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CHEMICAL COMPOSITION OF MARANDU PALISADE GRASS FERTILIZED WITH NITROGEN AND POTASSIUM

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Abstract

The goal was to evaluate the chemical composition of *Urochloa brizantha* cv. Marandu through the use of fertilization with nitrogen and potassium. The experiment was carried out at the Experimental Farm of UFMT, Cuiabá Campus, from December to April 2017/2018 and 2018/2019 - rainy season; and from May to September in 2018 and 2019 – dry season. Treatments corresponded to a 5x2 factorial scheme, with five nitrogen doses (0; 25; 50; 75; 100 kg ha-¹) and two potassium doses (0; 25 kg ha-1). The sample was unified as one for each individual period. The chemical characteristics evaluated were crude protein (CP), mineral matter (MM), neutral detergent fiber (NDF), acid detergent fiber (ADF), indigestible neutral detergent fiber (iNDF), total digestible nutrients (TDN) and net energy of lactation (NEF). For CP, a positive linear effect was observed for nitrogen fertilization, with 15.87% and 11.68% for the highest dose in the rainy and dry seasons, respectively. Likewise, a linear increase in TDN and in NEL was observed. For NDF, ADF and iNDF content there was a linear reduction in both rainy and dry seasons. For potassium fertilization, there is little influence on the chemical characteristics, in fact, only in the rainy season for fiber, TDN and NEL contents. However, nitrogen fertilization promoted an increase of 51.13% in the CP content at the highest applied dose. The NDE, ADF and iNDF content decrease linearly with nitrogen input, on the contrary, there was an increase in TDN and NEL.

Key words CP, iNDF, NDF, *Urochloa brizantha*

COMPOSIÇÃO BROMATOLOGICA DE CAPIM- MARANDU ADUBADO COM NITROGÊNIO E POTÁSSIO

Resumo

Objetivou-se avaliar a composição bromatológica da *Urochloa brizantha* cv. Marandu mediante uso de adubação com nitrogênio e potássio. O experimento foi realizado na Fazenda Experimental da UFMT, *campus* Cuiabá, no período de dezembro a abril de 2017/2018 e 2018/2019 águas; e de maio a setembro em 2018 e 2019 seca. Os tratamentos foram dispostos em esquema fatorial 5x2, sendo cinco doses de nitrogênio (0; 25; 50; 75; 100 kg ha^{-1}) e duas doses de potássio (0; 25 kg ha^{-1}). A amostra foi obtida de forma composta compreendendo cada período individualmente. As características bromatológicas avaliadas foram: proteína bruta (PB), matéria mineral (MM), fibra insolúvel em detergente neutro (FDN), fibra insolúvel em detergente ácido (FDA), fibra insolúvel em detergente neutro indigestível (FDNi), nutrientes digestíveis totais (NDT) e energia líquida de lactação (ELL). Para a PB, observou-se efeito linear positivo para adubação nitrogenada, 15,87% e 11,68% para a maior dose nas águas e seca respectivamente. Da mesma forma, observou-se aumento linear no teor de nutrientes digestíveis totais e energia líquida de lactação. Para FDN, FDA e FDNi ocorreu redução linear nos dois períodos águas e seca. Para adubação com potássio nota-se pouca influência para as características bromatológicas, com efeito, apenas no período das águas para teores de fibras, NDT e ELL. Entretanto, a adubação nitrogenada proporcionou um aumento de 51,13% no teor de PB na maior dose aplicada. Os teores de FDN; FDA; FDNi reduzem linearmente com a aplicação de nitrogênio, de forma contraria ocorre aumento de NDT e ELL.

Palavras-chave FDN, FDNi, PB, *Urochloa brizantha*

INTRODUCTION

Brazil is a country of continental dimensions with tropical climate predominantly in the Midwest region, which provides a great advantage in the exploration of tropical pastures. The main characteristic of these grasses is the high production of biomass, as they are adapted to high light intensities, high temperatures and have greater efficiency in water use (REIS et al., 2017).

