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M. R. Correa
Fundação de Apoio a Pesquisa Agropecuária e Ambiental, Brazil

Tsutomu Kanno
Japan International Research Center for Agricultural Sciences, Japan

Manuel C. M. Macedo
EMBRAPA, Brazil

J. D. G. Santos Junior
Fundação de Apoio a Pesquisa Agropecuária e Ambiental, Brazil

L. G. Beretta
Fundação de Apoio a Pesquisa Agropecuária e Ambiental, Brazil

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EFFECTS OF FERTILIZATION AND LEGUME INTRODUCTION ON THE FORAGE PRODUCTION OF *Brachiaria decumbens* PASTURES

M.R. Correa[1], T. Kanno[2], M.C.M. Macedo[3], J.D.G. Santos Junior[1] and L.G. Beretta[1]

[1] FUNDAPAM, BR 262, km 04, Campo Grande-MS, Brasil, 79002-970. [2] Japan International Research Center for Agricultural Sciences, Owashi, Tsukuba, 305-8686, Japan. [3] EMBRAPA - CNPGC, CNPq researcher, BR 262, km 04, Campo Grande-MS, Brasil, 79002-970.

Abstract

A grazing experiment was conducted to examine the effects of P and K fertilization and legume introduction on the forage production of *Brachiaria decumbens* (BD) pastures. Amount of biomass, dry matter production and forage quality were evaluated on BD pastures where three treatments were applied: without maintenance fertilizer (BD-N), with maintenance fertilizer (BD-F), and BD and *Stylosanthes guianensis* cv. Mineirao (SG) mixture with maintenance fertilizer (BD-FL). The fertilizer application increased an annual average of biomass and the contents of P and K in the leaves. On the other hand, the legume introduction had a positive influence on crude protein and digestibility, and the effect was obvious in the rainy season. The introduction of legume also increased litter decomposition constants, although the difference in the constants among the treatments was not significant.

Keywords: *Brachiaria decumbens*, crude protein, digestibility, phosphorous, potassium, *Stylosanthes guianensis*

Introduction

An important reason for pasture degradation in the Cerrado region is exhaustion of

soil fertility as a result of extensive pasture utilization. Lack of available phosphorus in the soil is a major restriction of forage production in the Cerrado region, because of the high P fixation capacity of the soils (Macedo *et al.*, 1993). Moreover, the concentration of soil available K is frequently low, and K can be run off easily in the heavy rains. Therefore, a minimum input of P and K seems to be necessary for sustainable grassland management in the Cerrado region. On the other hand, comparing with P or K, occasional application of N has only temporary benefits. Regular N application may be limited by economical constraints. Thus, the introduction of N_2 fixing forage legumes may be more practical and economic than fertilizer application, to maintain pasture productivity.

The understanding of the effects of fertilizer and the introduction of legumes is very important to optimize the fertilizer application and to develop rational pasture management. For that reason, the effects of the P and K fertilizer and the introduction of legumes on forage production and forage quality in *Bachiaria decumbens* pastures were examined in this study.

Material and Methods

An experiment was conducted at the National Beef Cattle Research Center, of the Brazilian Agricultural Research Corporation (EMBRAPA Gado de Corte) in Campo Grande, Mato Grosso do Sul State, Brazil. The pastures examined were *Brachiaria decumbens* (BD) pasture with no maintenance fertilizer applied (BD-N), with maintenance fertilizer applied (BD-F), and introduction of *Stylosanthes guianensis* cv. Minerao (SG) and maintenance fertilizer applied (BD-FL). Pastures were established in December 1993. Prior to their establishment, the experimental areas were limed with 3.0 t/ha of dolomite limestone, and fertilized with 80 kg/ha of P_2O_5 and 300 kg/ha of fertilizer (N- P_2O_5 -K_2O: 0-20-20). BD was sown at a seeding rate of 2.5 kg/ha, in 0.7 ha plots in a randomized block with two replicates, and SG was sown at 2.0 kg/ha, only in the BD-FL plots.

Since 2 June 1994, the experimental plots were grazed continuously by 2-4 nelore steers (average initial weight of 200 kg). In both BD-F and BD-FL, 400 kg/ha and 380 kg/ha of fertilizer (N- P_2O_5 -K_2O: 0-20-20) was applied at the beginning of the rainy season of 1995 and 1997, respectively.

For 336 days (from 24 Dec. 1997 until 25 Nov. 1998), forage yield and litter decomposition was estimated with the movable cage method and the litter bag method, respectively. Five 1.0m^2 cages were located in each plot at random. At six-week interval, 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, a 0.0625m^2 quadrate was set and plant litter samples were collected.

