

Effect of *Calliandra calothyrsus* on the yield and quality of Guinea grass

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Abstract

A field experiment was conducted to determine the associative effects of *Panicum maximum* (Guinea A) when grown in association with *Calliandra calothyrsus*. Planting of fodder grass (*P. maximum* Guinea A) in an existing *Calliandra* (6 years old) plantation was done according to a line-planting array. Guinea A was selected due to its natural abundance. Trees were pruned at 50 cm height above ground level before planting of grass. The experimental plots were arranged as split plot with three replicates. Tree and grasses were initially harvested three months after planting of grass. Subsequently grasses were harvested at 4 week intervals at 10 cm height while trees were harvested at 12 week intervals. During the experimental period from February 2005 to Nov 2005, 12 harvests for grasses and 3 harvests for tree were done accordingly.

Annual dry matter yield of grass (20.38 ton / ha/ year) grown with *C calothyrsus* was higher ($P < 0.05$) as compared with the grass grown in monoculture (14.71 ton / ha/ year). Similarly total dry matter yield was also higher ($P < 0.05$) in the mixed sward (37.68 ton/ ha/ year) as compared with pure *Calliandra* (23.26 ton / ha/ year) and grass swards. The land equivalent ratio (LER) was varied from 1.35 to 1.52 during a growing season in mixed sward. Relative yield total (RYT) for grass and legume was recorded as 1.35. Nitrogen percentage and nitrogen yield of grass increased with the legume. Total nitrogen yield was highest in mix culture (1.05 ton / ha/ year) and lowest with pure grass (0.54 ton / ha/ year). Further nitrogen percentage was higher ($P < 0.05$) in grass ($2.188 \% \pm 0.08$) growing with legume contrast to grass alone ($1.75 \% \pm 0.15$) at the end of the year. (The ratio of edible and non-edible portions of the legume was 1.37).

Organic matter content (1.74 %) and nitrogen concentration (0.121 %) in the soil increased in mixed culture as compared with pure culture at the end of the year.

Although, Guinea A is considered as a wild type of *P. maximum*, the results of this study revealed that, better performances in terms of quality (Nitrogen yield) could be obtained when grown in association with *Calliandra*. Introduction of Guinea A with legumes might not only improve feed supply for livestock and save labour, but also be used for controlling erosion and improving soil fertility.

Keywords: *Panicum maximum* and *Calliandra calothyrsus*, Dry matter yield, Nitrogen yield, Land equivalent ratio (LER), Relative yield total (RYT)

Introduction

A major cause of low productivity of livestock in Sri Lanka is the inadequate amount and poor quality of feed. There is no single variety of pasture or fodder that can supply the nutrient requirements of livestock in a balanced manner. Having a mixture of varieties and also introducing a legume can improve the overall quality. Wild eco-type of *Panicum maximum* cv. Guinea, locally known as Guinea A is well adapted grass up to 1500m above mean sea level in Sri Lanka. It is an important source of forage for ruminants throughout, even critical period of the year, when both quantity and quality of pasture herbage is limited. Available literature revealed that intercropping with leguminous tree species with Guinea grass increased the dry matter and nitrogen yield of grass (Seresinhe and Pathirana, 2000). These responses are attributed largely to increased fertility or nitrogen availability under the tree canopy (Wilson and Wild, 1995). Balogun *et al* (1998) also found that Nylon bag dry matter digestibility was higher in *Panicum maximum* grown with ten shrub legumes including *Calliandra calothyrsus*.

Macqueen (1993) showed that *Calliandra calothyrsus* is a fast growing tree fodder species suited to the humid tropics and used widely as a source of fodder, green manure, and fuel wood and as a basis for honey production. In the more extensive grazing area of Australia, Southern Africa and South America, tree legumes are increasingly being planted in association with improved grasses to increase carrying capacity and productivity of grazing cattle.