The country has the second largest herd, is the largest exporter and the second largest producer of beef in the world. The cattle herd in Brazil has around 196 million heads, having recorded a slaughter of 39.14 million heads in 2021. The State of Mato Grosso leads the ranking with the largest herd, approximately 27.8 million heads of the national herd (ABIEC, 2022)

According to the Brazilian Beef Exporters Association (ABIEC, 2021), from the 41.5 million heads slaughtered, only 15.6% of the animals are from feedlot systems, while the rest come from pasture production systems, with the forage as the exclusive source and/or main source of food.

Brazil has around 173 million ha of pastures, of which 117 million are cultivated pastures. According to EMBRAPA (2014), around 60% of cultivated pastures in Brazil are in a state of degradation and it is estimated that at State of Mato Grosso, 67% present considerable levels of degradation, exceeding the national average.

Pasture is the basal nutritional resource and provides most of the nutrients in these animals diet throughout their lives. Since most pastures are in some stage of degradation, there is a need to reestablish adequate levels of production in order to meet the animals nutritional requirements.

The pasture areas inappropriate for use may be due to the lack of adequate management to maintain their productive potential, combined with low natural soil fertility, and the failure to replace extracted nutrients or the absence of liming. These factors lead to vigor loss, greater incidence of weeds and erosion, resulting in the effective loss of productive potential and without the possibility of the pastures natural recovery (OLIVEIRA et al., 2020).

Therefore, technologies such as the use of fertilizers are important tools for recovering pastures at some degradation stage, to replace those nutrients extracted through forage mass production. The fertilizers use is a way of providing nutrients to meet the forage plants nutritional requirements. Nitrogen and potassium are elements responsible for positive effects on the forage plant structural characteristics and chemical composition, promoting an increase in biomass production and helping to recover the pastures (SILVA et al., 2013).

Given this confrontation, the goal was to determine the appropriate doses of nitrogen, in the presence and/or absence of potassium for *Urochloa brizantha* cv. Marandu aiming to improve the forage chemical composition.

MATERIAL AND METHODS

The trial was carried out at the Experimental Farm of the Federal University of Mato Grosso, located in Santo Antônio do Leverger, 28 km from Cuiabá municipality, Mato Grosso. The experimental area was located under the geographic coordinates 15° 51'08.6" south latitude, 56°04'15.2" west longitude and altitude of 141 m above sea level.

The region's climate is classified according to Köppen as Aw with well-defined rainy (October to March) and dry (April to September) seasons, with an average annual temperature of 26°C and 1,300 mm of annual precipitation. Climatic data were collected at the Pe. Ricardo Remetter Meteorological Station, 1000 m away from the experimental area (Figure 1).

