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The contribution of two tropical legumes to the productivity of signal grass-based pastures

(Sumbangan dua jenis kekacang pastura terhadap daya pengeluaran pastura berasaskan rumput signal)

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Key words: estimation of N-fixation, leucaena, productivity, signal grass, stylo

Abstrak

Satu ujikaji telah dilaksanakan untuk meneliti daya pengeluaran bahan kering foraj dua kekacang pastura iaitu kekacang stilo *(Stylosanthes guianensis* kultivar Schofield) atau petai belalang (*Leucaena leucocephala* kultivar ML 1) yang bercampur dengan rumput signal dalam pastura yang berasaskan rumput signal *(Brachiaria decumbens)*. Anggaran jumlah pengikatan N_2 yang diikat oleh kekacang stilo dan petai belalang dalam campuran rumput signal tersebut dalam 2 tahun tempoh pertumbuhan awal juga dikaji.

Rumput signal telah ditanam secara tunggal (kawalan), campuran bersama kekacang stilo atau petai belalang dan campuran bersama kedua-dua kekacang tersebut. Reka bentuk rawak lengkap berblok dengan lima pereplikatan telah digunakan.

Hasil bahan kering dan hasil protein kasar bagi campuran rumput signal + petai belalang, rumput signal + stilo + petai belalang dan rumput signal + stilo masing-masing 12 700 dan 2 112, 12 200 dan 1 849, 8 300 dan 848 kg/ha setahun berbanding dengan 7 400 dan 637 kg/ha setahun bagi kawalan.

Secara pengiraan, petai belalang mengikat N_2 sebanyak 240 kg N/ha setahun sementara kekacang stilo mengikat sebanyak 37 kg N/ha setahun. Apabila kedua-dua kekacang tersebut ditanam dengan rumput signal, jumlah N_2 yang dapat diikat ialah 298 kg N/ha setahun. Tidak seperti petai belalang, pengeluaran bahan kering kekacang stilo dalam campuran dengan rumput serta campuran rumput dengan petai belalang rendah dan berkurangan mengikut masa. Data ini menunjukkan bahawa kekacang renek seperti petai belalang ialah komponen yang sesuai dalam campuran pastura rumput signal dan mempunyai potensi yang baik sebagai protein untuk makanan ternakan.

Abstract

An experiment was conducted to study the dry matter productivity of two pasture legumes, stylo (*Stylosanthes guianensis* cv. Schofield) and leucaena (*Leucaena leucocephala* cv. ML 1) in combination with signal grass *(Brachiaria decumbens)* in signal grass-based pastures. The estimation of the amounts of N_2 fixed over the first 2 years of establishment of stylo and leucaena in their mixtures with signal grass was also studied. Signal grass was grown in pure

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swards (control) in association with stylo or leucaena and in association with both legumes. The experiment was laid out in a complete block design with five replications.

The dry matter and crude protein yields of signal grass + leucaena, signal grass + stylo + leucaena and signal grass + stylo were 12 700 and 2 112, 12 200 and 1 849, 8 300 and 848 kg/ha per year respectively compared with the control of 7 400 dan 637 kg/ha per year.

By calculation, leucaena fixed 240 kg N/ha per year in the mixed pasture while stylo fixed 37 kg N/ha per year. When both legumes were grown together in association with signal grass, the amount of N_2 fixed was 298 kg N/ha per year. Unlike leucaena, the dry matter productivity of the stylo component in mixtures was low and declined over time. The data show that tree-legume like leucaena are suitable components in mixed signal grass pastures and have a great potential as a protein source for animal feed.

Introduction

High productivity of pasture grasses could be achieved through the use of fertilisers. However, the manufacturing of fertilisers is closely related to the petro-chemical industry and the energy required for N fertiliser alone accounts for about 94% of the energy used in manufacturing all the fertilisers consumed in developing countries (Halliday 1982). Furthermore, about 90% of the ruminant animals in this country are reared by smallholders who have low incomes. Therefore, to encourage the development of better small-scale farming together with the present shortage of energy supply, it is worthwhile considering other alternative with relatively low fertiliser inputs.

Legumes in symbiotic association with *Rhizobium* have the ability to fix N_2 from the atmosphere. They have been shown to increase soil N content and the organic matter status of the soil and reduce soil compaction and soil moisture loss (Anon. 1984). Very little information is available on the contribution of leucaena (*Leucaena leucocephala* cv. ML 1) and stylo (*Stylosanthes guianensis* cv. Schofield) to signal grass *(Brachiaria decumbens)* production although these legumes could grow well with signal grass, which is too competitive for most trailing legumes (Ng and Wong 1976; De Geus 1977). This study therefore aimed to evaluate the contribution of these two legumes to the productivity of signal grass.

