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THE EFFECT OF NITROGEN RATES AND CUTTING FREQUENCIES ON THE PRODUCTIVITY OF TWO ECOTYPES OF *PANICUM MAXIMUM* INTERPLANTED WITH IMMATURE RUBBER

By

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ABSTRACT

Two ecotypes of *Panicum maximum* (Guinea A and Guinea B) were intercropped for 18 months with rubber. commencing when the rubber was 12 months old. The effect of rubber on growth of the grasses was not studied but was apparently little, during this period.

Guinea A yields more dry matter than Guinea B, but the two ecotypes were of comparable nutritive value. The dry matter yield of both grasses was low, averaging 8 to 9 kg/ha/yr.

The magnitude of response to nitrogen was also low, as increasing nitrogen from 90 to 360 kg/ha/yr increased dry matter by only about 20%. Therefore, application of such high rates of nitrogen is clearly uneconomic unless constraints to better yield and response to nitrogen can be removed.

The cutting frequency of 30 days was optimal with both grasses for both dry matter and crude protein yields.

INTRODUCTION

There are basically two options for tropical pasture production; legume-based mixtures or nitrogen fertilized pure grasses. Legume-based pastures generally have higher nutritive value, lower cost of production and should be preferred particularly on account of the current high cost of nitrogen fertilizer. However, they are essentially extensive systems requiring twice as much land per animal as heavily nitrogen fertilized, pure grass pastures (Jones, 1974). Further, most tropical legumes are sensitive to defoliation and the legume component in mixed pastures diminishes, often rapidly, under zero-grazing (Harris, 1978; Waidyanatha *et al*, 1983). On the other hand, high - yielding nitrogen responsive forage grasses under intensive management could produce much higher yield per unit of land under zero-grazing and should be of interest especially to commercial rubber plantations despite the higher production costs.

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Nitrogen is the most important single factor for pure tropical forage grass production. Yields normally increase linearly with increasing nitrogen applications with optimum responses around 300 – 400 kg/ha after which the returns diminish (Henzell, 1962; Vincente-Chandler 1966; Ng, 1972). Harvesting frequency is equally important in order to optimise both yield and quality because of their rapidity of maturing and concomitant decline in feeding value (Raymond *et al,* 1969; Minson and Milford, 1966).

Panicum maximum ecotype Guinea A and B have yielded satisfactorily in preliminary trials under rubber in the low country Wet Zone of Sri Lanka on a basal nitrogen application and cutting regime (Waidyanatha, 1976; Dissanayake, 1982). However, the response of Guinea B to applied nitrogen in a previous study was low (Waidyanatha, *et al,* 1983).

This investigation was aimed at ascertaining optimum nitrogen fertilizer levels and defoliation regimes for these two grasses during the intial years when growing under rubber.

MATERIALS AND METHODS

The experiment was conducted at the Pembroke Estate, Kalutara, in the low country Wet Zone of Sri Lanka. The design was 2 x 3^2 factorial with two *Panicum maximum* ecotypes, Guinea A and Guinea B, three nitrogen levels, 90, 180, and 360 kg/ha/yr and three cutting frequencies of 20, 30 and 40 days as treatments. The treatment combinations were replicated thrice. The plots (1.8 x 3.6 m) were set down between rows of 1 year old rubber trees planted 4.6 x 6.1 m. The climate is hot, wet and humid, and this location receives an annual rainfall of about 3000 mm; there being no prolonged dry spells. The soil is red yellow podsolic with a pH of 4.7 to 5.0 and deficient in N P K (total N = 0.992%, available P = 9.4 pm and exchangeable K = 0.17 m.e%).

The soil was tilled by digging fork and mamoty to a depth of 15 – 20 cm, and grass was planted 30 x 45 cm, two tillers per point. At planting, 100 kg of urea, 50 kg of muriate of potash (MP) and 100 kg of rockphosphate (RP) were applied to all plots. Nitrogen treatments (urea and ammonium sulphate alternatively) were applied after the first cut. Basal applications of 100 kg of MP and 200 kg of RP kg/ha/yr were continued 6 months after planting in four split dozes per year together with the nitrogen.

Pasture was cut back at 15 cm height and dry matter yields after oven-drying (80°, 48 h) and crude protein contents (total N x 6.25) of ground samples were measured. *In vitro* digestibility of pooled samples from several cuts was estimated as described by Minson and Mclead (1972) and by Tilley and Terry (1963).

