Revista Eletrônica Interdisciplinar
Barra do Garças – MT, Brasil
Ano: 2024 Volume: 16 Número: 3
ISSN 1984-431X

PRODUCTIVITY OF FORAGES SUBJECTED TO SOURCES AND DOSES OF NITROGEN IN THE DRY SEASON

Soraia Olivastro Teixeira[1]
Marco Antonio Camillo de Carvalho[2]
Gustavo Caione[3]
Anderson de Moura Zanine[4]
Oscar Mitsuo Yamashita[5]

ABSTRACT
The objective of this study was to evaluate the production of two cultivars of the genus *Brachiaria*, submitted to nitrogen sources and doses in the dry season. The experimental design was a randomized complete block in the 2x2x5 factorial scheme. The treatments were composed of two grasses (Marandu and Mulato II), two nitrogen sources (urea and ammonium sulfate) and five nitrogen doses (0, 50, 100, 150 and 200 kg ha^{-1}) in three replicates. Nitrogen fertilizations were carried out on a haul basis and were not parceled out. The leaf green color index, total dry matter yield, foliar nitrogen concentration and percentage of crude protein were evaluated. The application of ammonium sulfate at a dose of 200 kg ha^{-1} promoted the greatest gains in productivity and nutritional values. Application of 150 kg ha^{-1} of ammonium sulfate and 200 kg ha^{-1} of urea provided values greater than 19 g kg^{-1} for leaf nitrogen concentration and doses from 50 kg ha^{-1} N of both sources guaranteed values Higher than 7% for crude protein. The application of nitrogen at the end of the rainy season causes increases in yield and nutritional values important for the maintenance of the grass in the period of low precipitation.
Key words: Ammonium sulfate, *Brachiaria*, Marandu, Mulato II, urea.

PRODUTIVIDADE DE FORRAGEIRAS SUBMETIDAS A FONTES E DOSES DE NITROGÊNIO NO PERÍODO SECO

RESUMO:
O objetivo deste estudo foi avaliar a produção de duas cultivares do gênero Brachiaria, submetidas a fontes e doses de nitrogênio no período seco. O delineamento experimental foi em blocos completos casualizados no esquema fatorial 2x2x5. Os tratamentos foram compostos por duas gramíneas (Marandu e Mulato II), duas fontes de nitrogênio (uréia e sulfato de amônio) e cinco doses de nitrogênio (0, 50, 100, 150 e 200 kg ha^{-1}) em três repetições. As adubações nitrogenadas foram realizadas por lanço e não foram parceladas. Foram avaliados o índice de cor verde foliar, produtividade de matéria seca total, concentração de nitrogênio foliar e percentual de proteína bruta. A aplicação de sulfato de amônio na dose de 200 kg ha^{-1} promoveu os maiores ganhos em produtividade e valores nutricionais. A aplicação de 150 kg ha^{-1} de sulfato de amônio e 200 kg ha^{-1} de uréia proporcionou valores superiores a 19 g kg^{-1} para concentração de nitrogênio foliar e doses a partir de 50 kg ha^{-1} de N de ambas as fontes garantiram valores superiores a 7% para proteína bruta. A aplicação de nitrogênio no final do período chuvoso provoca aumentos na produtividade e nos valores nutricionais importantes para a manutenção do capim no período de baixas precipitações.
Palavras chave: Sulfato de amônio, Brachiaria, Marandu, Mulato II, uréia.

[1] Mestrado em Biodiversidade e Agroecossistemas Amazônicos pela Universidade do Estado de Mato Grosso, Brasil. Professor EBTT do Instituto Federal de Educação Ciência e Tecnologia de Mato Grosso, Brasil soraia_olivastro@hotmail.com
[2]Doutorado em Agronomia (Produção Vegetal) pela Universidade Estadual Paulista Júlio de Mesquita Filho. Professor Adjunto da Universidade do Estado de Mato Grosso, Brasil. marcocarvalho@unemat.br
[3]Doutorado em Agronomia (Produção Vegetal) pela Universidade Estadual Paulista Júlio de Mesquita Filho. Professor Adjunto da Universidade do Estado de Mato Grosso, Brasil. gcaione@unemat.br
[4]Doutorado em Zootecnia pela Universidade Federal de Viçosa, Brasil. Professor Titular da Universidade Federal do Maranhão, Brasil. anderson.zanine@ibest.com.br
[5]Doutorado em Agricultura Tropical pela Universidade Federal de Mato Grosso, Brasil. Professor da Universidade do Estado de Mato Grosso, Brasil. yama@unemat.br

Revista Eletrônica Interdisciplinar
Barra do Garças – MT, Brasil
Ano: 2024 Volume: 16 Número: 3
ISSN 1984-431X

1. INTRODUCTION

Cattle raising in Brazil is carried out mainly on pastures, predominantly formed by grasses of the genus Brachiaria, which make up 85% of cultivated pastures present in the national territory (VALLE et al., 2014). However, it is estimated that 70% of the pastures are in some degree of degradation and 50% are considered to have a high level of degradation (DIAS-FILHO, 2015).