Materials and methods

The experiment was conducted over 2 years on a well-drained Serdang sandy loam soil (Typic Paleudult) which is similar to the type reported by Aminah (1989).

The experimental treatments were: pure signal grass without N fertilisation (control), signal grass + stylo, signal grass + leucaena, signal grass + stylo + leucaena. The experiment was laid out in a randomised complete block design with five replications.

Land preparation was done prior to planting. Dolomitic limestone at 2.7 t/ha was applied 1 week prior to planting of pastures. Basal fertilisers of triple superphosphate (TSP) at 30 kg P/ha and Christmas Island rock phosphate (CIRP) at 30 kg P/ha and muriate of potash (MP) at 50 kg K/ha were applied 2 days before planting to all experimental plots. Maintenance fertilisers at 150 kg P/ha per year (TSP) and 200 kg K/ha per year (MP) were applied three times a year. Weeding was done manually, when necessary.

Prior to sowing, legume seeds were scarified in hot water at 80 °C for 3 min and then inoculated with the appropriate *Rhizobium* strain (MS 1076 for leucaena and MS 1029 for stylo). The legumes were planted in four strips within each plot with the distance between strips being about 1.5 m. Signal grass was planted between strips using stem cuttings spaced at 30 cm x 50 cm apart. Stylo was planted at a seeding rate of 3 kg/ha while leucaena at 13 333 plants/ha.

Signal grass was cut at 10 cm above ground level at 6 weekly intervals and stylo was cut at 10 cm while leucaena at 40 cm above ground level at 12 weekly intervals. The grass and legumes were sampled using 2 m x 1 m quadrat. For leucaena, 8 plants/ plot from two rows confined in the above mentioned quadrat were taken. The harvested portions were weighed, subsampled and oven dried at 70 °C for dry matter yield determination. The dried samples were ground (only leaf portion was taken for leucaena) and analysed for N concentration using an autoanalyser. The crude protein content was then calculated by multiplying the N concentration with 6.25.

The amount of N_2 fixed was estimated by substracting the total N yield of the grass and the legume with total N yield in the control (Nutman 1976).

The data were analysed using analysis of variance (ANOVA) table to compare the treatment effects and further subjected to Duncan's Multiple Range Test to see individual effect.

Results and discussion

Pasture dry matter yields

The grass-legume mixtures have resulted in the improvement of the total dry matter of herbage yield compared with the control *(Figure 1)*. However, the yield of grass + stylo mixtures was not significantly different from the control. Signal grass + leucaena mixtures gave the highest yield. The dry matter yields of grass-legume mixtures ranged from 8 300 to 12 700 kg/ha per year compared with the control of 7 400 kg/ha per year.

There was no significant difference between the dry matter yields of the grass component in the grass-legume mixtures compared with the control. This indicated that the yield of the grass component was not improved by the inclusion of the two legumes *(Figure 1)*. Bogdan (1977) generally stated that inclusion of legumes seldom increased the yield of companion grasses but often decreased them although the total yield of mixed herbage usually increased. In a separate experiment, centro and stylo grown in association with signal grass were less productive than signal grass

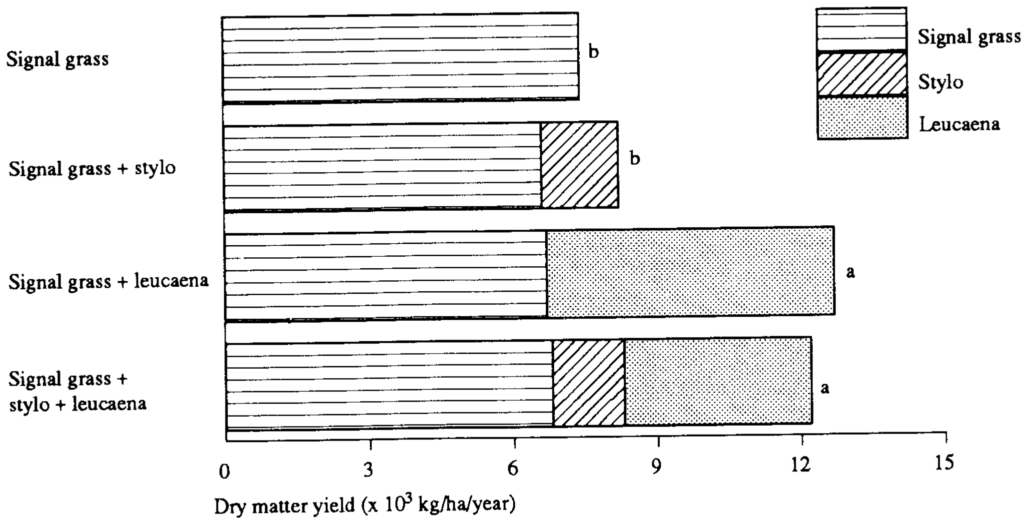

Figure 1. Dry matter yield of signal grass and its association with stylo and leucaena

supplied with 224 kg N/ha per year (Ng and Wong 1976). The reduced yield was associated with a lower production of the legume component, especially the growth of stylo in the mixture. Wong and Mannetje (1981) found that *Stylosanthes humilis* established poorly and formed less than 10% of the total dry matter when grown with *Panicum maximum* and subjected to intermittent heavy grazing.