The experiment was established in October 1977. The first recorded harvest was made in December 1977 and yield and other data for a period of 18 months therefrom are reported here.

RESULTS

Dry matter yields

Cultivars

Guinea A outyielded Guinea B by about 12% (Table 1) and this difference was highly significant ($P<0.01$). The dry matter yields, however, have been low for both cultivars compared to what has been recorded previously under similar conditions (Waidyanatha, 1976; Waidyanatha *et al,* 1983).

Table 1. *Dry matter yield (kg/ha/1.5yr) of the two grasses under three levels of nitrogen.*

	kg/N/ha/yr				
	90	180	360	Mean	%
Guinea B	9697	11119	12134	10984	100
Guinea A	11540	12118	13436	12365	112.5
Mean	10619	11619	12785		
%	100	109.4	120.3		

LSD (P = 0.01) for N means = 346

LSD (P = 0.01) for cultivar means = 283

The response to increasing nitrogen applications has been linear for both cultivars (Table 1). However, the magnitude of the response is low; increasing nitrogen from 90 to 360 kg/ha/yr increased dry matter yield only by 20%. The response of Guinea B to nitrogen fertilizer has been somewhat better than Guinea A, although the N x cultivar interaction is not significant. Increasing nitrogen applications from 90 to 180 to 360 kg/ha/yr increased dry matter yields only 15.8 and 5.6 kg per kg N for Guinea B; the corresponding values for Guinea A being 6.4 and 7.3. Also the nitrogen recovery has been poor : with increasing nitrogen application from 90 to 180 and 180 to 360 kg/ha/yr, the mean nitrogen recoveries were only 15.9 and 20.7% respectively.

Cutting frequency

The cutting frequency means over the two grasses are very significantly different ($P<0.001$) between the treatments. Thirty. days was the optimum cutting interval for both grasses, with respect to dry matter yield (Table 2), and it gave 22 and 26% more yield than the 20-day frequency for Guinea B and Guinea A, respectively. The 20-day frequency produced 4% less dry matter than the 40-day. Cultivar x cutting frequency or nitrogen x cutting frequency interactions are not significant, but there is strong indication thatthe 30-day cutting regime and 180 kg/N/ha/yr is the optimal combination for maximum dry matter productivity for both grasses (Table 3).

Table 2. *Effect of cutting frequencies on the dry matter yield (kg/ha/1.5yr) of the two grasses*

	Cutting frequency (days)			
	20	30	40	Mean
Guinea B	10108	12303	10539	10984
Guinea A	11214	14165	11714	12365
Mean	10771	13234	11127	
%	100	124.1	104.3	

LSD (P = 0.01) for cutting frequency means = 346

Table 3. *Cutting frequency and nitrogen effects on dry matter yields (kg/ha/1.5yr) of the two grasses*

Nitrogen	Cutting frequency		
kg/ha/yr	20	30	40
90	10043	11813	10000
180	10540	13976	10340
360	11401	13915	13039
		N S	

Crude protein contents

The % N (means over nitrogen levels and cutting frequencies) is 1.15 and 1.17, respectively, for Guiena B and Guinea A. Therefore the cutting frequency and nitrogen applications effects on % N and total crude protein yields as means over the two grasses are only presented (Table 4).

Table. 4. *% N and total amount of crude protein in leaf as affected by nitrogen application and cutting frequency (means over the two grasses)*

	% N cutting frequency				Total crude protein yield cutting frequency			
Nitrogen	20	30	40	Mean	20	30	40	Mean
90	1.01	1.19	1.03	1.08	634	879	643	719
180	1.06	1.23	1.04	1.11	698	1074	672	815
360	1.20	1.54	1.16	1.30	855	1339	945	980
Mean	1.09	1.32	1.08		729	1097	753	

LSD (means) (P = 0.05) = 0.15   LSD (means) (P = 0.05) = 108
(P = 0.01) = 0.02   (P = 0.01) = 144

Increasing nitrogen applications increased nitrogen concentration in the grass tissues; the difference between both the % nitrogen and the total crude protein yields between the 180 and 360 kg nitrogen rates is highly significant ($P<0.01$).