So far, few attempts have been made to evaluate the productive performance of Guinea A grown in association with leguminous trees under Sri Lankan condition. Therefore, the objective of this study was to explore associative effects on Guinea A grown in association with *Calliandra calothyrsus* on yield and quality of forages.

Methodology

A field experiment was conducted during 2004/2005 at the Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya. Three types of swards namely *Calliandra* with Guinea grass, *Calliandra pure* sward (150 cm X 150 cm) and *Guinea A pure* sward (45 cm X 45 cm) were maintained in the field. Planting of fodder grass in an existing *Calliandra* (6 years old) plantation was done in November 2004. Guinea A was selected due to its natural abundance. The space between Guinea A row to *Calliandra* rows was 60 cm. Guinea A monoculture was planted adjacent to tree lines far from 150 cm. The plot sizes were 3x3 m. cm for all swards (trees 2 rows, grass 4 rows/plot). Grasses and trees were initially harvested 3 months after planting of grass. Subsequently grasses were harvested at 4-week intervals at 10 cm height while trees were harvested at 12-week interval. The numbers of harvests during the period of Feb. to Nov. 2005 were 12 to grasses and 3 to trees.

Randomly selected 3 trees were pruned at 150 cm height. Branches were separated into tender leaves and stems (edible) and mature stems (non-edible) and fresh weights were recorded of edible parts. From each plot approximately 1 kg sample was taken from edible portion and dry weight was determined (80 °C for 08 hours). Grasses were harvested at 10 cm height in monoculture plots using a 1 X 1 m quadrat and fresh weights were taken separately. Samples each weighing 500g were randomly taken for proximate analysis. Kjeldhal nitrogen concentration was determined using ground plant samples. (Three samples /treatment from each legume harvest were analyzed. Grass samples of three harvests within the same treatment were pooled together and representative 3 samples /treatment were analysed).. Three types of swards were existed namely *Calliandra calothyrsus* with *Panicum maximum* mixed sward; *C. calothyrsus* pure sward (150 cm X 150 cm) and *P. maximum* pure sward (45 cm X 45 cm) Representative from sub samples were while ash content was determined using a muffle furnace (550 °C for a 3 and half hours).

Three soil samples /plot were taken randomly at 10 cm depth from legume and grass monoculture and mixed culture plots using a soil auger after the first and third tree harvests. Soil nitrogen and organic matter contents were determined using standard procedures.

Land equivalent ratio (LER) was calculated as the ratio of total dry matter yield obtained from mixed culture against the total dry matter yield of monoculture per unit area of land. Relative yield total (RYT) was calculated using the following formula:

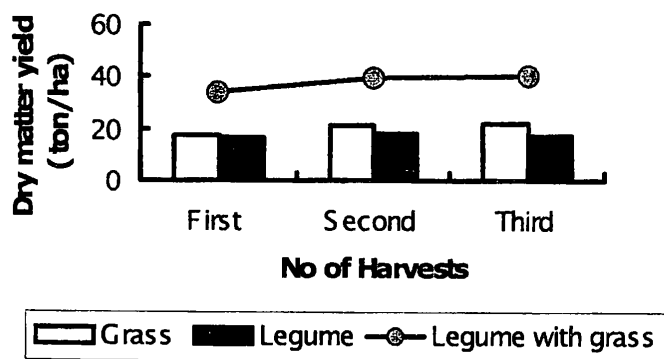
$$RYT = \frac{1}{2} [(W_{ij}/W_{ii}) + (W_{ji}/W_{jj})]$$

W_{ij} and W_{ji} are the dry matter shoot yield per m² of species *P. maximum* (i) and *C. calothyrsus* (j) when grown in interspecific competition, and W_{ii} and W_{jj} are their shoot yields when grown in monoculture. Data were analysed by using SAS package using GLM procedure.

Results and Discussion

The dry matter yield of *P. maximum* grown with *C. calothyrsus* was increased at subsequent harvests. However it was not clearly shown in grass monoculture. Annual dry matter yield of grass (20.38 ton / ha/ year) grown with *Calliandra* was higher (P<0.05) as compared with the grass grown in monoculture (14.71 ton / ha/ year).