Crude protein content and crude protein yield of forage

The crude protein content of the grass planted with the legumes ranged from 8.64% to 10.08% and was higher than the control (8.63%) *(Table 1)*. The increase in crude protein content of the associated grass may be due to the increased N uptake by grass in legume-intercropped plots. The crude protein content of leucaena in the signal grass + leucaena mixture (23.91%) and in the signal grass + stylo + leucaena mixture (24.15%) were significantly higher ($p < 0.05$) than stylo in the signal grass + stylo mixture (17.61%) and in the signal grass + stylo + leucaena mixture (16.84%). The values obtained were higher than that of Chandini et al. (1982) who found that intercropping the grass with centro and stylo produced a maximum crude protein content of 9.26% and 8.63% respectively. The highest total crude protein yield was observed in the signal grass + leucaena mixture followed by the signal grass + stylo + leucaena mixture *(Table 1)*. The data suggested that the crude protein content and crude protein yield of the pasture had been considerably improved by the inclusion of legumes even though the dry matter yield of the grass component was not enhanced.

Botanical composition of pastures

Starting with a composition of 15% stylo in the grass + stylo + leucaena mixture, the proportion of stylo continuously decreased with each sampling until the end of the second year with fluctuation in the early months of the second year *(Figure 2)*. In the grass + stylo mixture, the proportion of stylo was 40% in the beginning and it fluctuated with time, especially in the early months of the second year. The proportions were, however, lower than that of leucaena. Leucaena dominated signal grass and stylo in all the treatments having leucaena in the mixtures and it contributed a large percentage to the pasture yield over time *(Figure 2)*. Starting with about 25–35% in the mixtures in 1986, leucaena increased to 70–80% in 1987.

Comparing the two legume species grown in this experiment, leucaena showed a consistent growth and hence a better potential source of animal feed with a higher dry matter production than stylo. The yield of leucaena also showed an increasing trend in productivity with time compared with stylo which showed a tendency to decline and gave a lower yield than leucaena. The

Table 1. Crude protein content and crude protein yield of grass and legume components in legume-based grass pastures

Pasture	Crude protein (6.25 x N%)		Total crude protein yield (kg/ha/year)*
	Grass	Legume	
Signal grass	8.63b	–	637.33c
Signal grass+stylo	8.64b	17.61b	847.56c
Signal grass+leucaena	10.08a	23.91a	2 111.72a
Signal grass+stylo +leucaena	9.51ab	16.84b 24.15a	1 849.12b

Values in each column with different letter differ ($p < 0.05$) by DMRT
*Total crude protein yield = crude protein % x dry matter yield