The degradation situation of grasses reflects on the factors of growth, production, nutritional value and persistence, being aggravated by nutritional deficiency, mainly of nitrogen. Therefore, it is essential to rebuild soil fertility, which over the years has been decreasing due to intensive exploitation and incorrect pasture management. Thus, it is necessary to revert to the current situation of Brazilian pastures, to reach adequate levels of biomass production and achieve sustainable management for livestock activity (COSTA et al., 2009).

Thus, nitrogen fertilization is essential to keep grass plants productive, since this nutrient accelerates the formation and growth of new leaf blades, increases pasture regrowth and contributes to improving plant recovery after cutting.

One of the fundamental aspects in the management of fertilization is the nitrogen source, which seeks to reduce losses through ammonia volatilization and nitrate leaching (COSTA et al., 2010). Among the nitrogen fertilizers most commercialized and used in Brazilian pastures are urea and ammonium sulfate, which have the disadvantages, respectively, of greater nitrogen loss by volatilization and soil acidification (PRIMAVESI et al., 2004; MARTHA JÚNIOR et al. al., 2004).

The application of nitrogen in top dressing at the end of the rainy season can help ranchers in the production of forage with high nutritional value during the year, making it possible to maintain the production of meat or milk, especially in the absence of precipitation, a period when the grasses decrease their production and nutritional values. To reduce the seasonality of production Costa et al. (2013) and Freire et al. (2012) recommend applying nitrogen at the end of summer and/or beginning of autumn to increase dry mass production.

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, grasses of the genus Brachiaria have stood out for their dry matter productivity, ease of establishment, adequate nutritional value and ability to adapt to different environmental conditions, including the dry season (COSTA et al., 2005). Marandu grass is the cultivar used on a larger scale in the areas, however, the cultivar Mulato II has been attracting interest in the productive sector.

ISSN 1984-431X

Therefore, the objective was to evaluate the response of Marandu and Mulato II grasses as a function of the supply of nitrogen sources and doses applied at the end of the rainy season.

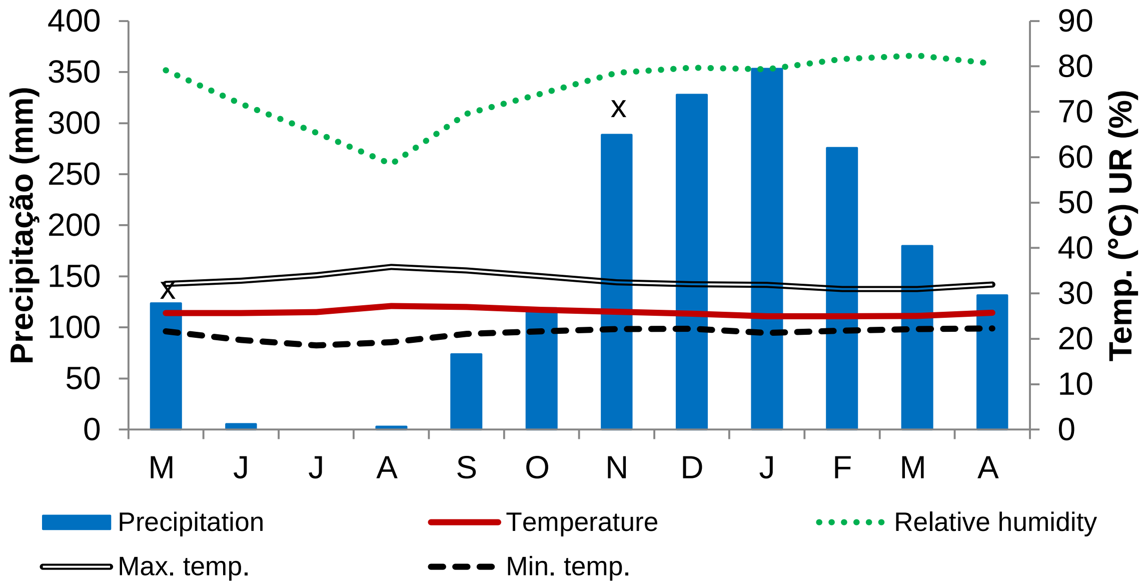
2. MATERIAL AND METHODS

The field experiment was carried out between May and October 2014, in the experimental area of the Universidade do Estado de Mato Grosso – UNEMAT, Campus de Alta Floresta – MT.

The municipality is located at the geographic coordinates of 09°51'42” S and 56°04'07” W, and is characterized by having a tropical rainy climate (Am type) according to Köppen, with two well-defined seasons, and may have annual rainfall. of up to 3,100 mm, with an average of 2,950 mm (ALVARES et al., 2014).

Information on climatic conditions during the period in which the work was carried out was obtained from the meteorological station of the Universidade do Estado de Mato Grosso, located close to the experimental area, and the values are expressed in Figure 1.

Figure 1. Monthly averages of temperatures and relative air humidity and monthly precipitation. x – maintenance and nitrogen fertilization at the beginning of the month.



The area used for the experiment was 1,500 m^2, divided into three blocks of 500 m^2, consisting of individual plots of 5x5 meters (25 m^2). The experimental area was already established with pasture formed two and a half years ago.

