cynodon magenisii* Hurcombe cv. Sunturf). Yield, % N, and N recovery at 3 cuttings at 30 day intervals were significantly higher at the 448 kg/ha rate than at the 224 kg/ha rate and were highest in the first of 3 cuttings and decreased significantly in the second and final cuttings. The slow-release N sources, except Agriform, generally gave higher yield, % N, and N recovery values than ammonium sulfate, especially at the third cutting and at the higher N rate. Osmocote, SCU and IBDU generally gave higher values than sewage sludge and Agriform.**

Several methods have been used to increase the efficiency of N fertilizers for a long term crop, such as turfgrass. These include the use of slowly available N sources, such as natural organics, slightly soluble N fertilizers, and coated materials. N fertilizers with controlled availability supply N continuously over an extended period and avoid the need for frequent repeat applications as is necessary with water-soluble forms. They also minimize excessive uptake of N, reduce N losses by leaching, decrease volatilization of N and reduce the hazard of soluble salt injury. There is an increasing amount of information on

[1]Received for publication March 8, 1975. Journal Series No. 1856 of the Hawaii Agricultural Experiment Station. This work was part of the senior author's MS Thesis, University of Hawaii, Honolulu.

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the effectiveness of slowly available N sources as fertilizers on turfgrass and on other related work (1–3, 6–12). However, such information is virtually nonexistent for turfgrass in Hawaii and other tropical areas.

The objective of this study was to compare N availability from slowly available N sources and a soluble N source (ammonium sulfate) on the yield, % N, and N recovery using "Sunturf" bermudagrass.

In a greenhouse experiment, stolons were transplanted on Feb. 1, 1972 in 8.5 x 33 x 48 cm flats containing 12.3 kg of Wahiawa silty clay (Tropectic Eutrustox). The soil depth in the flat was 8 cm. This soil had the following properties: pH (H_2O), 5.1; organic C, 1.44%; total N, 0.17%; CEC, 15 meq/ 100 g; and had kaolinite as the dominant clay mineral. The following N-containing materials were studied: ammonium sulfate (21N-0P-0K), analytical grade; activated sewage sludge (3.4-0.7-0.2) from the Wahiawa Sewage Treatment Plant, Oahu, Hawaii; Agriform[3] (38-0-0), a coarse granular ureaformaldehyde product supplied by International Chemicals Inc.; Osmocote (14-12-6), a product supplied by the Sierra Chemical Co.; IBDU (30-0-0), isobutylidene diurea, a condensation product of urea and isobutyladehyde (6) supplied by Mitsubishi Chemical Co.; SCU (37-0-0), sulfur-coated urea, a TVA experimental fertilizer with the following dissolution rate: 14.6% in 5 days, 17.7% in 10 days and 0.6% daily thereafter. Each material was applied at 224 and 448 kg N/ha, and the treatments were replicated twice. A zero N treatment (control) was also included. Calcium hydroxide, mono calcium phosphate, potassium sulfate, magnesium sulfate, ferrous sulfate, sodium molybdate and zinc sulfate were added as basal treatment at rates equivalent to 560 kg/ha $Ca(OH)_2$, 1344 kg/ha of P, 907 kg/ha of K, 112 kg/ha of Mg, 56 kg/ha of Fe, 10 kg/ha of Mo and 22 kg/ha Zn, respectively. A single application of N and basal fertilizers, except P, K, and Zn, was mixed in with the soil before planting. Application of the latter 3 nutrients was split, the first just before planting and the second at 2 months after planting. All flats were watered once daily to field capacity. Care was taken so that free flow of water out of the bottom of the perforated flats after each irrigation was kept to a minimum. Max and min air temp in the greenhouse were 34° and 18°C, respectively.

The grass was harvested by clipping to a ht of 2 cm above the soil at 30-day intervals for a total of 3 cuttings. The harvested leaf samples were dried in a blower oven at 65°C, weighed, ground, and analyzed for total N. Statistical analysis of yield, % N, and N recovery was carried out for each of the 3 individual cuttings separately and for the 3 cuttings combined using a split-plot analysis in time. Only the factorial combination of N sources and N rates were included in the analysis.