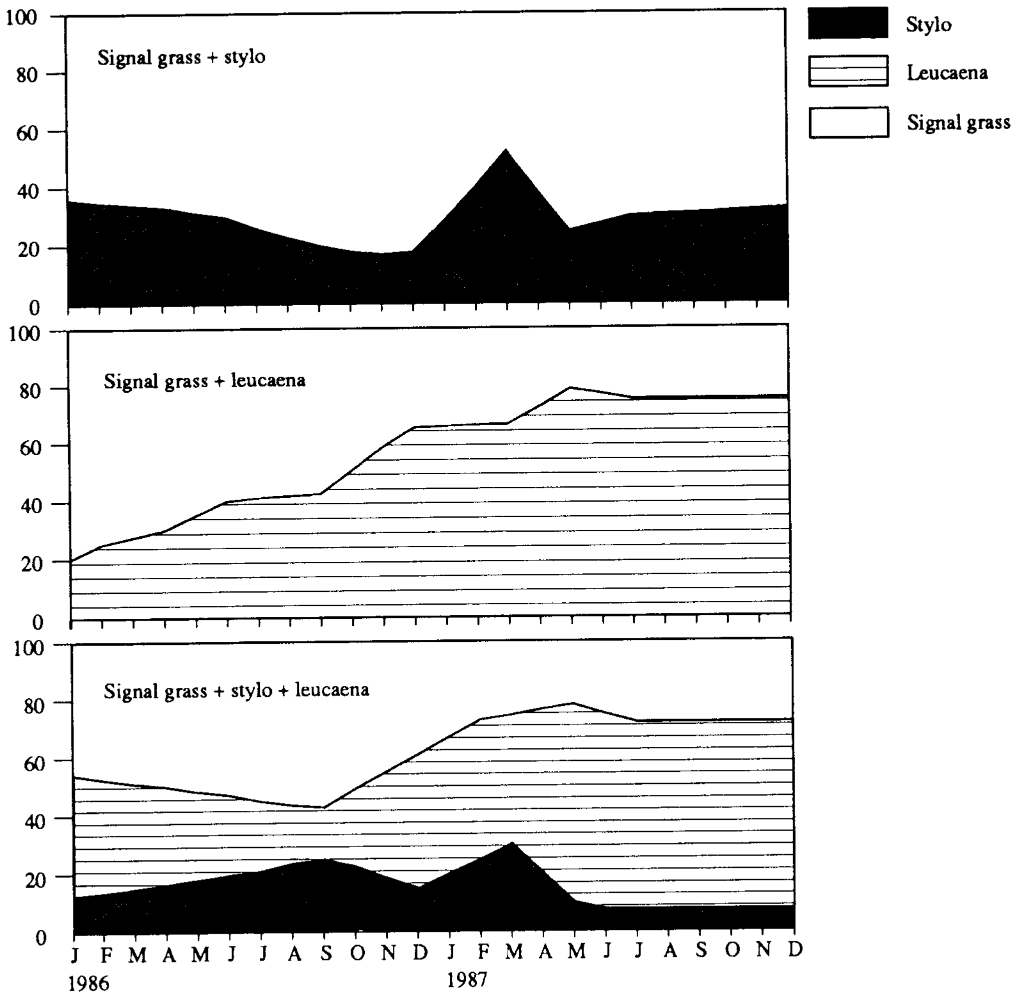

Figure 2. Seasonal changes in botanical composition of pasture species in various mixtures

poor yield of stylo in this experiment was probably due to poor regrowth which was associated with low rates of N_2 fixation and uneven stand. The decline in the proportion of the stylo component with time *(Figure 2)* suggested that stylo is not a compatible legume species to be grown with signal grass.

Estimation of N fixation

It is estimated that stylo fixed about 36.6 kg N/ha per year in the grass + stylo mixture *(Table 2)*. The value was lower than that of stylo in a guinea grass + stylo mixture which fixed N_2 equivalent to 100 kg N/ha per year as urea (Lopez 1980) and stylo grown with *Chloris gayana* which fixed N_2 equivalent to 84 kg N/ha per year. However, it was comparable to stylo in combination with *Pennisetum polystachion* which was equivalent to 32 kg N/ha per year (Singh et al. 1968).

It was estimated that leucaena fixed about 240.4 kg N/ha per year in the grass + leucaena mixtures *(Table 2)*. Leucaena has been reported to contribute about 197 kg N/ha per year (Lulandala and Hall 1986) while in another study, leucaena planted with *Setaria anceps* fixed 78–143 kg N/ha per year (Zaharah et al. 1986). Herbage

Table 2. The estimation of N_2-fixation by the difference in the total N yields of grass-legume mixtures and grass control

Pasture	Total N yield (kg/ha/year)	Estimation of N_2-fixation by legumes (kg/ha/year)*
Signal grass	98.1b	–
Signal grass+stylo	134.7b	36.6b
Signal grass+leucaena	338.5a	240.4a
Signal grass+stylo +leucaena	396.3a	298.2a

Values in each column with different letter differ ($p < 0.05$) by DMRT
*Estimation of N_2-fixation = total N yield in grass-legume mixtures minus total N yield in signal grass

production of signal grass + leucaena pastures in this study was comparable with the yield of pure grass fertilised with 200 kg N/ha per year obtained in another study (Aminah et al. 1991). This result suggests that by planting leucaena with signal grass, a yield comparable with that of grass + 200 kg N/ha per year could be produced. When both legumes were grown together in the signal + stylo + leucaena mixture, the amount of N fixed was 298.2 kg N/ha per year but the figure was not significantly different from that observed in leucaena (240.4 kg/ha per year). The quantity of N added to the soil through the growth of legumes varies according to the types of legumes, the nature of the soil, the effectiveness of the *Rhizobium* strain and seasonal conditions. In addition to fertiliser rates, grass-legume combination and climatic conditions affect the rate of N_2 fixed by the legume (Crowder and Chheda 1982).

Conclusion

By comparison, leucaena was the most vigorous amongst the pasture species planted. Given time, it definitely dominated the grass and stylo. The aggressiveness of signal grass is well recognised and results from this experiment a tree-legume like leucaena is able to combine well with it. The large amount of N_2 fixed by leucaena and its persistence in signal grass pastures indicate that this legume can contribute significantly to forage production and be a major source of protein for animal feeding. Meanwhile, stylo is possibly sensitive to cutting. Its persistence and true performance can be properly assessed if it is subjected to grazing.

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