The experimental design was randomized blocks in a 2x2x5 factorial scheme, with three

ISSN 1984-431X

replications. The treatments consisted of the combination of two grasses (*Brachiaria brizantha* cv. Marandu and Brachiaria hibrida cv. Mulato II "Convert* HD 364"), two nitrogen sources (urea and ammonium sulfate) and five nitrogen doses (0; 50; 100; 150 and 200 kg ha^{-1}). Nitrogen fertilization was carried out by broadcast near the end of the rainy season, without splitting.

The chemical and granulometric properties of the soil (Table 1) were determined by the Embrapa method and the soil was classified as a dystrophic Red-Yellow Latosol, of clayey-sandy textural class.

Table 1. Means of the results of chemical and granulometric analyzes of the soil in the experimental area at a depth of 0-0.20 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

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

There was no need to carry out liming in the first experiment, as the base saturation was above 45%. Before the application of fertilization, the experimental area was submitted to the uniformization cut of the plants at a height of 0.15 m. Maintenance fertilization was carried out, with application of 100 kg ha^{-1} of K_2O in two installments, in the form of potassium chloride (60% K_2O) and 50 kg ha^{-1} of P_2O_5 in the form of super simple phosphate (18 % P_2O_5, 20% Ca and 12% S), according to the recommendations described by Cantarutti et al. (1999). In this supply, 33 kg ha^{-1} of S was also made available, which is higher than the recommended amount for sulfur contents of 5-9 mg dm^{-3}, according to Rein & Sousa (2004).

During the dry season, the following variables were evaluated: leaf blade green color index, total dry matter, analysis of leaf nitrogen content and crude protein content.

Before each evaluation of the grass, the height of the plants was determined by measuring the distance from the ground level to the apex, in three points of the plot. The value of 0.30 m was considered as the pre-grazing height and 0.15 m post-grazing, allowing the collection of variables. These heights were adopted based on the rotational stocking method. This height management model provided only one cut for treatments with no fertilization and two for the others.

Subsequently, measurements were made of the intensity index of the green color of the

ISSN 1984-431X

leaf blades, determined with the aid of the SPAD 502 MINOLTA chlorophyll meter, always carried out in the late afternoon. The readings were performed in the middle third of the leaf blades located in the mediated region of the plant, collecting data from intact blades in five plants of each experimental plot.

In each plot, three sub-samples of green mass of the grass were collected, using an iron square measuring 0.5 m x 0.5 m (0.25 m^2), and cut at a height of 0.15 m from the surface of the ground. The samples were dried in a forced ventilation oven, at 65 °C, until reaching constant weight, being weighed to obtain the production of total dry mass (kg ha^{-1}).

The sub-samples of each plot were ground in a Willey mill, equipped with a mesh sieve with an opening of 1 mm, thus considering a composite sample. Leaf chemical analysis to determine leaf nitrogen (N) concentration was performed using the Kjeldahl methodology (SILVA, 2009).

In determining the percentage of crude protein, the value of leaf nitrogen concentration (g kg^{-1}) previously found by the Kjeldahl method was multiplied by a conversion factor equal to 6.25, considering that the proportion of N in the plant proteins is equal to 16% (AOAC, 1995).

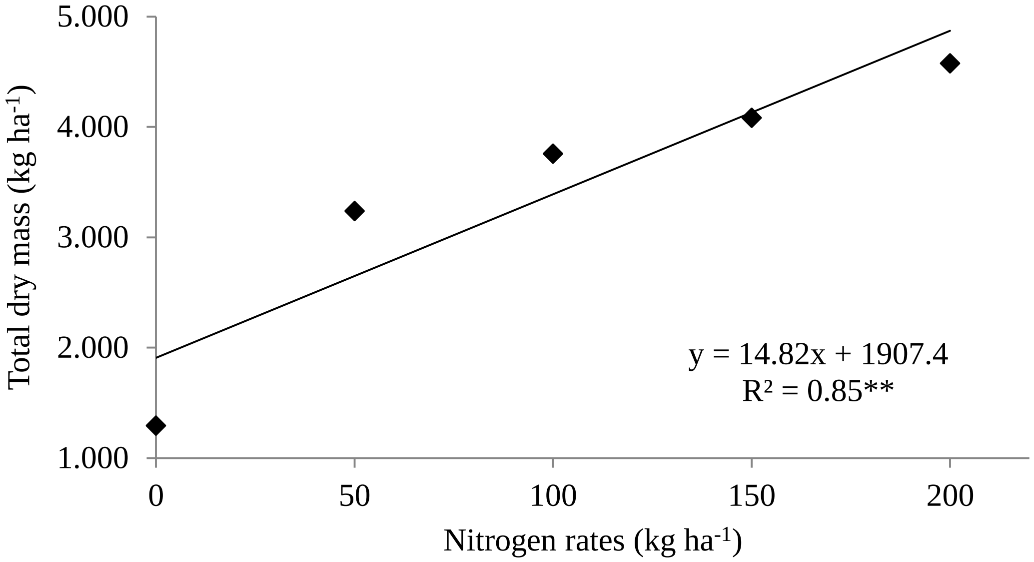
The results referring to the comparison between the Brachiaria cultivars and the nitrogen sources were submitted to analysis of variance and to the F test, adopting the Tukey test at a significance level of 5% of probability. Data referring to nitrogen levels were submitted to regression analysis, and the choice of models was based on the significance of the regression parameters, using SISVAR (FERREIRA, 2011).

