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THE PERFORMANCE OF SOME ZERO-GRAZED PASTURES IN RUBBER LANDS OF THE LOW COUNTRY WET ZONE OF SRI LANKA

by

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ABSTRACT

The dry matter yield, crude protein content and botanical composition of pastures of *Pennisetum purpureum* (Napier), *Panicum maximum* (Guinea B) and *Brachiaria brizantha* grown pure and in combination with *Pueraria phaseoloides*, *Centrosema pubescens* and two cultivars (Schofield and Fine Stem Oxley) of *Stylosanthes guianesis* were studied.

The dry matter and the crude protein yields for the 3 grasses when grown alone were comparable. The legume component dry matter yields were highest for Schofield Stylo, and both Stylo cultivars outyielded Pureo and Centro in the mixtures. Napier Stylo mixtures were the most productive. Because of the higher legume content, the total crude protein yields were higher in the Stylo associations than in the other associations or pure grasses. *Brachiaria* combined poorest with legumes. Weed growth was least in the *Brachiaria* pastures.

The results vindicate the advantages of legume based pastures over nitrogen-fertilized pure grasses of comparable yield.

INTRODUCTION

Vacant patches in mature rubber plantations from loss of trees, caused mainly by the white root disease (*Rigidoporus lignosus*), constitute about 8% of the total land under rubber in Sri Lanka (Liyanage, 1978); and pasture of fodder growing is one of several prospective land use systems for them. The smallness of these patches (often less than 0.1 ha) and their wide scatter in plantations suggest that fodder growing rather than grazed pasture is more appropriate.

Legume based mixed fodder are to be preferred to nitrogen-fertilized pure grasses because of the usually higher nutritive value of the former and the current high cost of nitrogen fertilizer. This should particularly be so for those rubber-growing (red yellow podzolic) soils which did not respond well to nitrogen fertilization in previous pasture trials (Dissanayake, 1982; Waidyanatha et *al* 1984). However, tropical pasture legumes, especially those with the trailing habit, are usually sensitive to excessive defolination and persist poorly in association with tropical grasses, particularly under zero-grazing. Thus Ng (1976) and Ng and Wong (1976) reported poor persistence of *Centrosema pubescens*, *Pueraria phaseoloides*, *Calopogonium mucunoides* and *Macroptilium atropurpureum* when grown in association with some tropical grasses in cutting trials under humid tropical conditions In Sarawak, Malaysia. *Stylosanthes guianesis*, on the other hand, persisted much better. Waidyanatha et *al*, (1984) also observed unsatisfactory persistence of *Pueraria* and *Centrosema* in mixed pastures under young rubber in Sri Lanka.

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Therefore, more persistent and productive legumes with good combining ability with tropical grasses under zero grazing and under the climatic and soil conditions of the low country wet zone of Sri Lanka are required if mixed pasture or fodder production is to be a viable proposition in rubber plantations.

MATERIALS AND METHODS

The experiment was conducted at the Rubber Research Institute Agalawatta (65m AMSL; 80°20' E, 6° 55' N) in the south west of Sri Lanka. The climate is very humid and wet with a mean annual rainfall exceeding 4000 mm (4368mm for 1979). The mean minimum and maximum ambient temperatures are 22°C and 31°C respectvely with little diurnal or seasonal fluctuation. The mean relative humidity is high averaging 82%.

The plots (3.0 x 2.0m) were laid out on flat terraces of a terraced hill of approximately 80% slope and devoid of rubber trees. The soil was red yellow podzolic with a pH of 4.5 to 5.0, deficient in NPK and of low base exchange capacity.

Three grasses, *Panicum maximum* cv Guinea B, *Brachiaria brizantha* and *Pennisetum purpureum* cv Napier were cultivated alone or in combination with 4 legumes, *Pueraria phaseoloides* (Puero), *Centrosema pubescens* (Centro) *Stylosanthes guianesis* (Stylo) cv Schofield and cv Fine Stem oxley (F. S. O.)

