THE IMPROVEMENT OF MISSION GRASS (*PENNISETUM POLYSTACHYON*) IN FIJI BY TOPDRESSING SUPERPHOSPHATE AND OVERSOWING A LEGUME (*MACROPTILIUM ATROPURPUREUM*)

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ABSTRACT

Broadcast treatments of superphosphate alone or of superphosphate and Siratro (Macroptilium atropurpureum) *seed and cutting frequencies of* 6 *and* 12 *weeks were compared on a natural mission grass* (Pennisetum polystachon) *stand growing on a nigrescent hill soil in south-west Viti Levu, Fiji. The addition of superphosphate alone increased total yield mainly due to the encouragement of naturalised* Desmodium heterophyllum. *The use of super and Siratro seed increased total yield threefold from* 6.0 *to* 19.5 *tonnes D.M. ha^{-1} mainly due to the increased legume* (9 *t ha^{-1} yr^{-1}, at an average* 14.7% *crude protein). Siratro increased the average crude protein of the associated grass by* 25%. *The longer cutting interval significantly increased total herbage yields mainly by increasing the grass component. Broadcasting high rates of superphosphate without the seed of a vigorous and responsive legume is not recommended, but the increased* D. heterophyllum *would be a useful bonus.*

INTRODUCTION

The grasslands of the dry and intermediate zones of Viti Levu in the Fiji group (18°S) consist mainly of steep hills with a highly phosphate-deficient nigrescent soil. The predominant vegetation is mission grass (*Pennisetum polystachyon*) which was introduced into Fiji in the 1920's. It has subsequently spread throughout the drier areas and can be regarded as the fire climax due to regular burning. A fuller description of the grass is given by Parham (1955). Although mission grass has long been regarded as a weed species, it has been observed to be palatable in its young growth and also to remain green in the dry season if grazed to prevent flowering. It flowers in April and seeds in May-June after which the flower stems lignify to a completely inedible straw, which, due to its bulk and height of two metres, prevents access of light and the grazing animal to the lower green leaves. One of its more useful attributes is the clumpy growth habit and the ability to burn to ground level, leaving a clean seed-bed suitable for easy legume establishment by oversowing. Elsewhere *P. polystachyon* is not always regarded poorly. In India it is known as 'thin Napier grass' and considered to be a potential species for fodder and grazing (Majumdar 1968).

Several legumes have also become naturalised including *Atylosia scarabaeoides*, *Alysicarpus vaginalis* and, more important, *Desmodium heterophyllum*—hetero (Roberts 1970). Hetero is ubiquitous in Fiji (Parham 1955) and has been observed to respond to phosphate (Payne 1955). Although it is often frequent in the mission grass sward, it is more common and vigorous along the horse and foot paths through the hills where the grass is kept short.

Macroptilium atropurpureum cv. Siratro outyields other legumes in the drier areas of Fiji, and responds very strongly to superphosphate on the hill soils; in fact it will not grow satisfactorily without it (Partridge 1973).

The trial was designed to see whether frequent cutting (to simulate grazing), and superphosphate could encourage the hetero to form a productive natural sward or whether Siratro would be required for maximum utilisation of the applied fertiliser.

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TABLE 1

Dry Matter production of grass and legume from mission grass broadcast treatments at two cutting frequencies

Cutting interval	D.M. Yield (t ha^{-1})												
	6 weeks						12 weeks						
Treatment*	Grass	1972 Legume	Total	Grass	1973 Legume	Total	Grass	1972 Legume	Total	Grass	1973 Legume	Total	Mean Total Herbage
1. Mission grass	6.0	0	6.0	4.5	0	4.5	7.1	0	7.1	6.4	0	6.4	6.0
2. Mission grass + superphosphate	6.7	1.9	8.6	7.4	2.1	9.5	7.7	1.9	9.6	8.5	1.8	10.3	9.5
3. Mission grass + superphosphate + Siratro	6.8	9.5	16.3	8.4	7.0	15.4	12.1	9.5	21.6	14.3	10.3	24.6	19.5

*All legume in treatment 2 was hetero, in treatment 3 Siratro.