3. RESULTS AND DISCUSSION

The total dry mass production was not influenced by cultivars and sources, but showed a response regarding the applied doses. The leaf blade green color index, nitrogen concentration and percentage of crude protein showed source and dose interactions. The nutritional characteristics nitrogen concentration and percentage of crude protein also showed interaction between cultivar and sources.

With the application of 200 kg ha^{-1} of nitrogen, the production of total dry mass reached 4,871 kg ha^{-1}, obtaining an increase of 2,964 kg ha^{-1}, that is, 155% higher when compared to the condition of absence of the nutrient (Figure 2). This behavior is similar for tropical forages where Martha Júnior et al. (2004) reports linear responses up to annual N doses of 400 to 600 kg ha^{-1} $year^{-1}$.

Figure 2. Total dry mass production (kg ha^{-1}) of grass in relation to nitrogen rates.



Nitrogen fertilization performed at the end of the rainy season provided an increase in production, thus indicating the importance of this nutrient, through its positive effect between the months of May and October, in the increase of biomass production. This increase in dry matter production would be enough to increase the stocking capacity by 1.5 AU ha^{-1} with consumption of 10 kg DM day^{-1}, even in periods of water scarcity (Figure 2).

In winter, with water deficit, Costa et al. (2013) observed that Xaraés grass increased the total dry mass and one of the factors that favored the increase in production was the division of nitrogen fertilization, with the last application at the end of March. Thus demonstrating the importance of fertilization at the end of the rainy season, minimizing the effect of seasonality in grass production. The application of 20% of 500 kg ha^{-1} of nitrogen fertilization in the dry period provided the production of 4,346 kg ha^{-1} of dry matter in Mombasa in the low rainfall period according to Mello et al. (2008). These results were similar to the behaviors observed for dry mass production.

To reduce the seasonality of the recurrent production of the greater supply of food in the rainy season compared to the dry season, Freire et al. (2012) recommends performing nitrogen fertilization at the end of summer and/or early autumn to increase dry mass production in the dry season.

The increase in production is due to the influence of nitrogen in the places of plant growth, mainly in the expansion of the aerial part, in the tillering, increase in the mass production of leaf blades and stems. Thus, nitrogen supply is one of the main factors

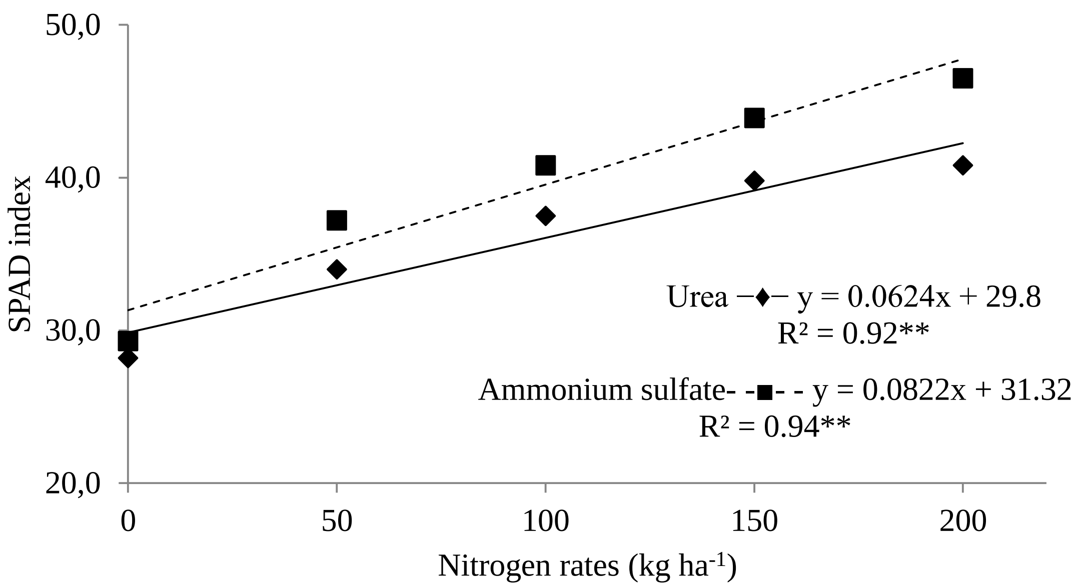
ISSN 1984-431X

controlling growth processes in plants (MARTUSCELLO et al., 2009). However, high doses of nitrogen can promote an increase in the proportion of stems and senescent material, an organ with low digestibility for cattle.

Other factors that may have contributed to the increase in dry mass production are the environmental and climatic factors of the region, which during the evaluation months presented a water regime of 325 mm (Figure 1). These values may be higher than those reported by other authors, thus providing an increase in the production and response of grasses to nitrogen fertilization.

Regardless of the nitrogen source, nitrogen made it possible to increase the intensity of the green color of the leaf blades (Figure 3), since the nutrient directly participates in the synthesis and structuring of chlorophyll molecules. Thus, the increase in nutrient availability to plants, up to a certain limit, promotes an increase in the chlorophyll content and green color intensity of the leaf blades (PÔRTO et al., 2011).