The resulting 16 treatments were replicated four times in a randomised block design.

The soil was tilled by digging fork and then by hoe to a depth of about 20cm, and pastures were established in rows, 50 cm, apart. Stem cuttings of *Brachiaria* and Napier and tillers of Guinea were planted 25 cm apart in the row. Acid-scarified legume seeds inoculated with appropriate peat cultures of *Rhizobium* were sown in the grass rows. All plots received 300 kg of rock phosphate (36 kg P) 150 kg muriate of potash (75 kg K), and pure grass plots received 270 kg urea (125 kg N) ha/yr in addition, in four applications per year.

Pasture was cut back every 5 to 6 weeks at 15 cm height. Its dry matter yield (after oven-drying at 80°C for 48h) and botanical composition were determined in an area of 2m² per plot. Dried materials were analysed for the crude protein contents (% Nx 6.25).

The experiment commenced in July 1978 but the first assessment of pasture yield was made in mid December 1978 when all pastures were well established.

RESULTS

Dry matter yield

The yield differences among pure Napier, Guinea B and *Brachiaria* of among the grass components in the various mixtures did not differ significantly (Table 1). Of the mixtures, highest yields were obtained from the 2 Napier-Stylo associations, but no mixture significantly out yielded the pure grasses. The legume component yields were much higher for Stylo cultivars than for Puero or Centro. The highest legume content of 33% by weight was in the Schofield - Guinea B association and the lowest of 3.5% in the Puero - Brachiaria association.

Table 1. *Dry matter and crude protein yields of pastures and dry weight of weeds (kg/ha/1.5 yr)*

Pastures	Dry matter yield Grass	Legume	Total	Crude protein	Dry weight of weeds
P. maximum (*Pm*)	27859	—	27859 bcde	1986 cdef	4836 c
Pm + Puero	26182	1460 de	27642 bcde	2118 cdef	3926 cd
Pm + Centro	19828	1346 de	21174 de	1673 def	5447 c
Pm + F. S. O. Stylo	18381	4680 bc	23061 de	2110 cdef	4604 c
Pm + Schofield Stylo	17888	8700 a	26588 bcde	2749 bc	2595 d
P. purpureum (*pp*)	29750	—	29750 abcd	2083 cdef	10630 a
Pp + Puero	23912	2839 cde	26751 bcde	2169 cde	8225 b
Pp + Centro	32689	1649 de	34338 abc	2538 bcd	9316 ab
Pp + F. S. O. Stylo	29928	6597 ab	36526 ab	3181 ab	4414 cd
Pp + Schofield Stylo	29560	9898 a	39459 a	3698 a	4633 c
B. brizantha (*Bb*)	27267	—	27267 bcde	2012 cdef	678 e
Bb + Puero	22061	802 de	22863 de	1509 ef	204 e
Bb + Centro	17548	768 de	18318 e	1230 f	454 e
Bb + F. S. O. Stylo	21875	3172 cd	25047 cde	1899 cdef	82 e
Bb + Schofield Stylo	19952	3914 c	23866 cde	1896 cdef	91 e

Values in the same column not followed by the same letter differ at P=0.05 by the Duncan's multiple range test.

When averaged over all the legumes (Tables 2 and 4), the mean of Napier mixtures was significantly more than that of Guinea or Brachiaria mixtures. Similarly, the mean Napier grass component yield was higher than that of the other two grasses. The mean legume component yield was significantly less for *Brachiaria* than the other two showing that *Brachiaria* combined poorest with the legumes. The component grass yields when meaned for each legume (Table 3) did not differ significantly, despite major differences in the productivity of the legumes. The legumes component means over the three grasses showed that Schofield Stylo yielded, more than Fine Stem Oxley; Puero and Centro yielded the least.