L.S.D., P = 0.05.

	1972	1973
Cutting interval (grass)	1.0	1.8
Treatment (legume yield)	1.8	1.7
Treatment (grass yield)	1.4	2.1
Interaction (grass yield x cutting interval)	2.0	

METHOD

The treatments were i) control, of natural mission grass ii) mission grass, broadcast with 450 kg ha^{-1} single superphosphate, and iii) mission grass with 450 kg ha^{-1} superphosphate, and scarified Siratro seed broadcast at 5 kg ha^{-1}. Two cutting frequencies of 6 or 12 weeks were imposed on these treatments as a factorial. In December 1970, mission grass growing on an area of sloping nigrescent soil near Sigatoka in south-west Viti Levu was mown to ground level, as wet weather prevented a proposed burning of the vegetation. The fertiliser and seed were then broadcast on 3.5 x 5.5 m plots arranged in a randomised block design with three replicates. 450 kg ha^{-1} superphosphate was reapplied as a topdressing in November 1971 and 225 kg ha^{-1} in November 1972. Growth in the first year was cut at irregular intervals to allow full establishment of the legume; thereafter the 6 and 12 week harvest treatments were cut for two years with a motor scythe at about 7 cm height. Herbage from one metre guard strips around the plots was discarded; total fresh weight of herbage was recorded and samples taken for grass-legume separation, dry matter determination and analysis for nitrogen.

RESULTS AND DISCUSSION

Dry matter yields

The dry matter yields of the grass and legume components of the sward for 1972 and 1973 are given in Table 1. In treatment 2, hetero was the only legume, while in treatment 3 the legume was all Siratro, the vigorous growth of which sup-

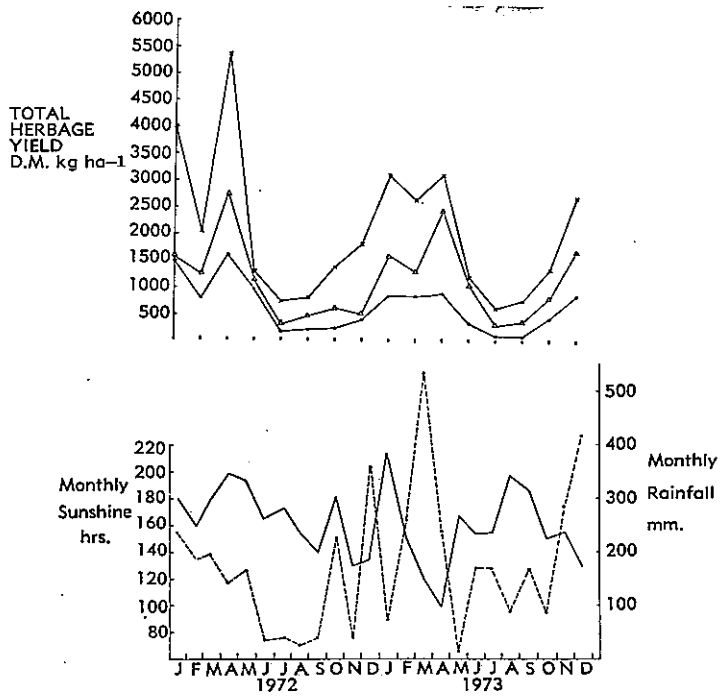

FIGURE 1

Seasonal dry matter production of total herbage (6 week cutting frequency).

×———× Mission grass + superphosphate + Siratro. ——— Sunshine

△———△ Mission grass + superphosphate (+ hetero). - - - - - - Rainfall

•———• Mission grass.

pressed any hetero. Main effects of broadcast treatments and cutting frequency on grass, legume and total herbage yield were significant ($P < 0.05$) while the cutting interval x treatment interaction was significant ($P < 0.05$) only for the grass yield in 1972.