Figure 3. Intensity of leaf blade green color index (SPAD index) in relation to nitrogen sources and doses.



The application of nitrogen in the form of ammonium sulfate promoted an increase in the intensity of the green color of the leaf blades (SPAD index), when compared to urea, regardless of the doses studied. The greater loss of the nutrient from urea, through the volatilization process, caused lower nitrogen availability for the grasses, reflecting in the intensity of the green color, which is directly associated with the nitrogen concentration in the leaf blades.

For Benett et al. (2008), nitrogen sources also influenced the chlorophyll content of

ISSN 1984-431X

Marandu grass plants, and the highest content was observed when ammonium sulfate was applied. This behavior results from the increase in chlorophyll concentration, promoted by the greater availability of nitrogen in plant tissues at high doses. This relationship is attributed to the fact that a large part of the total N of the leaf blade is part of enzymes that are associated with chloroplasts.

For the studied grasses, the highest concentrations of foliar nitrogen were observed with the application of ammonium sulfate, with an increase of 1.34 and 2.86 g N kg^{-1} of dry matter, compared to urea in the grasses of Marandu and Mulato II, respectively (Table 2). Regarding nitrogen sources, the application of urea did not cause any difference between the studied grasses. However, ammonium sulfate provided a higher concentration of the nutrient in the Mulato II grass, with an increase of 11.6% compared to Marandu.

Table 2. Leaf nitrogen concentration (g kg^{-1}) of *Brachiaria brizantha* cv. Marandu and Brachiaria hybrid cv. Mulatto II in relation to nitrogen sources.

Forage	Nitrogen rate	
	Urea	Ammonium sulfate
Marandu	15,42 b A	16,76 a B
Mulato II	15,85 b A	18,71 a A
CV (%)	6,21	

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

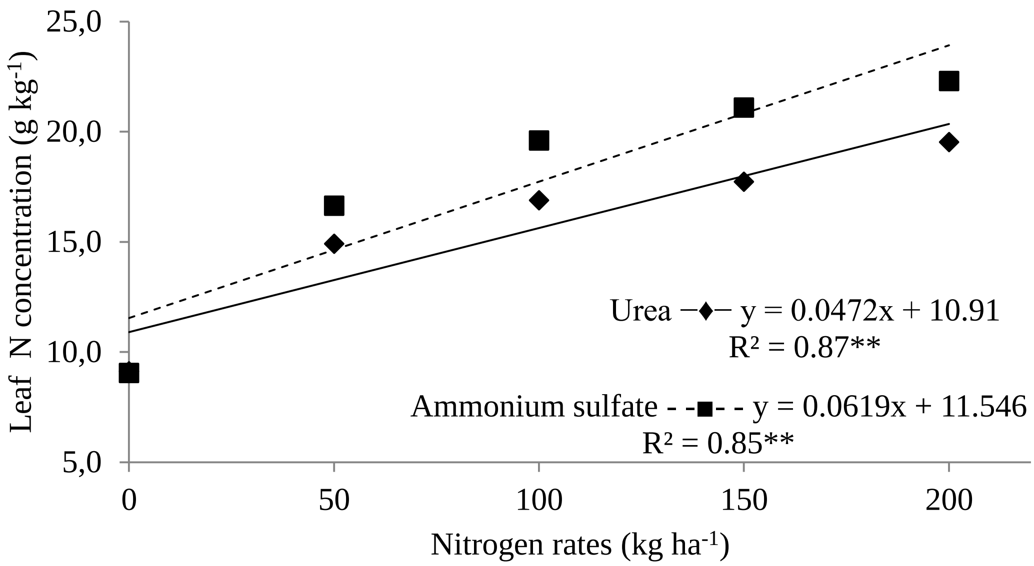
Similarly, Teixeira Filho et al. (2010) found that Entec (ammonium sulfonitrate + nitrification inhibitor – 26% N and 12% S) and ammonium sulfate, used as nitrogen sources, provided higher nitrogen contents in relation to urea, as well as Lourente et al. (2007) who also found a smaller increase in foliar nitrogen content with urea application, compared to the use of ammonium sulfate.

Thus, grasses that provide a higher concentration of nitrogen will consequently have a higher crude protein content which, according to Cabral et al. (2013) is a fundamental component in the maintenance of microorganisms present in the rumen, which digest fibrous carbohydrates and are a source of microbial protein for cattle.

The application of the maximum dose studied allowed an increase of 87 and 107% when compared with the absence of fertilizer use, for urea and ammonium sulfate, respectively (Figure 4).

ISSN 1984-431X

Figure 4. Leaf nitrogen concentration (g kg^{-1}) of grass in relation to nitrogen sources and doses.



The increase in foliar nitrogen content probably occurred because the use of N doses resulted in increases in nitrate and ammonium levels in the soil, culminating in greater availability of the nutrient, since this N is easily absorbed by plants, which causes greater absorption of the nutrient applied to the soil (COSTA et al., 2008).

Thus, the increase in nitrogen in the plant is a result of the increase in the external concentration of the nutrient, where low-affinity carriers are not subject to regulation, which can lead to excess nitrogen in the plant, which is stored in the vacuoles in the form of nitrate. (BREDEMEIER & MUNDSTOCK, 2000).