Table 2. *Comparison of pure grasses and grass-legume associations (means over four legumes) in respect of forage dry matter, crude protein and weed growth (kg/ha/1.5 yr)*

Pasture	Dry matter Pure	Dry matter Mixed	Crude protein Pure	Crude protein Mixed	Weed Pure	Weed Mixed
P. maximum	27859 ab	24617 b	1986 bc	2162 b	4836 c	4143 c
P. purpureum	29750 ab	34269 a	2083 b	2897 a	10630 a	6647 b
B. Brizantha	27267 ab	22523 b	2012 b	1634 c	678 d	208 d

Values under each estimate not followed by the same letter differ at P=0.05 by the Duncan's multiple range test.

Table 3. *Component dry matter, total crude protein and weed growth of mixed pastures expressed as means over 3 grasses for each legume (kg/ha/1.5 yr)*

	Dry matter Grass	Dry matter Legume	Crude protein (total)	Weeds
Puero	24051	1701 c	1932 b	4118 b
Centro	23354	1254 c	1814 b	5072 c
Fine Stem Oxley Stylo	23394	4816 b	2397 a	3033 a
Schofield Stylo	22467	7504 a	2781 a	2440 a
	N. S.			

Values in the same column not followed by the same letter differ at P—0.05 by the Duncan's multiple range test.

Table 4. *Dry matter yields of mixed pastures as means over the four legumes (kg/ha/1.5 yr)*

	Grass	Dry matter Legume	Total
P. maximum	20570 b	4047 a	24617 b
P. purpureum	29022 a	5247 a	34269 a
B. brizantha	20359 b	2164 b	22523 b

Values in the same column not followed by the same letter differ at P= 0.05 by the Duncan's multiple range test.

BOTANICAL COMPOSITION

Changes in the dry matter yield of the legume components with time, expressed as a percentage of the mixed pastures, are given in Fig. 1. Puero and Centro declined rapidly after the initial harvest, and remained much less productive than the Stylo cultivars in all the mixtures. At the beginning of the second year of harvest, Puero and Centro had almost completely disappeared from the mixed pastures of *Brachiaria* and Guinea.

Despite fluctuations, both Stylo cultivars persisted satisfactorily in the Guinea and Napier pastures. In the *Brachiaria* pastures, however, the proportion of both Stylo cultivars declined in the second half of the first year, and whereas Schofield Stylo component stabilized at about 10% of the total yield, in the second year, Fine Stem Oxley disappeared completely.

Data on rainfall and sunshine, the main climatic factors likely to affect the (legume) yield are also shown in Fig. 1.

The improvement in % Stylo yield in the first 6 months, especially in the Napier and Guinea mixtures, is possibly related to the increasing rainfall during this period. The dip in the Stylo yields in the August - October spell is presumably explained, at least in part, by the dry weather in August followed by exceptionally heavy rain and very low sunshine in September. It would seem possible that over-topping and shading by the tall grasses, when light was already limiting was detrimental to Stylo growth. The subsequent yield increase, peaking in January/February is consistent with the increased sunshine and high moderate rain in the preceeding months (September to December). By contrast, Puero and Centro produced relatively more dry matter coincident with the peak rain spell of September. These two trailing legumes which were able to creep and overtop the tall grasses apparently competed successfully against them under light limiting conditions. The Stylo cultivars in the *Brachiaria* pasture followed the same trend as those of the Napier and Guinea in the first 6 months, but declined thereafter apparently due to increased competition from the grass.

CRUDE PROTEIN YIELD

Highest crude protein yields were recorded for mixtures of Napier and of Guinea with Stylo, essentially because of the higher component yield of Stylo compared to the other two legumes (Tables 1 and 3). When averaged over all the legumes, the mixtures of Napier but not of Guinea had significantly more crude protein than the pure grass (Table 2). The mixtures of *Brachiaria* had significantly

