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Doses and Sources of Nitrogen in Two Forage Cultivars on the Dry Season

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Abstract

Nitrogen fertilization is an essential practice for the increase in biomass of forage, reducing the seasonality of production throughout the year. Thus, the objective was to evaluate the green and dry matter accumulation of more sheaths leaf blades and stems of *Brachiaria* cultivars in the dry season. The experiment was conducted from May to October 2014, at the State University of Mato Grosso, Brazil, in an area of 1.500 m^2. The experimental design was a randomized block design with three replications. The treatments were characterized by factorial 2 x 2 x 5, two forage (cv. Marandu and Mulato II), two N sources (urea and ammonium sulphate) and five doses of N (0, 50, 100, 150 and 200 kg ha^{-1}). Nitrogen fertilization affected the productive characteristics of forages, with greater accumulation of biomass at a dose of 200 ha^{-1} kg N. The nitrogen sources and forage influenced to a greater magnitude green mass production and dry stalks.

Keywords: Ammonium sulphate, *Brachiaria*, Marandu, Mulato II, urea

1. Introduction

Brazil has the largest commercial cattle herd in the world. However, the country's productivity is still low, with stocking rates below 0.8 animal units (USDA, 2015). This situation is directly associated with the degradation of areas, which was caused by inadequate grazing management practices, absence of periodic fertilization, failures in the establishment of pasture and biotic problems (Dias-Filho, 2011).

Nitrogen fertilization among the nutrients used to replenish the fertility of pasture soils has been an important practice to increase the production of forage, especially in intensively managed areas, because nitrogen is the nutrient most extracted by forages (Rosado et al., 2014; Freitas et al., 2011).

The application of nitrogen to haul at the end of the rainy season can assist ranchers in the production of quality forage in the months of low rainfall, where pasture tends to reduce the accumulation of green and dry biomass. The seasonality reduction of dry matter production according to Costa et al. (2013) and Freire et al. (2012) can be performed with the application of nitrogen in late summer and/or early autumn.

Among nitrogen fertilizers, urea and ammonium sulphate are the most commercialized and applied to pastures in Brazil, with urea being the most used source, due to the lower cost per kg of nitrogen, however, when applied on the surface, N losses volatilization are high, limiting the fertilizer effect (Rosado et al., 2014). In turn, ammonium sulphate has lower losses of N when applied to acidic soils, in addition to providing sulfur for forages (Teixeira Filho et al., 2010).

Another important factor is the choice of grass, which responds differently to nitrogen in relation to production and nutritional value. Among the various tropical species, the grasses of the genus Brachiaria have stood out for their productivity and ability to adapt to different environmental conditions and pasture management (Cruz, 2010). Marandu grass is the cultivar used on a larger scale in the areas, however, the Mulato II cultivar has been attracting interest from the productive sector (Valle et al., 2014; Leal, 2014).

Thus, the genus Braquiaria occupy extensive areas in the production of forage for Brazilian livestock. Recently, research companies presented this new option for the production system: Brachiaria Hibrida cv. Mulato II; a tetraploid hybrid, that the result of three generations of crosses and selection (Teixeira et al., 2018). This species, compared to the Marandu forage, has been identified as a plant that stands out for its productivity, adaptability and ability to tolerate diseases and pests that attack other species of the genus Brachiaria (Ramos and Vital, 2016; Pereira et al., 2017). Thus, it is important to study the response of this plant to nitrogen fertilization in periods of prolonged drought, when compared to the most used species of the genus Brachiaria (Teixeira, 2016).

Despite being a widely cultivated species, Brachiaria Hibrida cv. Mulato II has few research results in environmental conditions in the Amazon. Some research indicates that the forage has a high potential for productivity (up to 27 t.ha-1.year of dry matter), with very good development at different altitudes and levels of precipitation. In addition, the species adapts well to low fertility acid soils with high aluminum rates (Marques et al., 2017).

Therefore, the objective was to evaluate the effect of the application of nitrogen sources and doses in forages of the genus *Brachiaria* cv. Marandu and Mulato II in the dry season, in the northern region of the State of Mato Grosso, belonging to the Southern Amazon, Brazil.

2. Material and Methods

2.1 Study Site

The experiment was conducted from May to October 2014, at the Mato Grosso State

University, Campus de Alta Floresta-MT, Brazil. The municipality is characterized by a rainy tropical climate (type Am) according to Köppen, with two well-defined climatic seasons, with an annual precipitation of up to 3,100 mm, with an average of 2,950 mm (Alvares et al., 2014).