Figure 1 illustrates the patterns of growth and the increased production due to the treatments during the dry season, although there was a period of slower growth at this time.

The slight drop in production in February and March could have been due to waterlogging in the soil (which has poor internal drainage) as sunshine hours in this summer period were not exceptionally low. A similar drop has been noted in other cutting trials with grass species under nitrogen fertilisation.

The hope that a naturalised legume could become a very productive contributor in an improved pasture was not realised. Although the hetero was significantly encouraged by the application of super, especially with more frequent cutting intervals, it was not responsive enough to use the improved nutrient status when compared to Siratro.

Nitrogen content

The average nitrogen content of the herbage components for each year is shown in Table 2, there being no significant pattern of seasonal change.

TABLE 2

Average nitrogen percentage of grass and legume dry matter

Treatment	6 weeks				12 weeks			
	grass		legume		grass		legume	
	1972	1973	1972	1973	1972	1973	1972	1973
	Nitrogen %							
1	1.04	0.91	—	—	0.70	0.82	—	—
2	1.10	0.99	2.48	2.43	0.75	0.80	2.37	1.82
3	1.33	1.12	2.50	2.34	0.83	0.74	2.51	2.05

The colour of the mission grass associated with Siratro was greener than in the other plots, its crude protein content being considerably improved by the legume and super, illustrating that the grass was able to use nitrogen fixed by Siratro even under conditions of cutting and removal of herbage. No direct calculations of nitrogen fixation can be made from a trial of this design but then Bryan (1962) has pointed out objections to most methods of assessment. Comparison of legume-bearing plots with the unfertilised control would not allow for the effect of P and S on the nitrogen uptake by the grass, while the fertilised but unseeded plots produced a good growth of hetero. Vallis (1973) has shown different rates of mineralisation of leaf material between legumes, Siratro being faster than *Desmodium intortum* and hence more efficient in the transfer of N to the companion grass without an intervening animal. Assuming *Desmodium heterophyllum* to have a rate of mineralisation similar to *D. intortum*, nitrogen production and uptake from the hetero can be estimated at 43 kg ha^{-1}, while Siratro with the same level of superphosphate, produced 240 kg ha^{-1} N. Table 3 shows the total nitrogen content of the herbage yield for the sward components for 1972 and 1973. (The figures are obtained by multiplying the annual dry matter yield x average N%.)

TABLE 3

Nitrogen yield of herbage from broadcast treatments. (Average of 6 and 12 week cutting intervals)

Treatment	1972			1973			Mean		
	Grass	Legume	Total	Grass	Legume	Total	Grass	Legume	Total
	Nitrogen (kg ha^{-1} yr^{-1})								
1.	55	—	55	47	—	47	51	—	51
2.	66	45	111	71	42	112	68	43	111
3.	95	237	332	100	187	287	97	212	309

Sward structure

The frequencies of cutting, at 6 or 12 weeks, were both sufficient to prevent the mission grass from seeding fully and lignifying fully although many flower stems were produced at the longer cutting intervals, and the average nitrogen level dropped considerably even when associated with Siratro. The tall (2 m) dense growth and humid climate promoted Siratro leaf fall and rot from the lower horizons of the herbage mass, producing a hollow-bottomed sward. This would tend to limit the accumulation of legume after a certain time, contrary to the finding of Jones (1974) while the grass accumulated with the production of strong flower stems. In any event, the 12 week interval allowed a form of growth, which, due to its very high ratio of stem to leaf, would be of less use to the grazing animal (Stobbs 1973), especially as unimproved grasses of this type have completely inedible stems. Other experience has shown that longer intervals without grazing will lead to a reduction of the grass component when the mission grass stems lodge due to their height and the weight of twining legume. With time the Siratro becomes almost completely dominant as a low growing mat. Subsequent grazing allows new growth of grass to push through the mat so that a grass legume sward will return. The generally reasonable crude protein levels throughout the year suggest that with regular grazing, mission grass based pastures could be capable of providing reasonable quality feed although the dry matter content of the grass was generally low (c.20%) which could limit D.M. intake. However the mixture of grass and Siratro was extremely impressive in appearance and production, so that there is a good chance of improving the large areas of grazing on the hill by broadcasting superphosphate and oversowing legume seed following burning of the mission grass.

