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EVALUATION OF THREE TREE LEGUME SPECIES IN WESTERN SAMOA

Introduction. In Western Samoa and other South Pacific islands populations are increasing and traditional bush fallowing periods are decreasing, leading to land degradation. Selection of appropriate tree legume species suitable for alley cropping from among those common to Western Samoa is important. In this paper we report the results from a one-year evaluation study of three common tree legumes: *Sesbania grandiflora, Gliricidia sepium*, and *Calliandra calothyrsus*.

Materials and methods. The trial was carried out at the research farm of the Alafua Campus of the University of the South Pacific in Western Samoa. The soil is a Humitropept (pH 6.2) and volcanic in origin. It is dark brown (10 YR 2/2), deep, friable, well-drained, and with low water-holding capacity. The site had not been cultivated for the past ten years and at the time of clearing supported a mixture of tall grasses and shrubs. The land was prepared by clearing with bush knives (machetes). Three-month-old seedlings of the three species, *Sesbania grandiflora* (S), *Gliricidia sepium* (G), and *Calliandra calothyrsus* (C), were transplanted to the field in November, 1988. The plots (24 x 15 m) were laid along the contours of a sloping site (about 45°). There was 4.3 m between rows and 0.5 m spacing within rows. The layout was a randomized complete block design. A plot consisted of two rows of six plants each. The plants were cut at 1.0 m (1) or 1.5 m (2). Six treatments, 3 species x 2 cutting heights, were replicated five times.

Plants were cut approximately 6, 10, and 13 months after planting. Five randomly selected plants from each treatment were measured at the time of pruning for average plant height before cutting, fresh weight of leaves and stems of the cut portions, and percent dry weight of approximately 50 g sub-samples. N content of leaves and stems was determined by kjeldahl digestion followed by distillation with NaOH (Bremner 1965). P content of leaves and stems was obtained through digestion with an acid mixture followed by ascorbic acid estimation (Blakemore et al. 1986). After removing subsamples, the cut stems and leaves were spread evenly in the alleys made by the two legume rows that constituted a plot.

Results and discussion. *Plant height.* Plant heights of the three legume species subjected to the two treatments were not significantly different at any of the three cutting times, although as expected, the 1.5-m cutting treatments generally produced slightly taller trees (Table 1). Plant recovery after the first cut was slow probably due to drought conditions during the three months immediately preceding the second cut in September. Dry conditions affected the 1.0-m cutting treatments more severely. Gliricidia under this treatment was not cut at the second cutting because of insufficient growth recovery. During the first six months the three species showed similar rates of height growth (Table 1). During the next four months, cutting at 1.0 m resulted in faster growth compared to cutting at 1.5 m for calliandra and sesbania. The same tendency was seen in Sesbania during the subsequent three months.

Dry weights of leaves and stems. The total leaf dry weight of calliandra cut at 1.5 m was significantly higher than sesbania and gliricidia cut at the same height (Table 2). Leaf dry weight of gliricidia cut at 1.5 m was significantly higher than sesbania subjected to the same treatment. The total weight of leaves produced by calliandra (C2) was the highest (12 t/ha) of the three species evaluated. However, in Indonesia, at some locations, gliricidia and sesbania outperformed calliandra (Panjaitan and Blair 1985). Angel and Palm (1987) also noted that in Peru gliricidia produced more dry matter than calliandra. In studies carried out by Yamoah

Table 1. Average plant height (m) before cutting and increase in height/month (m/month).

Treatment	Harvest Dates			Cutting period		
	May/89	Sept/89	Dec/89	1	2	3
C 1	2.73	2.66	3.04	0.45	0.42	0.68
C 2	2.79	3.01	3.55	0.46	0.38	0.68
G 1	2.66	*	2.67	0.44	*	0.24
G 2	2.64	2.26	3.18	0.44	0.19	0.56
S 1	2.71	2.76	2.83	0.45	0.44	0.61
S 2	2.79	2.86	3.12	0.46	0.34	0.54

* Not recovered enough for cutting.