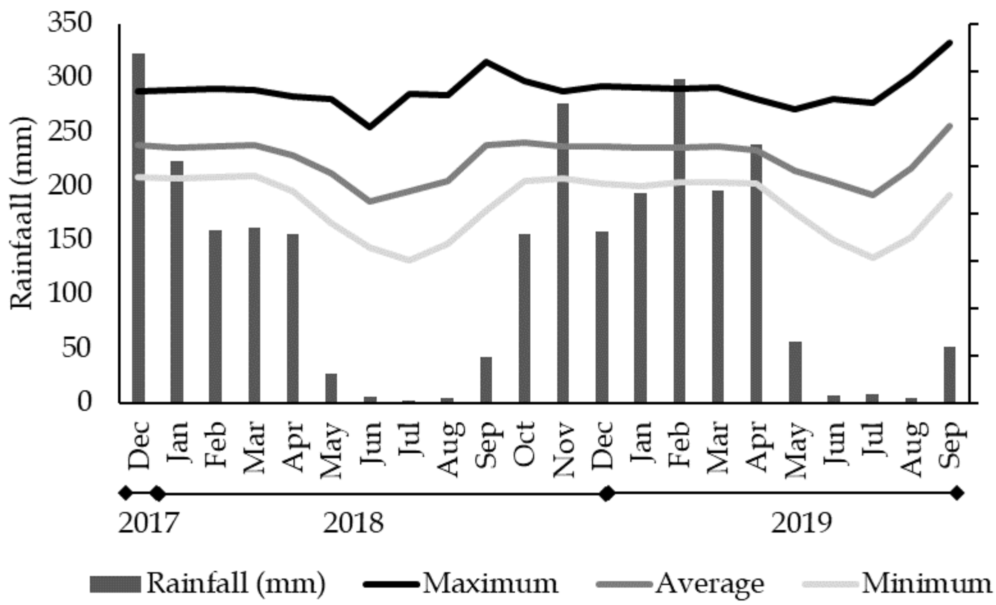

Figure 1. Mean of maximum, average, minimum temperature, and rainfall during the experimental period corresponding to rainy and dry season in the two years evaluated.

The experimental period was from December 2017 to September 2019 in an area with the forage *Urochloa brizantha* cv. Marandu, established in 2010. The experiment was carried out in a completely randomized design, with four replications. This design was used due to the experimental area had homogeneous characteristics, with the same soil, topography and management, since the pasture establishment. The treatments were arranged in a 5x2 factorial scheme, with five doses of nitrogen (0; 25; 50; 75; 100 kg N ha^{-1}) and two doses of potassium (0; 25 kg K_2O ha^{-1}). The fertilizers were applied at each cutting carried out during the rainy season. The area of each plot was 20 m^2 (5 m x 4 m). In the experimental area, 15 simple soil samples were collected to carry out the chemical characterization (Table 1) and acidity correction, with dolomitic limestone, in December 2017.

Table 1. Chemical and granulometric characterization of the soil in the experimental area with *U. brizantha* cv. Marandu.

pH	P	K	Ca+Mg	Al+H	CEC	V	m	OM	Sand	Silt	Clay
$CaCl_2$	mg dm^{-3}		cmol$_c$ dm^{-3}			%		g kg^{-1}			
4.5	9.4	51	2.2	5.1	7.4	31	16.9	27.1	748	58	194

CEC: Cation Exchange Capacity; V: base saturation; m: Aluminum saturation; OM: Organic Matter.

Fertilizer applications occurred after each defoliation cycle, using ammonium sulfate as nitrogen source and potassium chloride for potassium source. The assessments were carried out during two consecutive years, during the rainy season, from December to April (2017/2018 and 2018/2019), and dry season, from May to September (2018 and 2019).

At the beginning of each–rainy season, the pasture was cut to standardize it, using a mechanical brush cutter, adopting a residue height of 20 cm, in accordance with the recommendation of Costa and Queiroz (2013). After the uniformization cutting, maintenance fertilization was carried out, in accordance with the recommendations of Santos and Fonseca (2016). Then, the experimental period began, with the application of nitrogen and potassium according to each treatment.

After nitrogen fertilization, the forage canopy height was measured every three days, using a graduated ruler, in order to identify the moment in which the Marandu palisadegrass reached the pre-grazing height of 40 cm, corresponding to 95% light interception (FEITOSA, 2017). When the treatment reached the desired average height, the pasture was cut.

Three samples were taken per experimental unit, using a 1 m^2 metal frame (1.0 m x 1.0 m) to collect the forage mass present in this area, adopting a residue height of 20 cm. After cutting, the material present in each frame was weighed to determine the accumulation of green mass.

At the end of each cycle collection, uniformization cutting was performed ate the experimental plots using a mechanical brush cutter, at the level of residue. Then, the cut mass was removed with rakes and fertilizers were applied to the plots according to each treatment.

For chemical composition analyses, a sample of approximately 500 g of forage was taken, which was conditioned in paper bags and subjected pre-drying in a circulation air oven at 55± 5ºC for 72 h. After drying, the material was weighed. All procedures described were repeated in the two years of evaluation (2017/2018; 2018/2019).