The concentration of foliar nitrogen, when 200 kg ha^{-1} of nitrogen was applied in the form of urea and 100 kg ha^{-1} N with the application of ammonium sulfate, was 19.5 and 19.6 g kg^{-1}, respectively. These values are above the critical level range of 19 g kg^{-1} for *Brachiaria brizantha* cv. Marandu, established by Schiavuzzo et al. (2000). Therefore, the supply of these doses to the nitrogen sources were sufficient to prevent the grass from suffering this nutrient deficiency, where the lower requirement in the dose of ammonium sulfate may be due to the low loss of the nutrient by the volatilization process.

For Marandu and Mulato II, the highest percentages of crude protein observed were obtained with the application of ammonium sulfate (Table 3). The application of urea at the end of the rainy season showed no significant difference between the studied grasses, with an average crude protein percentage of 9.78%.

ISSN 1984-431X

Table 3. Crude protein percentage of *Brachiaria brizantha* cv. Marandu and Brachiaria hybrid cv. Mulatto II in relation to nitrogen sources.

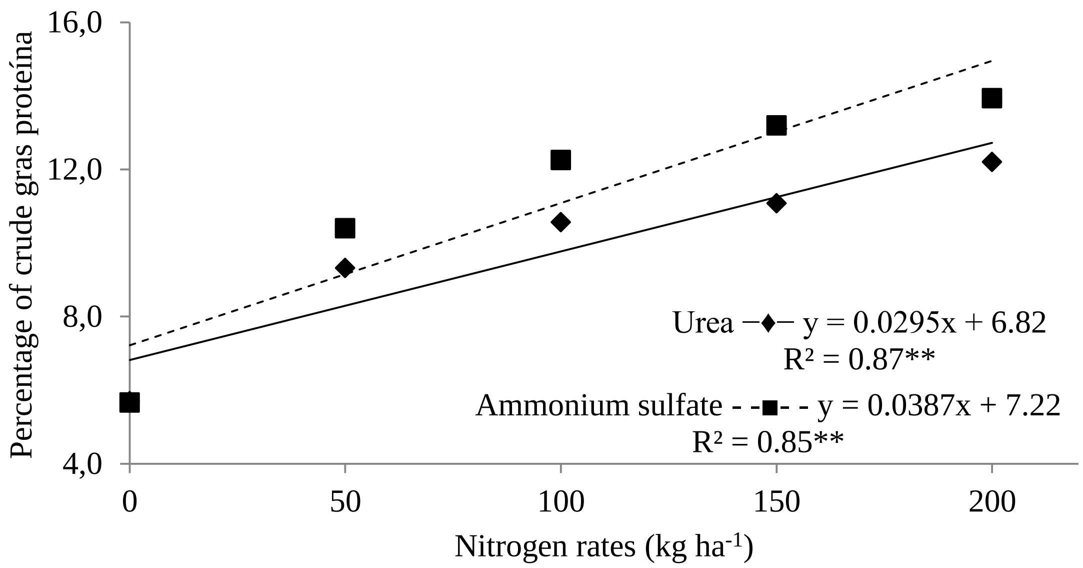
Forage	Nitrogen rates	
	Urea	Ammonium sulfate
Marandu	9,64 b A	10,48 a B
Mulato II	9,91 b A	11,69 a A
CV (%)	6,21	

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

When using ammonium sulfate as a nitrogen source, it can be observed that the percentage of crude protein was higher in Mulato II grass (11.69%) in relation to Marandu grass (10.48%), which indicates a higher nutritive value of the cultivar, which is possibly due to the improved characteristics in relation to cultivars of the genus Brachiaria.

Fertilization with both nitrogen sources increased the percentages of crude protein in the leaf blades, with an increasing linear effect, where at the highest dose the percentages obtained were 12.7 and 15.0% for urea and ammonium sulfate, respectively (Figure 5), this is due to the greater availability of nitrogen in the soil and later the increase in foliar concentration, being the nutrient used for the formation of amino acids and proteins.

Figure 5. Percentage of crude grass protein in relation to nitrogen sources and doses.



ISSN 1984-431X

The results obtained in the present work were superior to those reported by Faria (2010) who, in Xaraés grass, obtained 10% crude protein in the dry season with a higher dose than the one studied (289 kg ha^{-1} N); as well as Oliveira (2008) that signal grass in the dry period found that at the rate of 565 kg ha^{-1} of nitrogen the percentage of crude protein was 13.9%.

It was noted that all treatments presented values close to or greater than 9%, with the exception of the absence of fertilizer application where the averages of crude protein of the blades of 6.82 and 7.22% remained below or close to the critical level of 7%, which is considered in accordance with Costa et al. (2010) limiting for cattle feed.

The low percentage of crude protein is associated with a lower concentration of foliar nitrogen, since the absence of fertilization caused a reduction in the availability of the nutrient in the soil and later in the plants, thus, deficient plants do not present desirable crude protein content, due to lower amino acid synthesis. This makes it necessary at least low applications of nitrogen in the soil, in order to favor the elevation of the nutritional characteristics of the grass, especially in the dry season.

