Annual Dry Matter and Nutrient Yields in a *Dichanthium* Sward with or without *Gliricidia* Shrubs

P. Cruz
INRA, France

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ANNUAL DRY MATTER AND NUTRIENT YIELDS IN A *Dichanthium* SWARD WITH OR WITHOUT *Gliricidia* SHRUBS

P. Cruz

INRA, Station d'Agronomie, BP27, 31320 Castanet-Tolosan, France.

Abstract

The aim of this work was to compare the annual biomass production and nutrient removal of a *Dichanthium aristatum* pasture with those of a pasture of the same species associated with a leguminous tree, *Gliricidia sepium*. Measurements were made over twelve months between April 1993 and April 1994. Sampling was done with the same defoliation frequency as an intensive cut-and-carry system: every 4 and 10 weeks for the grassland and tree layers respectively. There was no significant difference between the yield of the pure grass (21.6 ± 2.0 t ha^{-1}) and that of the grass with trees (18.2 ± 2.9 t ha^{-2}). On the other hand the amounts of nitrogen removed by the *Dichanthium* grown with trees was very much greater than for the natural pasture: 167.3 ± 2.7 kg ha^{-1} and 114.8 ± 1.1 kg ha^{-1} respectively. The amounts of potassium and phosphorus removed by the grass grown with *Gliricidia* were also greater, but only significantly so for the former. Leaf production and nitrogen removed by the trees were 26.8 t ha^{-1} and 788.3 kg ha^{-1} respectively. It was shown that in this type of farming system, recycling of the nitrogen fixed by the trees via leaf-fall is negligible. These results confirm the value of the association between leguminous trees and grasses in tropical humid/sub-humid livestock systems since they increase the general production efficiency of the system as well as that of the grass layer itself.

Keywords : Silvopastoral system, grass, leguminous tree, shade, growth, mineral nutrition.

Introduction

The association of leguminous trees and forage grasses is an interesting alternative for animal production systems in tropical regions (Nygren and Cruz, 1998). *Gliricidia sepium* is a multipurpose tree legume which is frequently used as a forage crop in cut-and-carry systems in many parts of the tropics (Simons and Stewart, 1994). *D. aristatum* is the main component of natural grasslands in Guadeloupe (FWI). This resource plays an essential role in the feeding of cattle and goats on the island. It has been reported (Cruz, 1997) that planting *Gliricidia* in a natural pasture based on *D. aristatum* increases the removal of nitrogen by the grass layer on the scale of a single cut. In an intensive system without recycling such as cut-and-carry little is known about the continuing beneficial effect of the presence of the tree on the grass, nor about the production of the tree itself. The objective of this work was i) to estimate the biomass production of and nitrogen removal by *Gliricidia* over one whole annual cycle, and ii) to compare the biomass production and nutrient removal of a pure pasture with those of one in an association with trees.

Materials and Methods

The study was carried out from April 1993 to April 1994 in 0.2 ha of natural *D. aristatum* grassland at Godet, Guadeloupe (16°20’ N , 61°30’ W, 10 m a.s.l.). The experiment was established in May 1989 by planting four plots, each of 250m² , of *G. sepium* stakes. The planting arrangement was 0.3 x 2 m., resulting in a density of 16500 plants per hectare. Natural grassland was preserved in the remaining area (four plots of 250 m² each). The grassland was sampled every month by cutting five quadrats (0.2 x 1 m) in both unshaded and shaded stands. The production per unit area of shaded grassland was adjusted by reducing its value by 10% in accordance with the basal area occupied by the shrubs. The standing biomass

of five *G. sepium* shrubs was estimated every 2.5 months by pruning the edible parts of the trees (leaves and young green twigs). Its production per hectare was calculated as a function of planting density. Recycling of *Gliricidia* leaves into the soil was estimated by means of baskets arranged under the trees in two ways: A- 5 baskets of 0.20 x 0.20 m per plot were arranged non-contiguously but covering the width of a half-row of the association; B- 1 basket of 0.5 x 2 m per plot arranged to cover the total width of a row. The baskets were collected once a week. The samples taken in the field, both from the trees and of the leaves collected in the baskets, were dried (48 h at 90ºC) and ground (0.2 mm) for total nitrogen analysis (Kjeldahl). Measurement of phosphorus and potassium by atomic absorption spectrometry was only done on the grass samples. Tests of comparisons of means were made using STATISTIX software.

Results and Discussion

Biomass production and nutrient removal by the pure *D. aristatum* pasture (Dp) or the pasture associated with shrubs (Da), together with those of *G. sepium* (G) are shown in Table 1. The accumulated biomass of Dp and Da do not differ significantly. Despite the reduction in the amount of photon irradiance (PI) due to the shade of the shrubs, the annual production has not been affected in Da. This means that the radiation use efficiency (RUE) of the shaded pasture was greater than that in full sun, as reported by other authors (Wild *et al*., 1993). The higher RUE in Da has been related to an improvement in its mineral nutrition, particularly nitrogen (Wilson, 1966). Table 1 shows that the annual removals of N, P and K in Da were 45, 28 and 75% greater, respectively, than those of Dp. The possible reasons for the nutritional advantages to the shaded pasture were discussed recently (Cruz *et al*., 1999). In an intensive cut-and-carry system there is no recycling to the soil of tree foliage. Recycling to the soil of the large quantities of nitrogen fixed by this species (Nygren *et al*., 2000) could only

have taken place by the fall of senescent leaves, or by the death of underground parts following defoliation. It is observed (Table 1) that the mass of leaves recycled as litter, and the amount of nitrogen which they contain, are negligible : respectively 0.5% and 1.5% of amounts removed by the trees, whichever method of estimation (A or B) was used. Nygren and Cruz (1998) reported that the nitrogen recycled by the death of nodules of *Gliricidia* was not very great. Nevertheless, those data were obtained from a *Gliricidia* stand which was much less productive than that of the present work. The hypothesis of soil enrichment with nitrogen from the death of underground parts of the tree remains quite probable but needs to be quantified. The export of *Gliricidia* leaves in the study year reached a higher value than that cited in the bibliography (Simons and Stewart, 1994). It means that the forage production figures can be doubled, and the nitrogen figures may be multiplied 8-fold because of the very high N contents (3%) of the foliar tissue sampled. The introduction of leguminous trees into the pasture has confirmed, for an annual cycle, three of the presumed advantages of such a growing system compared with natural grass: i) to increase land-use efficiency (higher total production) ii) to increase radiation use efficiency of the grass layer, and iii) to provide a more balanced diet for livestock).

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Table 1 - Annual dry matter yield, litter fall and nutrients removal of a natural grassland associated (Da) or not (Dp) to a legume tree (G). Different letters indicate a significant difference at the 0.05 probability level between Dp an Da grass stands.

	Dp	Association			Litter fall	
		Da	Gs	Total	A	B
Dry matter ($t\ ha^{-1}$)	21.6 ± 1.9	18.2 ± 4.2	26.8 ± 2.7	45.0	0.13 ± 0.1	0.12 ± 0.1
N ($kg\ ha^{-1}$)	114.8[a] ± 25.2	167.3[b] ± 43.3	788.3 ± 122.0	955.6	19.0 ± 1.7	17.8 ± 1.8
P ($kg\ ha^{-1}$)	37.9 ± 4.5	43.7 ± 9.6	-	-	-	
K ($kg\ ha^{-1}$)	121.6[a] ± 8.5	213.1[b] ± 49.2	-	-	-	