Yield. In practically all cases, yield of N fertilizer treatments was higher than that of the control (Table 1) and mean yield of the 448 kg application was higher than that of the 224 kg application. At the 448 kg rate, yield magnitude was in the following order: SCU > Osmocote > IBDU = sewage sludge > ammonium sulfate = Agriform. At the 224 kg rate, there was no significant difference in mean yield among ammonium sulfate, sewage sludge, Osmocote, and SCU. These four carriers gave significantly higher mean yields than IBDU and Agriform. The data also show that mean yield was highest in the first cutting and that it significantly decreased with subsequent cuttings. However, there were exceptions to this overall trend, e.g. at the 224 kg level the yield of the second cutting with SCU was significantly higher than that of the first and at the 448 kg level, ammonium sulfate gave a higher yield in the second cutting as compared to the first.

Percent nitrogen. All N fertilizer treatments have higher % N than the control (Table 1). For the N carriers, % N was significantly higher at the

Table 1. Effect of N sources on yield, % N, and N recovery of bermudagrass at three 30-day cutting intervals.

N source	Rate (kg/ha)	Cutting 1	Cutting 2	Cutting 3	*Mean*[z]
			Yield (g/flat)		
Control	–	0.9	0.6	0.6	*0.7*
Ammonium sulfate	224	4.1klm[y]	5.3h-k	0.5r	*3.3e*
	448	8.2e	11.2cd	0.7qr	*6.7d*
Sewage sludge	224	7.5ef	1.9o-r	1.7p-r	*3.7e*
	448	10.9cd	5.0i-l	6.5fgh	*7.5c*
Agriform	224	1.3p-r	2.0opq	0.5r	*1.3g*
	448	10.0d	5.1h-l	4.0k-n	*6.4d*
Osmocote	224	6.9efg	3.7lmn	0.6qr	*3.7e*
	448	17.3a	5.4h-k	2.6hop	*8.4b*
SCU	224	3.3mno	6.0g-j	0.5r	*3.3e*
	448	11.8c	11.2cd	4.8jkl	*9.3a*
IBDU	224	5.4h-k	1.7p-r	0.9qr	*2.7f*
	448	15.6b	6.3fgh	1.2p-r	*7.7c*
Mean[z]		**8.52a**	**5.40b**	**2.04c**	
			% N		
Control	–	1.75	1.33	1.07	*1.38*
Ammonium sulfate	224	3.18ef	1.25opq	1.14pqr	*1.86cd*
	448	4.20b	1.36nop	1.14pqr	*2.23b*
Sewage sludge	224	2.34hi	1.62lmn	1.28opq	*1.75d*
	448	3.46de	1.86jkl	1.60lmn	*2.31b*
Agriform	224	2.44h	1.62lmn	1.02qr	*1.69d*
	448	3.34de	1.86jkl	1.39nop	*2.20b*
Osmocote	224	2.93fg	1.63lmn	0.99r	*1.85cd*
	448	4.62a	2.10ij	1.48mno	*2.73a*
SCU	224	2.86g	1.45mno	1.16pqr	*1.82d*
	448	3.82c	2.52h	1.68lm	*2.67a*
IBDU	224	3.52d	1.46mno	1.04qr	*2.01c*
	448	4.42ab	2.08ijk	1.81kl	*2.77a*
Mean[z]		**3.43a**	**1.74b**	**1.31c**	
					Summation
			% N recovery		
Ammonium sulfate	224	9.8h	5.0kl	0.2t	*15.0h*
	448	13.6f	5.7j	0.2t	*19.5ef*
Sewage sludge	224	13.4f	2.0p-s	1.6rs	*17.0g*
	448	15.1de	3.6no	4.1mn	*22.8d*
Agriform	224	2.2pq	2.3p	0.2t	*4.7i*
	448	13.3f	3.7no	2.1pqr	*19.1f*
Osmocote	224	15.3d	4.5lm	0.2t	*20.0e*
	448	32.1a	4.4lm	1.5s	*38.0a*
SCU	224	7.0i	6.9i	0.2t	*14.1h*
	448	18.0c	11.2g	3.1o	*32.3c*
IBDU	224	14.6e	1.7qrs	0.2t	*16.5g*
	448	28.0b	5.1k	0.8t	*33.9b*
Mean[z]		**15.2a**	**4.7b**	**1.2c**	

[z]Mean separation within yield, % N, or % N recovery by Duncan's multiple range test, 5% level.
[y]Mean separation (cutting x N source x N rate) by Duncan's multiple range test, 5% level.

[3]The use of trade names is for the convenience of readers only and does not constitute an endorsement of these products by the College of Tropical Agriculture, University of Hawaii.

448 kg rate than at the 224 kg rate. Among the N carriers IBDU, Osmocote and SCU gave significantly higher % N than sewage sludge, ammonium sulfate and Agriform at the 448 kg level. At the 224 kg rate, the % N magnitude was in the following order: IBDU $\geq$ ammonium sulfate = Osmocote $\geq$ SCU = sewage sludge = Agriform. Percent N in harvested samples significantly decreased with progressive cuttings.