Contribution of hetero

The hetero component of the natural sward can be expected to increase with grazing and the future use of super, especially where hard grazing occurs. It can be regarded as a useful bonus but is not productive enough to warrant heavy application of superphosphate. Cutting trials have shown yields of hetero on the hill soils to be low (1400 kg D.M. ha^{-1} when in association with *Dicanthium caricosum*) (Partridge 1972) although more vigorous invasions of hetero have been observed in fertiliser trials on mission grass. Due to its shallow rooting habit, production can be poor in the dry season when leaves often show a yellow blotching which disappears in summer. Hetero will also grow on most inhospitable sites colonising new road cuttings of subsoil, while showing profuse and vigorous nodulation.

In Queensland, steers grazing pangola-hetero and signal-hetero at variable stocking rates have produced over 780 kg ha^{-1} liveweight gain (Anon 1973) but this was on fertile soils where the value of the hetero was not compared with a pure grass sward. The somewhat similar *Desmodium canum* has also produced up to 780 kg ha^{-1} yr^{-1} in association with pangola and other grasses in Hawaii (Younge *et al.* 1964), again on fertile soil. It could be that the prostrate growth is more available to the grazing animal than when mown for recording production. Certainly it withstands heavy grazing which promotes an optimal consumption of highly digestible herbage but mission grass would be unlikely to persist when managed in this way.

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REFERENCES

ANON (1973)—Register of Australian Herbage Plant Cultivars B. Legumes 2. Desmodium c.D. heterophyllum D.C. (hetero) *Journal of Australian Institute of Agricultural Science* **39**: 147.

BRYAN, W. W. (1962)—The role of the legume in legume/grass pastures. Commonwealth Bureau of Pastures and Field Crops, Hurley, Berkshire, England, Bulletin 46, p. 150.

JONES, R. J. (1974)—Effect of an associate grass, cutting intervals, and cutting height on yield and botanical composition of Siratro pastures in a subtropical environment. *Australian Journal of Experimental Agriculture and Animal Husbandry* **14**: 334-342.

MAJUMDAR, B. R., and ROY, S. R. (1968)—Thin Napier (*Pennisetum polystachyon*, Schult) a promising tropical grass as silage and pasture. *Indian Dairyman* **20**: 335-8.

PARHAM, J. W. (1955)—The Grasses of Fjji, Department of Agriculture, Fiji Bulletin No. 30, p. 103.

PARTRIDGE, I. J. (1972)—Annual Research Report of Department of Agriculture Fiji, p. 13.

PARTRIDGE, I. J. (1973)—Phosphate Responses by a Pasture Legume on a nigrescent hill soil in S.W. Viti Levu, *Fiji Agricultural Journal*, Fiji **35**: 67-69.

PAYNE, W. J. A., LAING, W. I., MILES, N. S., and MASON, R. R. (1955)—Fodder and Pasture Investigational work at Sigatoka 1949-1953. *Agriculturdl Journal Fiji* **26**: 55-60.

ROBERTS, O. T. (1970)—A Review of Pasture Species in Fiji II, Legumes *Tropical Grasslands* **4**: 213-222.

STOBBS, T. H. (1973)—The effect of plant structure on the intake of tropical pastures 1. Variation in the bite size of grazing cattle. *Australian Journal of Agricultural Research* **24**: 809-19.

YOUNGE, C. R., PLUCKNETT, D. L., and ROTAR, P. P. (1964)—Culture and Yield Performance of *Desmodium intortum* and *D. canum* in Hawaii. Hawaii Agricultural Experiment Station Tech. Bull. 59.

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