The area used for grazing was 1,500 m^2, divided into three blocks of 500 m^2, with individual plots of 25 m^2. The pasture was already established for more than 2 years, with high forage production.

The soil was classified as a dystrophic Red-Yellow Latosol (Embrapa, 2013), with a sandy clay texture, whose average chemical characteristics, at a depth of 0.00-0.20 m, are shown in Table 1.

Table 1. Chemical and soil granulometric characteristics of the experimental area in depth 0.00-0.20 m

pH	pH	P[1]	S	K^+	Ca^{2+}	Mg^{2+}	Al^{3+}	H^+	M.O.
H_2O	$CaCl_2$	mg dm^{-3}		-------------------cmol$_c$ dm^{-3}------------------					g dm^{-3}
5.50	4.60	2.00	9.60	0.17	2.26	0.60	0.03	2.97	20.00
SB	T	V	M				Sand	Silt	Clay
cmol$_c$ dm^{-3}		-------%------						g kg^{-1}	
3.00	6.00	50.2	1.00				453.00	101.00	446.00

Plante Certo Laboratory, Várzea Grande-MT, Brazil. 2015. EMBRAPA method of soil analysis.
[1] Mehlich^{-1} method.

2.2 Experimental Design and Treatments

The experimental design used was randomized blocks in a 2x2x5 factorial scheme, with three replications each. The treatments consisted of two forages (*Brachiaria brizantha* cv. Marandu and *Brachiaria hibrida* Mulato II "Convert*HD 364"), two nitrogen sources (urea and ammonium sulphate) and five doses of nitrogen (0; 50; 100; 150 and 200 kg ha^{-1}).

Maintenance fertilization was carried out in early May, with application of 50 kg ha^{-1} of P_2O_5 and two installments of 50 kg ha^{-1} of K_2O each (Cantarutti et al., 1999), using as sources: super simple phosphate and potassium chloride, making 33 kg ha^{-1} of S available through the phosphorus source, an amount higher than that recommended by Rein and Sousa (2004) when the sulfur content is 5-9 mg dm^{-3}. Nitrogen fertilization was applied to haulage without parceling, immediately after the uniformity cut of the total area carried out in May.

2.3 Evaluations

To determine the productivity of green and dry matter, the material was collected when the forage plants had grazing height of approximately 0.30 meters from the soil. Three samples per plot were collected using a 0.50x0.50 m iron square and cut with scissors at a height of 0.15 m from the soil surface. At the end of each assessment, the uniform cut of all plots assessed at the same time was carried out, with the residue of grass removed from the area.

The material collected in the field was separated into leaf and stalk (stalk + sheaths) and packed in paper bags, where it was weighed to determine green mass. Subsequently, the samples were placed in an oven with forced air ventilation, with temperatures between 60 and 65 °C, for 72 hours, to obtain the dry mass. The production of total green mass (MVT) and total dry mass (MST) of the treatments were obtained by the accumulated sum of the production of MV and MS of leaves and stems in each cut during the dry season.

Information on climatic conditions during the period in which the experiment was conducted was obtained by the meteorological station at the of the Mato Grosso State University, located next to the experimental area, the results of which were shown in Figure 1.

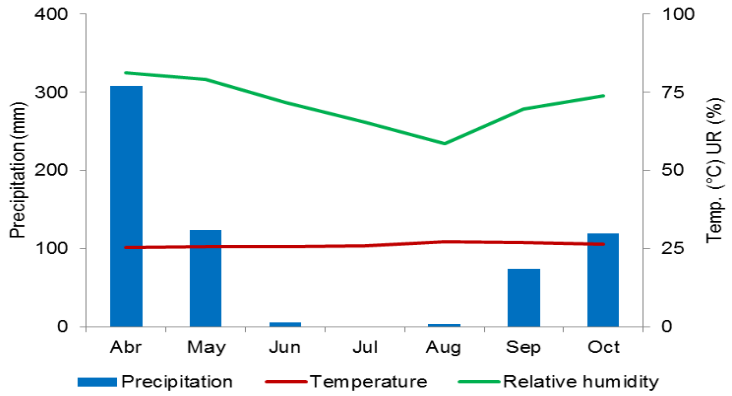

Figure 1. Average monthly values of temperature, relative humidity and monthly precipitation from May to October 2014 in Alta Floresta, MT, Brazil

2.4 Statistical Analysis

The data obtained were subjected to analysis of variance and F test. When significant, the sources of nitrogen and forage factors were compared using the Tukey test at 5% probability and for nitrogen doses, the polynomial regression study was performed. For the statistical analysis of the data, the SISVAR statistical program was used (Ferreira, 2011).