At the end of the experimental period, a composite sample was made comprising all the cuts that occurred during both periods evaluated, to be representative for estimating the chemical composition during rainy and dry seasons. The forage pre-dried samples were ground through a 1 mm sieve in a Willey mill to determine the contents of mineral matter (MM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), indigestible neutral detergent fiber (iNDF), total digestible nutrients (TDN) and net lactation energy (NEL). These analyzes were carried out using near-infrared reflectance spectroscopy (NIRS), using EspectraAnalyzer equipment from the Zeutec Opto brand with 19 filters.

For the apparent recovery of N(rec), in percentage, it was calculated by the formula: N(rec)= 100 x [(N(extr) in the fertilized plot – N(extr) in the control plot)/ N dose applied].

The collected data were subjected to analysis of variance, considering the effects of nitrogen and potassium fertilization, interaction, between these factors. In case of a significant effect, it was carried out the regression analysis for nitrogen fertilization and the Tukey mean test for potassium fertilization, adopting a 5% probability of error.

RESULTS

There was no interaction between nitrogen and potassium fertilization for the chemical composition of Marandu palisade grass (MM, CP, NDF, ADF, iNDF, TDN, NEL) in the two periods (rainy and dry season) (Table 2). Nitrogen alone influenced all the variables analyzed. Potassium, on the other hand, had an isolated effect only for the variables NDF, ADF, iNDF, TDN and NEL for the dry season (Table 2).

Table 2. Chemical composition of Marandu palisade grass fertilized with doses of nitrogen and potassium.

			Rainy				
Effects	MM	CP	NDF	ADF	iNDF	TDN	NEL
NIT (N)	*	**	**	**	**	**	**
POT (K)	ns	ns	ns	ns	ns	ns	ns
NxK	ns	ns	ns	ns	ns	ns	ns
CV (%)	1.39	3.33	2.91	3.26	5.36	1.35	2.43
			Dry				
Effects	MM	CP	NDF	ADF	iNDF	TDN	NEL
NIT (N)	**	**	**	**	**	**	**
POT (K)	ns	ns	**	**	**	**	**
NxK	ns	ns	ns	ns	ns	ns	ns
CV (%)	1.94	6.2	3.45	3.74	4.11	1.49	2.54

** Significant at the 1% level, *significant at the 5% probability level using the F test. CV: Coefficient of variation; R2: coefficient of determination; ns: not significant. MM: mineral matter; CP: Crude Protein; NDF: Neutral Detergent Fiber; ADF: Acid Detergent Fiber; iNDF: Indigestible Neutral Detergent Fiber; TDN: Total digestible Nutrients; NEL: Net Energy of Lactation.

For the rainy season, a linear effect of nitrogen fertilization was observed on the levels of MM, CP, TDN and NEL, with an increase of 0.002%; 0.05%; 0.04% and 0.02 Mcal kg^{-1} for each kg of nitrogen ha^{-1} applied, respectively. On the other hand, there was a linear decrease in the levels of NDF, ADF, iNDF in the order of 0.11%; 0.07% and 0.05% per kg of nitrogen applied per ha (Table 3).

Table 3. Chemical composition of Marandu palisade grass as a function of nitrogen doses.