Another factor that may explain the lower percentage of crude protein in the absence and low doses of fertilizer for both sources is the longer period of days elapsed for the grass to reach cutting height in the dry season of the year, where the intervals tended to be wider. mainly for plants that were not fertilized with nitrogen, consequently, the crude protein contents reduced. Differently, this behavior was noticed in treatments with high doses of the nutrient, since the increase in the availability of nitrogen caused the intensification of grass growth, favoring the reduction of the cutting interval and the renewal of aerial organs.

In this way, the temperature and precipitation conditions in the dry season are limiting factors for the development of plants, as they delay the growth and formation of new shoots, consequently, there is the aging of the pasture, thus reducing the nutritional values, since the cut-off interval tends to be greater than that of the rainy season (COSTA et al., 2013). Therefore, as the physiological age of the plant advances, the percentages of cellulose, hemicellulose and lignin increase, unlike the digestible components (soluble carbohydrates, protein, minerals and vitamins), causing a reduction in grass digestibility (COSTA et al., 2007).

4. CONCLUSIONS

1. The maximum dose of 200 kg ha^{-1} applied near the end of the rainy season provided an increasing linear behavior for production and nutritional values.

ISSN 1984-431X

2. Mulato II grass with ammonium sulfate provided the highest concentration of foliar nitrogen and percentage of crude protein.
3. Ammonium sulfate promoted the highest values of green color index of the slides and nutritional values.

5. REFERENCES

ALVARES, C.A.; STAPE, J.L.; SENTELHAS, P.C.; GONÇALVES, J.L.M.; SPAROVEK, G. Köppen's climate classification map for Brazil. **Meteorologische Zeitschrift**, v.22, p. 711–728, 2014.

ASSOCIATION OFFICIAL ANALYTICAL CHEMISTS (AOAC). **Offical methods of analysis**. 16.ed. Arlington: Association of Analytical Communities, 1995. 1025p.

BENETT, C.G.S.; BUZETTI, S.; SILVA, K.S.; BERGAMASCHINE, A.F.; FABRICIO, J.A. Produtividade e composição bromatológica do capim-marandu a fontes e doses de nitrogênio. **Ciência e Agrotecnologia**, v.32, p.1629-1636, 2008.

BREDEMEIER, C.; MUNDSTOCK, C.M. Regulação da absorção e assimilação de nitrogênio nas plantas. **Ciência Rural**, v.30, p.365-372, 2000.

CABRAL, C.E.A.; ABREU, J.G.; BONFIM-SILVA, E.M.; CABRAL, C.H.A.; SCARAMUZZA, J.F.; SILVA, T.J.A. Eficiência de produção e concentração de nitrogênio nos capins Marandu, decumbens e convert submetidos à adubação nitrogenada. **Bioscience Journal**, v.29, p.1653-1662, 2013.

CANTARUTTI, R.B.; MARTINS, C.E.; CARVALHO, M.M.; FONSECA, D.M.; ARRUDA, M.L.; VILELA, H.; OLIVEIRA, F.T.T. Pastagens. In: RIBEIRO, A.C.; GUIMARÃES, P.T.G.; ALVAREZ V.V.H. **Recomendações para uso de corretivos e fertilizantes em Minas Gerais:** 5ª Aproximação. Viçosa: CFSEMG/UFV, 1999. p.296-303.

COSTA, K.A.P.; FAQUIN, V.; OLIVEIRA, I.P. Doses e fontes de nitrogênio na recuperação de pastagens do capim-marandu. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v.62, p.192-199, 2010.

COSTA, K.A.P.; FAQUIN, V.; OLIVEIRA, I.P.; ARAÚJO, J.L.; RODRIGUES, R.B. Doses e fontes de nitrogênio em pastagem de capim-marandu: nutrição nitrogenada da planta. **Revista Brasileira de Ciência do Solo**, v.32, p.1601-1607, 2008.

COSTA, K.A.P.; FAQUIN, V.; OLIVEIRA, I.P.; SEVERIANO, E.C.; OLIVEIRA, M.A. Doses e fontes de nitrogênio na nutrição mineral do capim-marandu. **Ciência Animal Brasileira**, v.10, p.115-123, 2009.

COSTA, K.A.P.; OLIVEIRA, I.P.; FAQUIN, V.; NEVES, B.P.; RODRIGUES, C.; SAMPAIO, F.M.T. Intervalo de corte na produção de massa seca e composição químico-bromatológica da *Brachiaria brizantha* cv. MG-5. **Ciência e Agrotecnologia**, v.31, p.1197-1202, 2007.

COSTA, K.A.P.; ROSA, B.; OLIVEIRA, I.P.; CUSTÓDIO, D.P.; SILVA, D.C. Efeito da estacionalidade na produção de matéria seca e composição bromatológica da *Brachiaria brizantha* cv. Marandu. **Ciência Animal Brasileira**, v.6, p.187-193, 2005.

COSTA, K.A.P.; SEVERIANO, E.C.; SILVA, F.G.; BORGES, E.F.; EPIFÂNIO, P.S.; GUIMARÃES, K.C. Doses and sources of nitrogen on yield and bromatological composition of Xaraés grass. **Ciência Animal Brasileira**, v.14, p.288-298, 2013.