3. Results and Discussion

3.1 Green Mass

The production of green leaf mass was influenced by the doses and forages, showing linear adjustments of the regression for both cultivars of Brachiaria (Figure 2). At the maximum nitrogen dose, the production of green leaf mass with Mulato II was 11% higher than Marandu. This can be explained by the hybrid forage being more responsive in high doses of nitrogen.

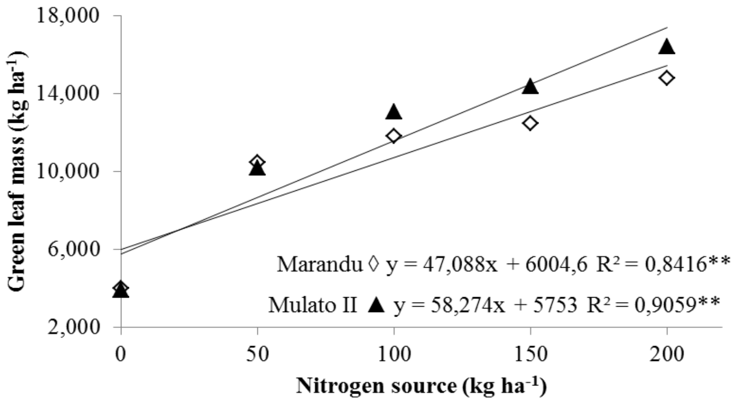

Figure 2. Production of green leaf mass (kg ha^{-1}) of *Brachiaria brizantha* cv. Marandu and *Brachiaria hibrida* cv. Mulato II in relation to nitrogen rates in the dry season

In the production of green stem mass, there was a triple interaction between the forage factors, sources and nitrogen doses, with a linear increase in green mass as the nitrogen doses increased (Figure 3). Thus, it is noted that the cultivar Mulato II has a tendency to lower stalk production, being observed during the experiment a greater number of leaf blades in the same stalk, differently from the morphological characteristics of Marandu. This result corroborates with the characteristic evaluated by Demski (2013), who noticed between January and March a higher leaf: stem ratio of 1.4 in the pre-grazing phase for Mulato II, whereas for Marandu it was 1.1.

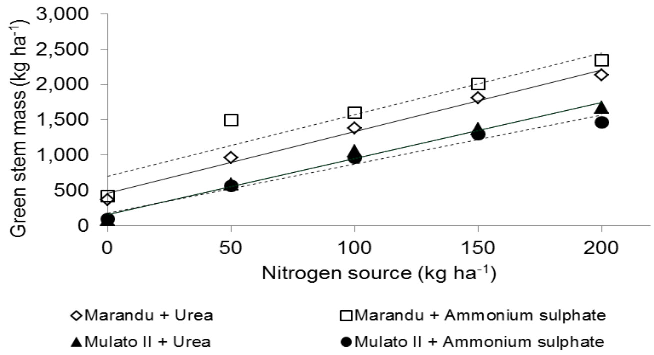

Figure 3. Production of green stems mass (kg ha^{-1}) of forages in relation to the sources and doses of nitrogen in the dry season

Marandu + Urea −◊− $y = 8.75x + 454.6$ $R^2 = 0.9892$**
Marandu + Ammonium sulphate - -□- - $y = 8.736x + 697.4$ $R^2 = 0.898$**
Mulato II + Urea −▲− $y = 7.914x + 160.2$ $R^2 = 0.9851$**
Mulato II + Ammonium sulphate - -●- - $y = 6.938x + 180.2$ $R^2 = 0.9748$**

The application of nitrogen with the use of the ammonium sulphate source provided Marandu grass with greater production of green stem mass when compared to urea. This behavior can be explained by the greater availability of nitrogen in the soil, where the use of ammonium sulphate showed less loss by volatilization, consequently, it allowed greater absorption of the nutrient and conversion into green mass by the plant.

The application of nitrogen in different doses and nitrogen sources for Mulato II grass did not cause a significant difference in the production of green stem mass, except for the maximum dose studied, which provided an increase of 14% with urea.