Variable			**Rainy**				
			N (kg ha^{-1} cutting^{-1})				
	0	25	50	75	100	**Equation**	**R2**
MM	8.08	8.09	8.27	8.27	8.25	Y= 8.0871+0.0021x*	0.70
CP	10.79	10.77	13.87	15.11	15.35	y=10.4940+0.053834x**	0.89
NDF	69.18	68.94	61.34	59.25	59.84	y=69.388857-0.113514x**	0.82
ADF	40.16	40.23	35.12	33.7	34.06	y=40.400286-0.07484x**	0.82
iNDF	20.89	20.06	17.93	15.59	15.78	y=20.987429-0.058703x**	0.92
TDN	54.93	55.03	58.2	59.07	58.83	y=54.851143+0.047303x**	0.82
NEL	1.26	1.26	1.4	1.44	1.43	y=1.259429+0.002109x**	0.81
			Dry				
MM	8.65	8.57	8.84	8.9	8.76	y=8.6380+0.0022x*	0.42
CP	9.55	9.46	9.9	10.99	12.03	y=9.0920+0.025937x**	0.87
NDF	63.64	61.77	60.62	58.63	58.54	y=63.309714-0.053337x**	0.95
ADF	37.1	35.63	35.14	33.6	33.2	y=36.900857-0.039297x**	0.97
iNDF	27.93	27.99	27.66	27.25	25.5	y=28.387714-0.022383x**	0.75
TDN	57.24	58.02	58.5	59.33	59.37	y=57.384286+0.022251x**	0.95
NEL	1.35	1.39	1.4	1.44	1.46	y=1.3580+0.001080x**	0.97

** Si3gnificant at 5% probability level using the F test.

During the dry season, there were also increases in the levels of MM, CP, TDN, NEL; and reduction in NDF, ADF and iNDF contents, for each kg of nitrogen applied per ha (Table 3). Potassium fertilization promoted a reduction in TDN, NEL and iNDF levels and an increase in NDF and ADF, only in the dry period (Table 4).

Table 4. Chemical composition of Marandu palisadegrass in the presence and absence of potassium.

K_2O (kg ha^{-1})	Rainy						
	MM	CP	NDF	ADF	iNDF	TDN	NEL
0	8.15	13.11	63.28	36.21	18.37	57.39	1.37
25	8.22	13.23	64.03	36.99	17.80	57.08	1.35
K_2O (kg ha^{-1})	Dry						
	MM	CP	NDF	ADF	iNDF	TDN	NEL
0	8.77	10.44	59.26b	33.89b	27.99a	59.07a	1.44a
25	8.73	10.39	61.67a	35.71a	26.72b	58.07b	1.39b

Means followed by different letter in the column differ according to the Tukey test (P>0.05).

DISCUSSION

The increase in MM content may be related to forage production and rainfall throughout the experimental period, leading to different MM contents and the possible dilution effect according to Rodrigues Júnior (2015).

During the rainy season, the nitrogen application promoted a 51.29% increase in the CP content of the forage produced, comparing the highest dose of nitrogen used (100 kg $cutting^{-1}$ ha^{-1}) and the absence of nitrogen. The same occurred during the dry period, with the CP content at a dose of 100 kg ha^{-1} being 28.52% higher than in the absence of nitrogen fertilization (Table 3).

In this way, 1,585 kg CP ha^{-1} were produced due to the nitrogen application, corresponding to 844 kg CP ha^{-1} more than the treatment that were in the absence of nitrogen fertilization. In this condition, apparent nitrogen recovery of 76.7 kg of the 85.48 kg applied at the point of highest mass production is observed, which corresponds to a loss of only 10.3% of the N dose applied in each plot per cutting during the rainy season. In this case, it is likely that the main loss of nitrogen is due to leaching, since losses due to volatilization are greater when using urea and the necessary precautions are not taken, such as meteorological monitoring to ensure that rain occurs immediately after application (CASSIMIRO et al. al., 2020).

The CP levels found during the rainy season indicate the appropriate management that the forage was subjected to by simulating a rotated grazing system respecting cutting and residue height, which is in line with the high levels of crude protein obtained in the absence of fertilization. nitrogen (10.49%). Thus, all treatments present levels above 8% of CP, considered sufficient to guarantee adequate fiber degradation in the rumen in tropical pasture conditions (RUFINO et al., 2016). The same behavior was observed during the dry period with a CP content of 9.09% in the absence of nitrogen fertilization.

On the other hand, to obtain better results in animal production, CP levels in forage close to 12.4% are necessary, as this level guarantees good nitrogen availability for animal metabolism (DETMANN et al., 2014). Therefore, a dose of 35.4 kg N ha^{-1} applied during the rainy season would already meet this adequate level of CP.