Nitrogen recovery. Total N recovery in the 3 cuttings ranged from 4.7% to 38.0% (Table 1) and was greater with the 448 kg rate. The highest total recoveries were found with the higher rate of Osmocote, SCU, and IBDU. This finding reflected the highest 3 values obtained with yield, and % N for the 3 comparable treatments. Recovery was highest in the first cutting and decreased progressively with subsequent cuttings. Beaton et al. (3) similarly showed that N recovery was about 3x greater in the first cutting of orchardgrass (26 days after fertilization) than in the second cutting (54 days after fertilization). The following relationship in total N recovery generally held true: Osmocote > IBDU > SCU > sewage sludge > ammonium sulfate > Agriform. This was also the general order for yield and % N.

Among 2 comparable inorganic products, Moberg et al. (9) found higher N recovery from IBDU than from Uramite (ureaform) with Kentucky bluegrass over a 2-year period. They further reported that recovery ranged from 22% to 54% from 7 slow release sources. Skogley and King (10) also reported ureaform to be lowest in N recovery among various N carriers tested with turfgrass.

Conclusion. Our results (Table 1) indicate good agreement among the 3 measurements used to assess N availability at a given cutting period; i.e. when yeild was high for a given N treatment at a particular cutting period, % N, and N recovery were also high.

Yield, % N, and N recovery were generally higher with slow-release N sources (Agriform excepted) than ammonium sulfate, especially at the third cutting (90 days after planting) and at the 448 kg rate. Moberg et al. (9) showed that urea gave a relatively high N recovery value as compared to slow-release sources. The relatively poor performance of ammonium sulfate, especially at the third cutting and at the higher N level, leads us to believe that some of the fertilizer N may have been lost from the soil through leaching, in spite of the precaution that was taken to keep free flow of water out of the bottom of the flats to a minimum after each irrigation. Dalal (4) in his work with corn grown in an acidic (pH 5.1) Trinidad soil reported that apparent N recovery was greater with urea than with ammonium sulfate, mainly because of the smaller effect on soil pH and exchangeable Al by urea.

Among the slow-release N sources, Osmocote, SCU and IBDU generally gave higher values, especially at the 448 kg rate, than sewage sludge and Agriform.

N recovery generally appeared lower in this study than in similar studies carried out in the continental U.S. (3, 9) and in a study done in Trinidad (4). Part of this could be explained by the greater number of clippings, longer duration and cooler temp used in the continental U.S. studies and a different plant (corn) being used in the Trinidad study. Moreover, the clippings included leaf tissue only, and not the stoloniferous tissue and roots. This will, of course, be reflected in lower N recovery values. Fox (5) reported that fertilizer N effeciency in Hawaii was as low as 15% in a Dystrandept and 11% in a Eutrandept. He further reported that a high rate (291–795 kg/ha) of N fertilization was much more effective than a low rate (117–291 kg/ha). Efficiency is believed to be increased with a larger and more extensive root system which results from the higher rate of N fertilization.

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HortScience 11(4):381–383. 1976.

Effect of Pre-sowing Treatments and Temperatures on Seed Germination of *Acacia cyanophylla* Lindl.[1]

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Additional index words. scarification, hot water treatment

Abstract. **Seeds of *Acacia cyanophylla* Lindl. were treated by: 1) placing in boiling water and cooling to room temperature; 2) boiling in water for 5 or 10 min and cooling to room temperature; 3) soaking in concentrated H_2SO_4 at room temperature or at 50°C for 30, 60, 90, and 120 minutes. Seeds from all treatments were germinated at 5, 10, 15, 20, 25, 30, and 35°C in the dark. All pre-sowing treatments increased the germination percentage and rate over controls. Seeds treated with concentrated H_2SO_4 for 90 minutes and germinated at 15° had 98.5% germination in 6 days.**

Depending on the habitat, acacias are propagated by direct seeding or by transplanting (10). Because of the very low percentage and rate of natural seed germination (11), pre-sowing seed treatments are usually employed. Acacia seeds do not possess dormant embryos but rather dormancy is due to a very hard and impermeable seed coat (1, 6, 9, 11). Germination can only occur when the impervious layer of the testa has been destroyed (6). The various methods employed in breaking seed dormancy of acacias include mechanical

[1]Received for publication March 2, 1976. This research was supported by grant No. 53-AG-57-111 of the Pahlavi University Research Council.

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