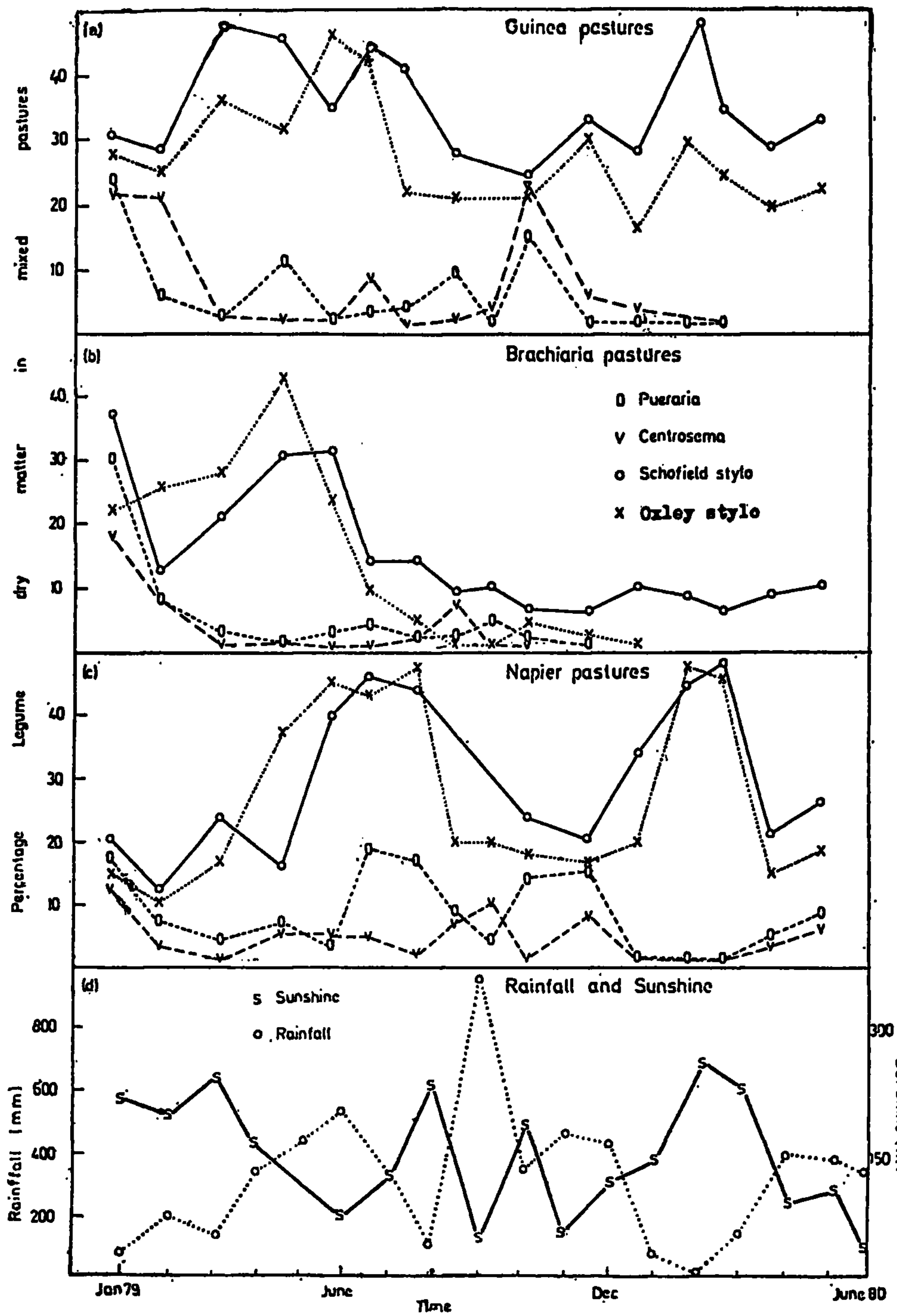

Fig. 1. Variation in the legume component of mixed pastures and distribution of rainfall and sunshine during the experimental period.

less crude protein than the pure *Brachiaria* pasture clearly because of the relatively poor legume component as well as total yields of the *Brachiaria* associations.