Herbage samples were hand-separated into leaves, stems and dead parts of BD, SG and weeds, then oven-dried at 65°C. Litter samples were washed, using a 2.0mm sieve, and oven-dried at 65°C. The litter samples collected from same plot were gathered and mixed to make 5 litter bags for each plot: 3g of dried litter was placed in a nylon bag (15 x 15 cm with a 1.5mm mesh). In each movable cage, one litter bag was placed and replaced at approximately six-week interval. The decomposition constant (k) of litter was calculated based on a single exponential decay function (Thomas and Asakawa, 1993): $X_t = X_0 e^{-kt}$, where X_0 was the initial litter weight in the litter bag of each interval, X_t was the final litter weight in the litter bag, and t was the number of days in six-week interval. Then the quantity of the decomposed litter (LD) was estimated for each interval with the following equation: $LD=((L_0+L_t)/2).k.t$, where L_0 was the litter weight on the experimental plot at the beginning of the interval, and L_t was the litter weight at the end of the interval.

In May and September of 1998 and February of 1999, leaf samples (approximately 300g of fresh weight) were harvested from the experimental plots. In each plot, tillers of BD were randomly selected, and the third newest leaves of the tillers were harvested: the contents

of P and K of the leaves were analysed by methods described by Sarruge and Haag (1974). The contents of crude protein and *in vitro* organic matter digestibility were estimated, using a Near Infra Red Analyzer (NIRSystems Ltd., TR3700-C). Analysis of variance was calculated with the SAS Computer Program (SAS/STAT, 1993).

Results and Discussion

Annual average of biomass (plant tops + litter) was significantly increased by fertilizer application, although the difference between BD-F and BD-FL was not significant (Table 1). Fertilizer application and the introduction of SG much improved forage production and total dry matter production, although their differences among the treatments were not significant.

The decomposition constant (k) of litter was, on average, 0.0078 and 0.0029 g/g/day, in the rainy season and the dry season, respectively. The annual average of the decomposition constant was 0.0051, 0.0052 and 0.0058 g/g/day, in BD-N, BD-L and BD-FL, respectively, and the difference was not significant. Litter decomposition increased from 5.8 h/ha in BD-N to 7.3 t/ha, on average, for BD-F and BD-FL (Table 1). Since the decomposition constant of litter was not affected by fertilizer application, the increase in litter decomposition was not induced by an increase of the litter decomposition rate, but rather by an increase of existing litter caused by the fertilizer application. Ninety percent of the annual amount of litter decomposition occurred during the rainy season.

Crude protein (CP) and *in vitro* organic matter digestibility (IVOMD) in BD-FL was higher than in BD-N or BD-F in the rainy season (Table 2), although this effect of legume introduction on the crude protein and digestibility was not observed in the dry season. Moreover, fertilizer application improved the P and K contents of the leaves, but the difference was significant only in February of 1999. All of the nutritive values such as CP, IVOMD, and P and K contents of *Brachiaria decumbens* declined during the dry season, and

this seasonal change of the nutritive values was also observed by Euclides *et al*. (1996) and Macedo *et al*. (1993). It is concluded that the fertilizer application improves the annual average of biomass and the contents of P and K in the leaves, and that the legume introduction has a positive effect on crude protein and digestibility. However, the decline of forage productivity and forage quality during the dry season was inevitable, in spite of the utilization of the fertilizer and the legume.

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Table 1 - Annual average of biomass and annual dry matter production of *Brachiaria decumbens* pastures with three treatments

Treatment	Annual average of biomass (DM t/ha)			Annual dry matter production (DM t/ha)		
	Plant top	Litter	Total	Forage production	Litter decomp.[2]	Total
BD without fertilizer	5.4 b[1]	2.8 b	8.1 b	8.8	5.8	14.6
BD with fertilizer	6.2 a	3.5 a	9.7 a	9.6	8.0	17.6
BD with fertilizer + legume	6.3 a	3.2 ab	9.5 a	13.1	6.6	19.7
Mean	6.0	3.1	9.1	10.5	6.8	17.3
LSD	0.6	0.5	0.7	ns	ns	ns

1 Values followed by same letters within columns are not significantly different at P=0.05, using the Tukey test.
2 Litter decomposition

Table 2 - Crude protein (CP), in vitro organic matter digestibility (IVOMD), P and K contents in the leaves of *Brachiaria decumbens* pastures with three treatments

Treatment	CP (%)			IVDMD (%)		
	May/98	Sep/98	Feb/99	May/98	Sep/98	Feb/99
BD without fertilizer	13.2	9.4	10.4 b[1]	60.3	58.8	55.3
BD with fertilizer	12.8	9.8	10.8 b	59.9	57.7	56.5
BD with fertilizer + legume	15.1	8.1	15.7 a	62.6	55.8	65.7
Mean	13.7	9.1	13.3	61.0	57.5	59.2
LSD	ns	ns	1.9	Ns	ns	ns
	P (%)			K(%)		
	May/98	Sep/98	Feb/99	May/98	Sep/98	Feb/99
BD without fertilizer	0.17	0.12	0.16b	1.48	1.38	1.34c
BD with fertilizer	0.20	0.17	0.20b	1.75	1.73	1.81b
BD with fertilizer +legume	0.20	0.12	0.25a	1.91	1.40	2.11a
Mean	0.19	0.13	0.20	1.71	1.50	1.75
LSD	ns	ns	0.04	Ns	ns	0.17

1 Values followed by same letters within columns are not significantly different at P=0.05, using the Tukey test.