The levels observed corroborate those found by Galindo et al. (2018) and Bernardi et al. (2018), however higher CP levels obtained in the dry period are not commonly reported in the literature. The levels observed may be related to the low height of the plant at the time of cutting, given that the water deficit reduced vegetative growth, causing an increase in the CP content.

There was a linear decrease in the NDF content as the doses of N applied increased in both seasons analyzed. The lowest NDF values were found at a dose of 100 kg N ha^{-1}, 58.03% and 57.96% for rainy and dry seasons, respectively. The linear reduction in NDF content corresponds to 19.56% and 9.22%, respectively, corroborating the results found by Sales et al. (2020) and Bernardi et al. (2018).

Potassium only influenced in the dry season and in the opposite way, increasing the NDF and ADF contents to 61.67% and 35.71%, respectively (Table 4). The supply of nitrogen promoted a reduction of up to 18.53% during the rainy season and 10.65% during the dry season for the ADF, with the lowest levels being 32.91% and 36.9% for the highest dose of nitrogen used (Table 3). The ADF levels found are similar to those obtained by Leite et al. (2021), as well as being found in levels suitable for intake by ruminants without limiting consumption.

In relation to iNDF, a reduction in its content (15.78%) was observed as nitrogen doses increased, with a decrease of 28.01% compared to the absence of nitrogen fertilization during the rainy season (Table 3). The same occurred in the dry period, with a 9.52% reduction in the iNDF content (Table 3). The results obtained indicate adequate content for good forage intake by ruminants, according to Cabral et al. (2017) and Sales et al. (2020).

Potassium fertilization also promoted a reduction in the iNDF content, however only in the dry period of the year, with a decrease of 4.53% in the presence of potassium (Table 4). The TDN had a positive linear effect as N doses increased.

The results found were coherent, since ADF is correlated with NDT, so this increase was expected, since there was a significant reduction in the concentration of ADF, as observed by Santana et al. (2021).

For NEL, a positive linear effect was observed when it comes to nitrogen fertilization for both periods, with a 14.28% increase in the rainy season comparing the highest and lowest dose of N, and 7.53% for the dry season. For fertilization with potassium, an increase of 3.59% was observed compared to the absence of potassium.

CONCLUSION

Nitrogen fertilization provided an increase of 51.29% in crude protein content at the highest dose applied compared to the absence of N.

The fiber content reduces linearly with the application of nitrogen, however, the total digestible nutrients and net energy of lactation levels increase inversely.

Therefore, it is recommended to apply 100 kg N ha^{-1} cut^{-1} with the presence of potassium at dose of 25 kg ha^{-1} cut^{-1}.

REFERENCES

ASSOCIAÇÃO BRASILEIRA DAS INDÚSTRIAS EXPORTADORAS DE CARNES (ABIEC). **Beef Report**, 2022. Disponível em: http://abiec.com.br/publicacoes/beef-report-2021/. Acesso em: 21 nov. 2022.

BERNARDI, A.; SILVA, A. W. L.; BARETTA, D. Estudo metanalítico da resposta de gramíneas perenes de verão à adubação nitrogenada. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v.70, n.2, p.545-553, 2018. https://doi.org/10.1590/1678-4162-9501

CABRAL, C. E. A.; BARROS, L. B.; ABREU, J. G.; SILVA, F. G.; CABRAL, C. H. A.; NETO, A. B.; ANDRADE. F. C. F.; SALES. K. C.; HERRERA. D. M.; DELLARMELINDA, T. M. M. Marandu palisade grass intercropped with densely spaced teak in silvopastoral system. **Semina: Ciências Agrárias**, v.38, n.4, p. 2075-2082, 2017. https://doi.org/10.5433/1679-0359.2017v38n4p2075

CASSIMIRO, J.B.; ROCHETTI, A.C.A.; HEINRICHS, R.; CASTILLO, E.O.F. Volatilização da amônia e avaliação do capim-marandu sob doses e fontes de fertilizantes nitrogenados. **Research, Society and Development**, v.9, n.8, 2020. https://doi.org/10.33448/rsd-v9i8.5823

COSTA, J. A. A.; QUEIROZ, H. P. **Régua de manejo de pastagens**. Embrapa Gado de Corte-Comunicado Técnico (INFOTECAE), 2013.