Table 2. Dry weight of leaves (kg/ha) and rate of leaf production (kg/ha/month).

Treatment	Harvest dates				Cutting period		
	May/89	Sept/89	Dec/89	Total	1	2	3
C 1	2,594.7 a	1,778.6 c	5,997.0 ab	10,370.3 ab		445	19,991
C 2	2,731.5 a	3,134.7 a	7,013.2 a	12,879.4 a	586 **	784	2,338
G 1	2,399.5 ab	--	2,624.4 c	4,963.9 c		--	875
G 2	1,773.1 ab	2,381.4 ab	4,252.0 bc	8,406.5 b	452 **	595	1,417
S 1	1,317.9 bc	1,231.0 d	2,540.8 d	5,089.7 c		308	847
S 2	1,020.8 c	909.2 d	1,905.6 d	3,835.6 c	257 **	227	635

** Average of the two treatments for the species.
Values within columns followed by the same letter are not significantly different at P=0.05.

Table 3. Dry weight of stems (kg/ha) and rate of stem production (kg/ha/month).

Treatment	Harvest Dates				Cutting period		
	May/89	Sept/89	Dec/89	Total	1	2	3
C 1	2,269.6 a	1,757.3 c	7,092.6 a	11,119.6 a		439	2,364
C 2	1,383.3 b	3,200.3 a	5,898.8 a	10,482.4 a	401 **	800	1,966
G 1	2,254.3 a	--	2,908.8 b	5,163.1 b		--	
G 2	767.2 cd	2,555.4 b	2,514.9 b	5,837.4 b	332 **	639	838
S 1	887.1 bc	1,113.6 d	1,946.9 b	3,947.6 bc		278	649
S 2	616.7 d	1,276.8 d	1,147.4 b	3,040.4 c	165 **	319	382

** Average for the two treatments.
Figures followed by the same letter are not significantly different using an LSD of 5%.

et al. (1986), the dry matter yield of gliricidia produced after two years was approximately 4.4 t/ha. Budelman (1988) reported production of 10.5 t gliricidia dry matter/ha/year on the Ivory Coast. In Western Samoa, 30.2 tons of gliricidia green matter/ha/year was obtained (Kidd and Taogaga 1984). According to Kang and Mulongoy (1987), gliricidia can yield a biomass of 5-15 t/ha/year. The rate of leaf production (Table 2) during the first six months was highest in calliandra and lowest in sesbania. As expected, this rate was highest during the last three months of the study period. Cutting at 1.5 m produced significantly more dry matter per month than cutting at 1.0 m, except in sesbania where it was vice-versa.

The total dry weights of stems (Table 3) was highest in calliandra followed by gliricidia and sesbania, a pattern similar to those of leaves. In calliandra (C2) the second cut produced the highest amount of stem followed by gliricidia (G2) and sesbania (S2). In the third cut too calliandra also produced significantly higher amount of stem. The rate of stem production (Table 3) in plants cut at 1.5 m was higher than that in plants cut at 1 m during the second

Table 4. Combined leaf and stem dry weight (kg/ha).

Treatment	Harvest dates			
	May/89	Sept/89	Dec/89	Total
C 1	4,864.3 a	3,535.9 c	13,089.6 a	21,489.8 a
C 2	4,114.8 ab	6,335.0 a	12,912.0 a	23,361.8 a
G 1	4,593.8 a	--	5,533.2 b	10,127.0 bc
G 2	2,540.3 bc	4,936.8 b	6,766.9 b	14,243.9 b
S 1	2,205.0 c	2,344.6 d	4,487.7 b	9,037.3 c
S 2	1,637.6 c	2,185.4 d	3,053.0 b	6,876.0 c

Figures followed by the same letter are not significantly different at P=0.05.

Table 5. Leaf to stem ratios.

