FORAGE PRODUCTIVITY OF *Panicum maximum* PASTURES IN TWO DIFFERENT AGROPASTORAL SYSTEMS

T. Kanno[1], M.C.M. Macedo[2], J.A. Bono[3], J.D.G. Santos Jr.[3], M.R. Correa[3] and L.G.R. Beretta[3]
[1] Japan International Research Center for Agricultural Sciences, Owashi, Tsukuba, 305-8686, Japan. [2] EMBRAPA-CNPGC, CNPq researcher, BR262, km04, Campo Grande-MS, Brasil, 79002-970.[3] FUNDAPAM, BR262, km04, Campo Grande-MS, Brasil, 79002-970

Abstract

Forage productivity was evaluated for *Panicum maximum* pastures established after 4 years of soybean cultivation in the summer (PM-SO), and 4 years of rotation of soybeans in the summer and millet for winter grazing (PM-MI). In the PM-MI pasture, biomass and dry matter production were much lower than in the PM-SO, and the amount of copper and nitrogen in the top part of the plants in PM-MI were significantly lower than that in PM-SO. Thus, it was considered that the shortage of copper and nitrogen restricted photosynthesis and forage production in PM-MI.

Keywords: agropastoral system, crop-pasture rotation, millet, *Panicum maximum*, soybean

Introduction

Since the 1970's, the Brazilian Savannas, the Cerrados, have been colonized rapidly, to where the total area of introduced grass pastures reached 48 to 50 million hectares. However, extensive pasture utilization without fertilizer application has caused pasture degradation in over 50% of the introduced grass pasture (Macedo 1995). Recently, the use of agropastoral systems (sustainable crop-pasture rotation systems) has been discussed as an option for land management in the tropics (Vera et. al., 1992), and some agropastoral systems are currently being tested in the Cerrados (Kichel et.al., 1996, Macedo and Zimmer 1993, Spain et. al. 1996). The most important advance in agropastoral systems for forage production is the residual effect of fertilizer applied to the preceding crops. However, the residual fertilizer effect can change easily, due to the cropping system used (for example, the choice of crop species or cropping sequence). Thus, in this study, we examined the growth of *Panicum maximum* pastures established after two different cropping sequences of soybeans and millet.

Material and Methods

The *Panicum maximum* (PM) pastures examined were established after two different cropping sequences: one anterior cropping sequence was 4 years of soybean cultivation in the summer only (PM-SO), and the other was 4 years of cultivation of soybeans in the summer and millet in the winter for grazing (PM-MI).

In October of 1993, the experimental area was limed with 3.0t/ha of dolomite limestone, and fertilized with 80 kg /ha of P_2O_5. In November of each of the years 1993-1996, soybeans were planted at a row width of 40-45 cm and a seed rate of approximately 20 seeds/m. At seeding time, 0-20-20 (N-P_2O_5-K_2O) fertilizer was applied at the rate of 380 - 400kg/ha. The average soybean yield of the anterior four years was 2500 and 2618 kg/ha in PM-SO and PM-MI, respectively.

Panicum maximum (2.5kg/ha) was sown in November 1997 in 0.7ha plots in a randomized block design with two replicates. Since April of 1998, the experimental plots were grazed continuously by 2-4 nelore steers; the initial body weight of the grazing steers was 200kg.

From April 28 of 1998 until Jan.05 of 1999 (253 days), forage yield and litter decomposition were estimated with the movable cage method and the litter bag method, respectively. Five 1.0m^2 cages were located on each plot randomly. At six-week intervals, a 0.5m^2 quadrate was set, both inside and outside, of the movable cages, and forage samples were cut at the soil surface. Then, within the 0.5m^2 quadrate, 0.0625m^2 (25cm x 25cm) area was selected and plant litter was collected. Herbage samples and litter samples were oven-dried at 60°C for 48 hours.

After the litter samples were weighed, they were gathered and mixed to make five litter bags for each plot: 3g of dried litter was put in a nylon bag (15 x 15 cm with a 1.5 mm mesh). In each movable cage, one litter bag was placed and replaced at approximately six-week intervals. The decomposition constant of litter was calculated based on a single exponential decay function, and the quantity of decomposed litter was estimated, using values of the decomposition constant and the litter weight at the beginning and the end of the intervals (Thomas and Asakawa 1993). The sum of the forage yield and the decomposed litter during the 253 days was calculated as the total dry matter production.

In May and September of 1998, thirty plants of PM were selected in each paddock randomly, and the top plant parts over 30cm above ground were harvested, oven-dried and ground for chemical analysis: the content of N, Ca, Mg, P, K, Na, Fe, Mn, Zn, and Cu were measured in the forage samples.