CRUZ, P.G. **Produção de forragem em *Brachiaria brizantha*:** adaptação, geração e avaliação de modelos empíricos e mecanicistas para estimativa do acúmulo de forragem. 2010.

103p. Tese (Doutorado em Ciências) – Universidade de São Paulo, Escola Superior de Agricultura "Luiz de Queiroz", Piracicaba.

DIAS-FILHO, M.B. **Estratégias para recuperação de pastagens degradadas na Amazônia brasileira**. Belém: Embrapa Oriental, 2015. 25p.

FARIA, A.F.G. **Acúmulo de forragem verde, extração de nutrientes e valor nutricional do capim-xaraés adubado com nitrogênio**. 2010. 81p. Dissertação (Mestrado em Ciência do Solo) – Universidade Estadual Paulista "Júlio de Mesquita Filho", Jaboticabal.

FERREIRA, D. F. Sisvar: a computer statistical analysis system. **Ciência e Agrotecnologia**, v.35, p.1039-1042, 2011.

FREIRE, F.M.; COELHO, A.M.; VIANA, M.C.M.; SILVA, E.A. Adubação nitrogenada e potássica em sistemas de produção intensiva de pastagens. **Informe Agropecuário**, v.33, p.60-68, 2012.

LOURENTE, E.R.P.; ONTOCELLI, R.; SOUZA, L.C.F.; GONÇALVES, M.C.; MARCHETTI, M.E.; RODRIGUES, E.T. Culturas antecessoras, doses e fontes de nitrogênio nos componentes de produção do milho. **Acta Scientiarum Agronomy**, v.29, p.55-61, 2007.

MARTHA JÚNIOR, G.B.; CORSI, M.; TRIVELIN, P.C.O.; VILELA, L.; PINTO, T.L.F.; TEIXEIRA, G.M.; MANZONI, C.S.; BARIONI, L.G. Perdas de amônia por volatilização em pastagem de capim-tanzânia adubada com ureia no verão. **Revista Brasileira de Zootecnia**, v.33, p.2240-2247, 2004.

MARTUSCELLO, J.A.; FARIA, D.J.G.; CUNHA, D.N.F.V.; FONSECA, D.M. Adubação nitrogenada e partição de massa seca em plantas de *Brachiaria brizantha* cv. Xaraés e *Panicum maximum* x *Panicum infestum* cv. Massai. **Ciência e Agrotecnologia**, v.33, p.663-667, 2009.

MELLO, S.Q.S.; FRANÇA, A.F.S.; LANNA, A.C.; BERGAMASHINE, A.F. Adubação nitrogenada em capim-mombaça: produção, eficiência de conversão e recuperação aparente do nitrogênio. **Ciência Animal Brasileira**, v.9, p.935-947, 2008.

MOREIRA, L.M.; SANTOS, M.E.R.; FONSECA, D.M.; MARTUSCELLO, J.A.; MORAIS, R.V.; MISTURA, C. Produção animal em pastagem de capim-braquiária adubada com nitrogênio. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v.63, p.914-921, 2011.

OLIVEIRA, D.A. **Características produtivas e valor nutritivo num ano de recuperação do capim-braquiária com aplicações de nitrogênio e enxofre**. 2008. 119p. Dissertação (Mestrado em Solos e Nutrição de Plantas) – Universidade de São Paulo "Escola Superior de Agricultura Luiz de Queiroz", Piracicaba.

PÔRTO, M.L.; PUIATTI, M.; FONTES, P.C.R.; CECON, P.R.; ALVES, J.C.; ARRUDA, J.A. Índice SPAD para o diagnóstico do estado de nitrogênio na cultura da abobrinha. **Horticultura Brasileira**, v.29, p.311-315, 2011.

PRIMAVESI, A.C.; PRIMAVESI, O.; CORRÊA, L.A.; CANTARELLA, H.; VIVALDI, L.F. Adubação nitrogenada em capim-coastcross: efeitos na extração de nutrientes e recuperação aparente do nitrogênio. **Revista Brasileira de Zootecnia**, v.33, p.68-78, 2004.

REIN, T.A.; SOUSA, D.M.G. Adubação com enxofre. In: SOUSA, D.M.G.; LOBATO, E. **Cerrado:** correção do solo e adubação. Brasília: Embrapa Informação Tecnológica, 2004. 416p.

SCHIAVUZZO, P.F.; MONTEIRO, F.A.; LAVRES JÚNIOR, J. Nitrogênio na produção e na nutrição da braquiária Marandu. In: REUNIÃO ANUAL DA SOCIEDADE BRASILEIRA DE ZOOTECNIA, 37., 2000, Viçosa. **Anais**. Viçosa: SBZ, 2000. p.107.

ISSN 1984-431X

SILVA, F.C. **Manual de análises químicas de solos, plantas e fertilizantes**. 2. ed. Brasília: Embrapa Informação Tecnológica, 2009. 627p.

TEIXEIRA FILHO, M.C.M.; BUZETTI, S.; ANDREOTTI, M.; ARF, O.; BENETT, C.G.S. Doses, fontes e épocas de aplicação de nitrogênio em trigo irrigado em plantio direto. **Pesquisa Agropecuária Brasileira**, v.45, p.797-804, 2010.