The ratio of edible and non-edible portions of the legume was 1.37 for both pure and mixed cultures.



* Each bar for Legume DMY (ton/ha) of 1 harvest

** Each bar for grass DMY (ton/ha) of 12 harvests

Figure 1. Dry matter yields of forages

As expected, mixed sward of Guinea grass + Calliandra gave the highest total dry matter yield of 40 ton / ha/ year (Fig. 1) and grass alone had the lowest dry matter yield of 17.2 ton / ha/ year. Similarly, total dry matter yields were also higher for Calliandra in the mixed sward (37.68 ton/ ha/ year) as compared with pure Calliandra sward (23.26 ton / ha/ year). The land equivalent ratio (LER) was varied from 1.35 to 1.52 during the growing season in mixed sward. Relative yield total (RYT) for grass and legume was recorded as 1.35 and revealed that Guinea A and Calliandra species show least partial resource complementary. That means they do not fully compete for the common limiting resources. This may be due to the nitrogen fixation activity and associative effects between grasses and legumes (Carlen, 1994). The soil nitrogen concentration and organic matter content increased from the beginning to the end of growing season, when Guinea A grown with Calliandra (0.121 % and 1.74 % respectively) as compared with Guinea A grass alone (0.070 % and 1.06 % respectively). Results of this study confirm that growing Guinea A with Calliandra significantly increased the DM yield. Numerous workers (Seresinhe & Pathirana, 2000; Wilson & Wild, 1995) have reported enhanced grass growth and soil fertility under adjacent tree canopies over than open grassland. They attributed the positive growth response of grass under the tree canopy to the influence of shade on soil nitrogen availability. Shading in fact, the most important pathway in which trees interferes with associated herbaceous species. As expected *C. calothyrsus* had significantly higher nitrogen content than grass. However, legume significantly increased the nitrogen content and yield of grass over that of grass monoculture. Total nitrogen yield heavily favors the legume treatment.

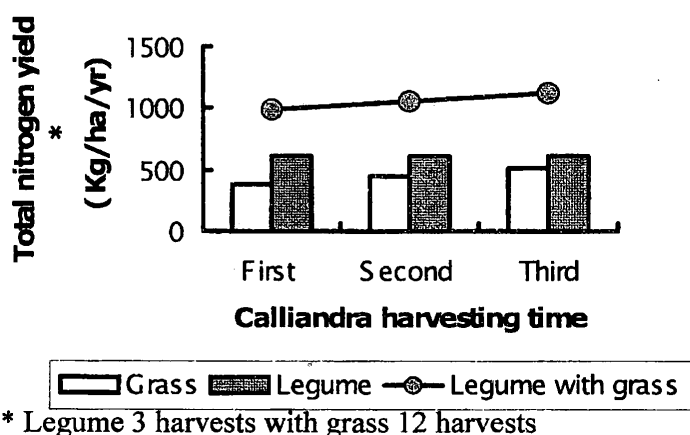


Figure 2. Total nitrogen yields of different forage combinations

Total nitrogen yield was highest in mixed culture (1.05 ton / ha/ year) and lowest with pure grass (0.54 ton / ha/ year). Seresinhe *et al*, (1994) indicated that, the inclusion of legume in a pasture mixture stimulates the growth and increases the nitrogen uptake of grass. The higher nitrogen yield in Guinea A. grass under Calliandra in our current study supports this contention.

Conclusion

The results of this study showed that, better performances of *Panicum maximum* in terms of better yield and quality (Nitrogen yield) when grown in association with *C. calothyrsus*. Introduction of Guinea A and legumes might not only improve feed supply for livestock and save labour, but also be used for controlling erosion and improving soil fertility.

Acknowledgment

The authors wish to thank Mr. G.A.Chandana for his support during the period of data analyses.

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