Herbage mass, forage accumulation and nutritive value of *Brachiaria decumbens* in a silvopastoral system

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Introduction

The use of silvopastoral systems has been suggested to ensure sustainability in animal production systems because of their potential to increase soil fertility, improve forage quality, promote animal thermal comfort and provide income diversification for the producer (Paciullo *et al.* 2011). Nevertheless, the shade provided by trees may affect plant growth and nutritive value of forage (Sousa *et al.* 2010).

This study aimed to assess the impact of shading on the allocation pattern of dry matter and on herbage nutritive value, under various shading regimes, in a silvopastoral system, during both the dry and rainy seasons.

Methods

The experiment was carried out at the Embrapa Dairy Cattle Research Centre, in Juiz de Fora, Minas Gerais State, Brazil. The municipality's geographical coordinates are 21°41'20'' latitude south, 43°20'40'' longitude west and 678 m mean altitude. The Köppen classification for the regional climate is type Cwa (mesothermal). The average monthly rainfall is 60 mm and mean air temperature of 17°C from April to September, and 230 mm and 24°C from October to March. The trial was conducted in the dry and rainy seasons, in a randomized block design with three treatments (full sun, 30 and 60% of shading) and four replications. The assessments were made in a 4-ha silvopastoral system that was established in November 1997. The area has a mountainous topography, and the plots were composed of *Brachiaria decumbens* cv. Basilisk grass intercropped by the *Acacia mangium* and *Eucalyptus grandis* arboreal species measuring about 14 and 22 m in height, respectively. The trees were arranged in 10 m-wide strips, each strip included 3 × 3 m spaced rows. The distance between two ranks of trees was 30 m. The area were managed with Holstein × Zebu heifers (live body weight of 250 kg), in a rotational stocking management, with seven days of grazing and 35 days of rest period. Photosynthetically active radiation measurements were made bimonthly using a LP 80 model Decagon ceptometer. The herbage mass (HM) and forage accumulation (FA) were estimated for each grazing cycle from the cuts made before and after grazing. Samples of the root system were collected with a 10 cm diameter and 100 cm high steel cylindrical soil sampler. The pasture shoot/root ratio was calculated as the relation between herbage mass and the root mass. The dried samples were submitted to analysis for the determination of crude protein content (CP) (AOAC, 1980) and neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin (Van Soest *et al.* 1991). Variance analysis was performed using the MIXED procedure of the SAS® statistical package, considering the effects of systems and season of the year (dry and rainy) as fixed effects and the experimental error as random effect. The estimated averages through the LSMEANS option were compared by the Tukey test with a probability level of 5%.

Results

The HM and FA varied ($P \leq 0.05$) according to season and shading (Table 1). The highest values for both variables were obtained in the rainy season due to the optimal growth supported by climatic conditions. The values reduced at the sites with the highest percentage of shade (60% under tree canopy), which is consistent with other studies that showed reduced grass growth above 35-40% shade (Guenni *et al.* 2008; Paciullo *et al.* 2011). On the other hand, the FA and HM was similar in full sun and 30% shading. Shade percentages up to 30-35% do not affect grass growth, when the forage specie is moderately tolerant to shade (Sousa *et al.* 2010). The root density was greater ($P \leq 0.05$) in the rainy season compared to the dry season, as well as in full sun condition (Table 1). Plants under shade usually modify their biomass allocation pattern, favoring the production of the aerial parts compared to roots, to maximize sunlight exposure under limited radiation conditions (Guenni *et al.* 2008). The most significant decrease of root mass in relation to the aerial parts of the plant was reflected in the higher shoot/root ratio for plants growing under shading conditions, in relation to those plants growing under full sun (Table 1). The CP content was higher ($P \leq 0.05$) in the rainy season and increased with shading (Table 2).

Table 1. Herbage mass (kg/ha of dry matter), forage accumulation (kg/ha/day of dry matter), root density (g/dm^3) and shoot/root ratio of *B. decumbens* swards, according to the season of the year and shading.

Dry mass	Season		Shading (%)		
	Dry	Rainy	0	30	60
Herbage mass	526 b	1496 a	1103 a	1194 a	813 b
Forage accumulation	13.1 b	36.4 a	29.1 a	29.4 a	18.4 b
Root density	0.30 b	0.52 a	0.58 a	0.31 b	0.34 b
Shoot/root	1.33 a	0.57 b	0.64 b	1.21 a	1.00 a

Means followed by the same lower case letter in rows for either season of the year or shading are not different ($P > 0.05$).

Table 2. Chemical composition (% of dry matter) in *Brachiaria decumbens* pasture, according to season of the year and shading.

Characteristic	Season		Shading (%)		
	Dry	Rainy	0	30	60
Crude protein	7.4 b	8.9 a	6.5 c	7.6 b	9.8 a
Neutral detergent fiber	75.6	74.8 a	76.2 a	74.7 a	75.5 a
Acid detergent fiber	45.3 a	45.9 a	44.9 a	46.8 a	45.2 a
Lignin	5.7 a	5.1 a	5.0 a	5.3 a	5.8 a

Means followed by the same lower case letter in rows for either season of the year or shading are not different ($P > 0.05$).

The highest CP would be associated with an increased flow of nitrogen in the soil, especially when the tree component consists of legume (Sousa *et al.* 2010). The NDF, ADF and lignin contents did not varied ($P>0.05$) with treatments (Table 2).

Conclusion

The shading modifies the biomass allocation of *B. decumbens*, which is characterized by the priority of forming shoots at the expense of the root system. This allocation pattern may increase pasture vulnerability to environmental stresses that depend heavily on root system for regrowth. For this reason, the use of tree density that promotes intense shading should be avoided. The use of moderate shading is recommended as it does not alter forage production and may increases the crude protein content of the pasture, in relation to pasture under full sun.

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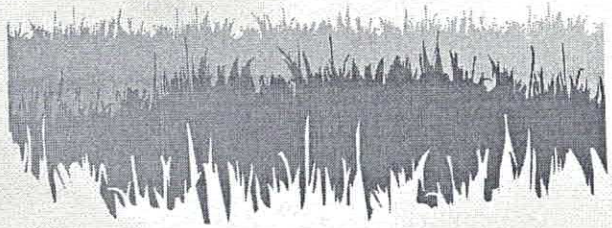

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