Treatment	Sept/89	Dec/89	Cumulative
C 1	1.01	0.84	0.93
C 2	0.97	0.19	1.22
G 1	--	0.90	0.96
G 2	0.93	1.69	1.44
S 1	1.10	1.30	1.29
S 2	0.78	1.66	1.29

Table 6. N, P, and K concentration of leaves and stems (%).

Treatment	Harvest 1			Harvest 2			Harvest 3		
	N	P	K	N	P	K	N	P	K
Leaves									
C 1				3.1	0.5	1.5	3.4	0.5	1.5
C 2	3.2	0.3	1.6	3.0	0.5	1.6	3.3	0.6	1.5
G 1				--	--	--	3.5	0.7	1.4
G 2	3.7	0.4	2.0	3.0	0.4	1.5	3.7	0.7	1.5
S 1				3.2	0.5	1.3	3.8	0.6	1.4
S 2	4.0	0.3	1.8	2.9	0.6	1.5	3.8	0.8	1.5
Stems									
C 1				1.2	0.5	2.4	1.3	0.6	2.4
C 2	1.2	0.4	2.2	1.3	0.6	2.6	1.4	0.7	2.8
G 1				--	--	--	1.3	0.7	2.6
G 2	1.7	0.3	2.0	1.3	0.6	2.1	1.5	0.8	2.6
S 1				0.8	0.7	1.3	1.3	0.6	1.6
S 2	0.9	0.4	1.4	1.0	0.8	1.6	1.5	0.9	2.2

period. In the third period the rate of stem production is higher in plants cut at 1 m. The total combined dry weight of leaf and stem was highest in calliandra, irrespective of the height of cutting (Table 4). Cumulative dry matter produced by the three species was not influenced by the two cutting heights.

At the end of the study period the weight of stems was generally greater than that of leaf in calliandra and gliricidia plants cut at 1.0 m (Table 5). At 1.5 m cutting height the weight of leaves of the two species were more than that of stems. In sesbania there was no difference in the two pruning levels with regard to leaf : stem ratio.

N, P, K content. Leaf and stem nitrogen concentration of the three species at the three harvests did not differ considerably during the study period (Table 6). As can be expected, N concentrations in stems were much lower than in leaves. During the first year of growth stem N concentration had not changed considerably and was higher in plants cut at 2.5 m than those cut at 2 m. However, P concentrations were generally higher in plants cut at 1.5 m than those

Treatment	Leaves			Stems			Total		
	N	P	K	N	P	K	N	P	K
C 1	342.4	47.4	157.3	122.3	55.5	233.5	464.7	102.9	390.8
C 2	420.0	68.8	200.6	155.0	73.9	308.8	575.0	142.7	509.4
G 1	179.5	26.0	82.9	72.1	27.5	114.2	251.6	53.5	196.9
G 2	294.2	46.9	135.7	77.8	54.6	180.3	372.0	101.5	316.0
S 1	187.9	25.8	74.8	51.0	26.8	67.8	238.9	52.6	142.6
S 2	138.6	23.2	60.1	47.3	28.9	70.1	185.9	52.1	130.2

cut at 2 m. Phosphorus concentrations in leaves and stems continued to increase during the study period.

Total N, P, and K of leaves and stems. The cumulative N yield of the leaves of calliandra was the highest, followed by gliricidia and sesbania (Table 7). The cumulative phosphorus contents of calliandra and gliricidia leaves and stems except G1 were nearly the same and higher than that of sesbania. The cumulative potassium contents were highest in calliandra, followed by gliricidia and sesbania. Data on overall species performance at the end of one year (after three cuts) clearly indicate that in Western Samoa calliandra is the best species out of the three species tested with regard to dry matter production and nutrient yield. Calliandra is followed by gliricidia and sesbania. Application of calliandra as a mulch would supply an appreciable amount of nutrients to soil. The results also indicate that pruning at 1.5 m is better than at 1.0 m for calliandra and gliricidia in regard to leaf dry matter production and nutrient yield.

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