Weeds

The predominent weeds in the plots were *Paspalum conjugatum*, *Axonopus compressus*, *Borreria* sp and *Mikania cordata*. As is to be expected, weed growth was more in the pure than in the mixed pastures (Tables 1 and 2). Napier and Stylo mixtures had significantly less weeds than the other corresponding pastures of Napier. Weeds were most in pastures of Napier and least in those of *Brachiaria* and the differences when averaged over the three grasses are significant (Tablé 2). *Brachiaria* with its complete ground cover completed better with weeds than the other two grasses. The weed-checking effectiveness of the legumes followed the same pattern as their dry matter yields: the Stylo cultivars suppressed weeds more than the other two legumes, and Puero more than Centro (Table 3).

DISCUSSION

This investigation confirms the other observations (Waidyanatha et *al* 1984) that in the rubber lands (red yellow podzolic soils) of the Wet zone of Sri Lanka, legume based pastures are equally or more productive in terms of dry matter yield and distinctly better in nutritive value (crude protein content) than nitrogen fertilized pure grasses receiving moderate (100-125 kg) N/ha/yr) rates of nitrogen. This average dry matter yield of 28 t/ha for the 18 month period is quite satisfatory for a legume based pasture, or at the level of applied nitrogen in the case of the pure grasses. The long-term sustainability of this yield is however questionable as evidenced from other work (Waidyanatha et *al* 1984, Ng and Wong 1976).

The trailing legumes again yielded poorly (see Waidyanatha et *al*, 1984) and failed to persist under repeated zero grazing. More careful management of the pastures involving less frequent harvesting of *Pueraria* and *Centrosema* in mixed pastures seem necessary for sustaining a high legume component in them. The two cultivars of Stylo (see also Ng and Wong, 1978) on the other hand, were more persistent and combined well with Guinea grass and Napier. Of the two Stylo cultivars, Schofield was superior and produced more dry matter and crude protein in association with all three grasses than Fine Stem Oxley. Of particular interest is the Napier+Schofield Stylo mixture which was by far the most productive both in terms of dry matter and crude protein. It produced 33% more dry matter and 78% more crude protein than the pure nitrogen fertilized Napier pasture. The Guinea+Schofield Stylo mixture produced as much dry matter as the nitrogen fertilized Guinea but only 38% crude protein. These figures amply emphasise the advantage of productive legume based pastures. However as the experiment lasted only for 18 months, the long term behaviour of Schofield Stylo in association with Napier and Guinea grass is not known except that, at the termination of the experiment, there was no indication that the legume component was deteriorating (Fig. 1). It is also of interest that the Stylo based pastures suppressed weeds more than the other legume based pastures.

Whereas nitrogen-fertilized *Brachiaria* compared well with that of Napier and Guinea its performance in association with the legumes has been comparatively poor. This is due to poor legume persistence in competition with the aggressive *Brachiaria* which covered the ground completely, some months after planting, and suppressing the legumes.

However, Stylo was less affected than Puero and Centro. This contrasts with the results of Ng (1976) who has reported good performance of a mixture of Stylo Centro and *Brachiaria decumbens*, the latter being very similar to *B. brizantha*.

It is of interest that despite the poor growth and persistence of Puero and Centro and consequently meagre nitrogen release to the companion grass that should be expected, the mixtures containing these legumes were able to produce, on average over 19 tons dry matter/ha/yr for 18 months, and without indications of serious nitrogen deficiency. This is hard to explain because soil nitrogen status was low at this site. Perhaps other means of nitrogen accretion such as associative symbiosis reported for tropical grasses (Schank et *al.* 1978) may have been contributory.

In conclusion, it appears that *Stylosanthes guyanensis*, *cv*, Schofield which is a legume well adapted to the rubber lands, in combination with *Pennisetum purpureum* cv Napier or *Panicum maximum cv* Guinea B should give productive pastures. However their long term persistence and performance need further investigation.

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