Total green mass was found to have significant significance for forage and source interactions and forage and nitrogen doses. Regarding the forage response to the sources, it was found that the application of ammonium sulphate caused greater production of total green mass for the cultivar Marandu, with an increase of 6% in relation to urea, however, for Mulato II there was no difference between nitrogen sources (Table 2). The use of urea as a nitrogen source promoted a greater production of total green mass of forage Mulato II in relation to Marandu, differently from what happened with ammonium sulphate.

Table 2. Total green mass production (kg ha^{-1}) of *Brachiaria brizantha* cv. Marandu and *Brachiaria hibrida* cv. Mulato II in relation to nitrogen sources in the dry season

Forage	**Nitrogen sources**	
	Urea	**Ammonium sulphate**
Marandu	11,794 b B	12,534 a A
Mulato II	12,646 a A	12,340 a A
Significant minimum difference	718.88	
CV (%)	7.89	
Standard deviation	251.10	

Averages followed by the same lowercase letter in the row and uppercase in the column, do not differ statistically from each other by the Tukey test at the level of 5% probability.

The increase in nitrogen doses made it possible to increase the total green mass for both forages, however, without significant difference between cultivars, with the exception of the dose of 150 kg ha^{-1} of N (Figure 4). A result similar to that observed by Teodoro (2007), who also did not find any difference between the cultivars of Mulato and Marandu up to the dose of 200 kg ha^{-1} of nitrogen.

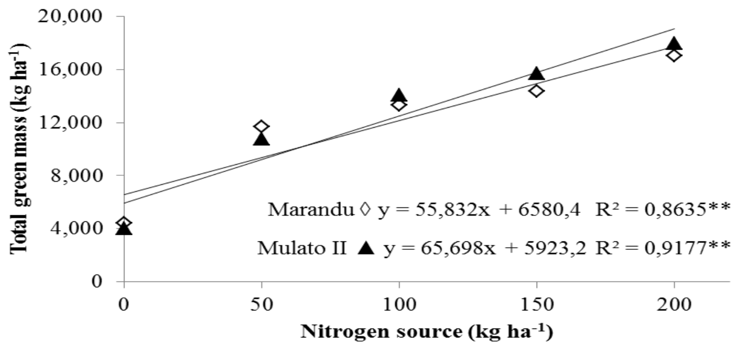

Figure 4. Total green mass production (kg ha^{-1}) of *Brachiaria brizantha* cv. Marandu and *Brachiaria hibrida* cv. Mulato II in relation to nitrogen rates in the dry season

3.2 Dry Mass

The dry mass of leaves was not influenced by forage and sources, however, there was significance only for nitrogen doses. As the nitrogen doses increased, the leaf dry mass showed a linear adjustment in the mass accumulation, providing an increase of 2,903 kg ha^{-1} of mass in relation to the absence of fertilizer application (Figure 5).

This result made evident the effect of nitrogen fertilizer, when applied in adequate quantities and in climatic conditions not favorable to production, as the greater availability of the nutrient allowed greater production of leaf blades, a fundamental organ for the nutritious maintenance of plants.

Some research, including the hybrid Brachiaria cv. Mulato II, show high forage yields and similar to other cultivars of Brachiaria (4.2 t ha^{-1} of dry mass every 8 weeks, during the rainy season). However, production was reduced in the dry season of the year (2.7 t ha^{-1} of dry mass every 12 weeks), even so, the production of dry matter was superior to other species of Brachiaria (Jacovetti, 2016; Silva et al., 2016)

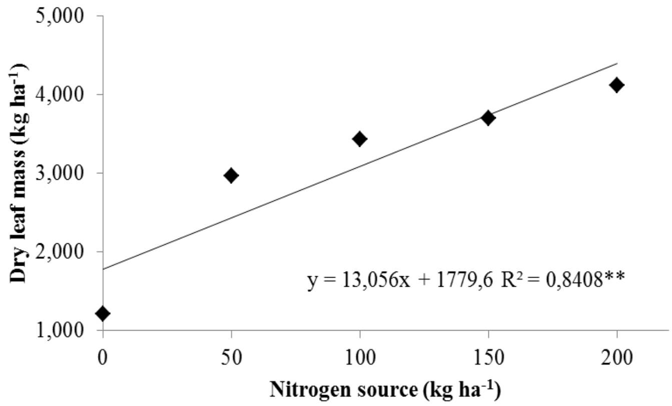

Figure 5. Production of dry leaf mass (kg ha^{-1}) of forage in relation to nitrogen rates in the dry season

The production of dry stem mass was influenced by the interaction of forages, sources and nitrogen doses, behaving similarly to the other variables previously reported, in which the increase in the amount of nitrogen applied resulted in an increase in production. The Marandu + urea forage promoted a higher production of dry stem mass (577 kg ha^{-1}) compared to the other combinations (Figure 6).