Results and Discussion

The average value of total biomass (plant top + existing litter) during the experimental period in PM-SO was significantly higher than that in PM-MI (Table 1). Forage yield, litter decomposition and total dry matter production of PM-SO were much higher than that of PM-MI, however the differences were not significant, because of the large variance among the cages within the same paddock.

Between the treatments, there was no significant difference in macro and micro nutrient content in the top part of the plant, except for nitrogen and copper content (Table2). Both in May and September of 1998, the nitrogen content of the plant tops in PM-SO was significantly higher than that in PM-MI. Moreover, the copper content in PM-MI was much less than that in PM-SO, and the difference in September was significant. Since it is well known that both copper and nitrogen closely influence the photosynthesis rate of higher plants (Ishii 1992, Tino and Kobata 1992), it is considered that the shortage of these elements restricted the growth of PM in the PM-MI pastures.

Although we could not determine the reason for the nitrogen and copper shortage on the PM-MI pasture, the following reasons of the nitrogen shortage are possible: (1) difference in soybean yield, (2) animal excreta losses during the winter grazing period on the millet, and (3) immobilization of nitrogen due to millet cultivation.

In farming practice, the use of *Panicum maximum* in a crop-pasture rotation is common, and the crop sequence of PM-MI will be more rational than PM-SO from the point of view of economic profit and weed management. To develop sustainable agropastoral systems, the mineral deficiency problem in the PM-MI pasture needs to be overcome. It is thought that the use of species other than *Panicum maximum* (such as *Brachiaria* with less external N requirements) could be another option to establish a sustainable agropastoral system (Spain et.al. 1996).

References

Ishii, R. (1992). Concentration of nitrogen compounds in plant leaf. Pages 85-86. In S.Miyati ed. Plant physiology. Vol.1. Photosynthesis. Asakura Shoten Ltd. Tokyo, Japan.

Kichel, A.N., Miranda C.H.B. and Macedo M.C. (1996). Conventional and multiple cropping systems of upland rice for reclamation of degraded *Brachiaria decumbens* pastures. Proc. 8th Cerrado Symposium. EMBRAPA-CPAC, Brasilia-DF, Brazil, pp.443-445..

Macedo, M.C.M. (1995). Pastagens no ecossistema Cerrados: Pesquisa para o desenvolvimento sutentavel. Proc. Symposium of Pasture ecosystem in Brazil. (32nd Ann. Mtg. Brazilian Zootechny Association), Brasilia-DF, Brazil. pp.28-62.

Macedo, M.C.M. and Zimmer A.H. (1993). Sistema pasto-lavoura e seus efeito na produtividade agropecaria. Proc. of 2nd Symposium of Pasture Ecosystem. FUNEP, Jaboticabal, Brazil, pp.216-245.

Spain, J.M., Ayarza M.A. and Vilela L. (1996). Crop pasture rotation in the Brazilian Cerrados. Proc. 8th Cerrado symposium. EMBRAPA-CPAC, Brasilia-DF, Brazil, pp.39-45.

Thomas, R.J. and Asakawa N.M. (1993). Decomposition of leaf litter from tropical forage grass and legumes. Soil Biology and Biochemistry, **25:**(10), 1351-1361.

Tino, M. and Kobata H. (1992). Physiological action of microelements. In M.Tino ed. Plant physiology. Vol.5. Transportation and reserve of substances. Asakura Shoten Ltd. Tokyo Japan, 110-127.

Vera, R.R., Thomas R.J., Sanint L. and Sanz J.I. (1992). Development of sustainable ley-farming systems for the acid-soil savannas of tropical America. An.Acad.Bras.Cienc. **64** (Suppl.) 1: 105-125.

Table 1 - Average biomass and Dry matter production of *Panicum maximum* pastures established of 4 years of soybean cultivation and soybean + millet cultivation

Treatment	Average biomass (DM t/ha)	Dry matter production (DM t/ha)		
		Forage production	Litter decomposition	Total
After 4 years of soybean	12.73 a	13.59	6.51	20.10
After 4 years of soybean + millet	9.00 b	7.29	5.28	12.55
Mean	10.88	10.43	5.90	16.32
LSD 5%	1.03	ns	ns	ns

Note: Means with the same letters are not significantly different, according to Tukey Studentized Range Test.

Table 2 - Nitrogen and Copper content of the top part of the plant of *Panicum maximum* pastures established after 4 years of soybean cultivation and soybean + millet cultivation

Treatment	N content (%)		Cu (mg/kg)	
	May-98	Sep-98	May-98	Sep-98
After 4 years of soybean	2.01 a	1.83 a	6.60	6.40 a
After 4 years of soybean + millet	1.47 b	1.15 b	4.80	4.30 b
Mean	1.74	1.49	5.70	5.35
LSD 5%	0.19	0.10	ns	0.06

Note: Means with the same letters are not significantly different, according to Tukey Studentized Range Test.