Rather contrary to expectation, % N in the leaf tissue did not increase with increasing cutting frequency. The optimum cutting frequency with respect to % nitrogen was 30 days as also was the dry matter yield. Consequently, crude protein yield was also highest at the 30-day cutting interval. Both the mean nitrogen concentration and mean total crude protein yield at the 30-day cutting regime differed from the other two, very significantly ($P< 0.01$). The interaction nitrogen X cutting frequency was not significant.

In vitro organic matter digestibility

The mean organic matter digestibility (OMD) of Guinea A and Guinea B was identical (49.9% and 50% respectively) and hence only the nitrogen and cutting frequency effects on OMD are presented (Table 5). Neither cutting frequency nor nitrogen rates had affected the OMD, which is unusual.

Table 5. *Effect of cutting frequencies and nitrogen rates on the organic matter digestibility (means over the two grasses)*

Nitrogen	Cutting frequency (days)			
(kg/ha/yr)	20	30	40	Mean
90	49.5	49.4	52.7	50.5
160	50.6	42.8	51.2	48.2
360	52.7	51.2	49.5	51.1
Mean	50.9	47.8	51.1	

DISCUSSION

The low magnitude of the response of the two *Panicum* cultivars to applied nitrogen is consistent with results of a previous experiment on similar soils and climate (Waidyanatha *et al,* 1983). Dry matter yield increases of 50% or more have been reported by many workers for humid tropical situations when nitrogen was increased from about 100 kg to 200 – 300 kg/ha/yr (Vincente – Chandler *et al,* 1959 ; Henzell, 1962 ; Ng, 1976 and Chadhoker, 1978). It is possible that losses of the applied nitrogen by excessive leaching and wash – off due to the heavy rainfall, volatilization, as also the high soil acidity, resulting in possible micronutrient deficiencies, may be partly responsible for this observation. It might thus be of interest to investigate pasture response to liming of this soil.

Possibly, increasing shading from the growing rubber canopy was a further factor that affected yield and more importantly, response to nitrogen. However even at the termination of the experiment, the rubber canopy very clearly intercepted less than 50% of the incident light, and Erikson and Whitney (1981) reported a dry matter yield as high as 24 t/ha/yr for *Panicum maximum* at 45% daylight and 365 kg N/ha/yr.

Also competition from rubber roots for nutrients and water even at the latter stages of the experiment should probably have been small according to reported root spread measurements (Soong, 1970) and previous observations (Waidyanatha *et al,* 1983) on competition between rubber and pasture.

Therefore, if substantial responses to nitrogen fertilization are not obtainable in the early years after the removal of any possible constraints as mentioned, applications of nitrogen at rates higher than 150 – 200 kg/ha/yr should be uneconomic, because there is now good evidence (Waidyanatha *et al,* 1983 ; Dissanayake, 1982) that legume-based pastures are as productive under zero-grazing as moderately nitrogen-fertilized pure grasses.

Both grasses when harvested every 30 days had higher % N than when harvested every 20 or 40 days. This is inconsistent with the usual observation (*e.g.* Appadurai and Gunawardane, 1973) that the concentration of leaf nitrogen (crude protein) decreases with increasing age. It is however also possible that too frequent defoliation as at every 20 days, impaired uptake of nitrogen through decreased root activity caused by death of roots. Also frequent defoliation leads to reduced carbohydrate reserves in the remaining plant parts which in turn can adversily affect nitrogen uptake and nutrition (Williams, 1970). Prates (1972) also provided evidence that the highest concentration of nitrogen need not necessarily be in the youngest tissues and that the best nutritive value was obtained on a 6–weeks cutting cycle, and not at 4, or 8 for *Paspalum notatum*. It is of interest that optimum dry matter yield and % nitrogen, as also the highest total crude protein content for both cultivars coincided on the 30-day cutting regime.

The OMD of the grasses was not affected, either by the nitrogen rate, or by the harvesting frequency. Digestibility increases normally, with increasing cutting frequency (Minson and Milford, 1966), but increasing nitrogen, does not always increase digestibility (Minson, 1973). However, the data reported here are only from one analysis and should be insufficient to draw firm conclusions on digestibility.

It is of interest that the OMD of the two *Panicum* cultivars is very comparable, and this is consistent with the observation that differences between species of *Panicum* are small (Minson and Haydock, 1971; Minson, 1971).

The results point to the potential of Guinea A which grows wild in many part of the island as a forage grass, when compared to the widely accepted Guinea B. Guinea A not only outyielded Guinea B but also was of comparable nutritive value.

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