This response due to the application of nitrogen, promoting an increase in mass production is due to the fact that fertilizer is the main nutritional component consumed in the maintenance of the production of green and dry mass of grasses, being responsible for the increase of plant size, size of leaves, stems and formation and development of tillers, characteristics that are noticed in the field.

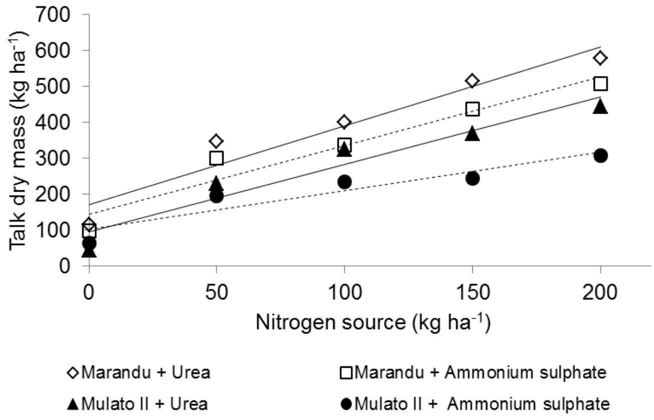

Figure 6. Stalk dry mass production (kg ha^{-1}) of forages in relation to sources and nitrogen rates in the dry season

Marandu + Urea −◊− $y = 2.186x + 171.8$ $R^2 = 0.9316$**
Marandu + Ammonium sulphate - -□- - $y = 1.91x + 144.2$ $R^2 = 0.9378$**
Mulato II + Urea −▲− $y = 1.878x + 94$ $R^2 = 0.9274$**
Mulato II + Ammonium sulphate - -●- - $y = 1.072x + 102$ $R^2 = 0.876$**

The production of total dry mass was not influenced by forages and sources, and the increase in doses up to 200 kg ha^{-1} provided the production of 4,576 kg ha^{-1}, obtaining an increase of 254% in relation to the condition of absence of the nutrient (Figure 7). The nitrogen fertilization carried out at the end of the rainy season provided an increase in dry matter production, thus indicating the importance of this nutrient and its residual effect between the months of May and October, in increasing forage productivity, even in periods of water scarcity. .

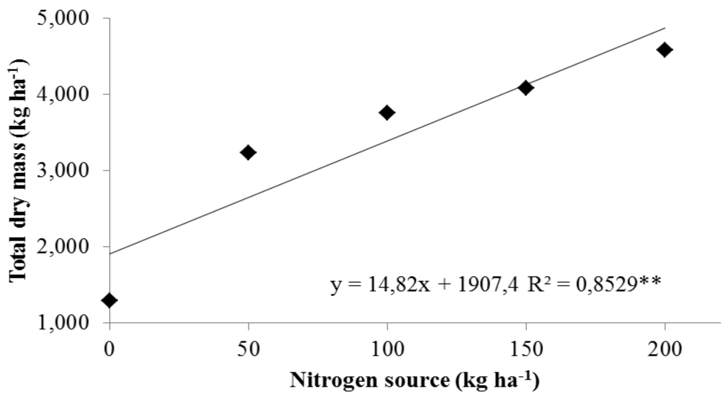

Figure 7. Production of total dry mass (kg ha^{-1}) of forage in relation to nitrogen rates in the dry season

The increase in dry matter production of Xaraés grass in the winter season under nitrogen doses was a reflection of the last nitrogen application to occur in late March, thus demonstrating the importance of carrying out fertilization at the end of the rainy season, to minimize the effect of seasonality of forage production (Costa et al., 2013). Behavior also observed by Mello et al. (2008) who noted an increase in dry matter production in the low precipitation period with the application of 20% nitrogen in the dry period of the year.

4. Conclusion

The highest yields of green and dry leaf and stem mass were found at a dose of 200 kg ha^{-1} of N.

The cultivars Mulato II and Marandu behaved similarly in the production of green and dry leaf and total mass, however, the forage Mulato II showed lower stalk production in relation to Marandu.

The nitrogen sources influenced the magnitude of green and dry stalk masses to a greater extent, since in the dry season nitrogen losses by volatilization are reduced.

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