DETMANN, E.; VALENTE, E.E.; BATISTA, E.D.; HUHTANEN, P. An evaluation of the performance and efficiency of nitrogen utilization in cattle fed tropical grass pastures with supplementation. **Livestock Science**, v.162, n.1, p.141-153, 2014. https://doi.org/10.1016/j.livsci.2014.01.029

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA (EMBRAPA). Centro Nacional de Pesquisa de Solos. **Sistema Brasileiro de Classificação de Solos**. 3.ed. Brasília: Embrapa Solos, 353p, 2013.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA (EMBRAPA). **Sistema de Observação e Monitoramento da Agricultura no Brasil**. Portal Embrapa (Versão 3.37.0), 2014. Disponível em: https://www.embrapa.br/busca-de-noticias/-/noticia/2361250/embrapa-mapeia-degradacao-das-pastagens-do-cerrado

FEITOSA, T. S. **Respostas Agronômicas de Brachiaria brizantha cv. Marandu e Panicum maximum cv. Mombaça em função do suprimento de nitrogênio e água**. Universidade Federal de Lavras, p57, 2017.

GALINDO, F. S.; BUZETTI, S.; TEIXEIRA FILHO, M. C. M.; DUPAS, E.; LUDKIEWICZ, M. G. Z. Acúmulo de matéria seca e nutrientes no capim-mombaça em função do manejo da adubação nitrogenada. **Revista de Agricultura Neotropical**, v.5 n.3, p.1-9, 2018. https://doi.org/10.32404/rean.v5i3.2132

LEITE, R.G.; CARDOSO, A.S.; FONSECA, N.V.B.; SILVA, M.L.C.; TEDESCHI, L.O.; DELEVATTI, L.M.; RUGGIERI, A.C.; REIS, R.A. Efects of nitrogen fertilization on protein and carbohydrate fractions of Marandu palisadegrass. **Scientifc Reports**, v.11, n.1, e-14786, 2021. https://doi.org/10.1038/s41598-021-94098-4

OLIVEIRA, E.R.; SILVA, J.R.; BAUMANN, L.R.F.; MIZIARA, F.; FERREIRA, L.G.; MERELLES, L.R.O. Technology and degradation of pastures in livestock in the brazilian Cerrado. **Sociedade & Natureza**, v.32, p.585-596, 2020. https://doi.org/10.14393/SN-v32-2020-55795

REIS, M.M.; SANTOS, L.D.T.; OLIVEIRA, F.G.; SANTOS, M.V. Irrigação de pastagens tropicais: desafios e perspectivas. **Revista Unimontes Científica**, v.19, n.1, p.178-190, 2017.

RODRIGUES JÚNIOR, C. T.; SOUZA CARNEIRO, M. S.; MAGALHÃES, J. A.; PEREIRA, E. S.; RODRIGUES, B. H. N.; LUCENA COSTA, N.; CARVALHO CASTRO, K. N. Produção e composição bromatológica do capim-Marandu em diferentes épocas de diferimento e utilização. **Semina: Ciências Agrárias**, v.36, n.1, p.2141-2154, 2015. https://doi.org/10.5433/1679-0359.2015v36n3Supl1p2141

RUFINO, L. M. D. A.; DETMANN, E.; GOMES, D. Í.; REIS, W. L. S. D.; BATISTA, E. D.; VALADARES FILHO, S. D. C.; PAULINO, M. F. Intake, digestibility and nitrogen utilization in cattle fed tropical forage and supplemented with protein in the rumen, abomasum, or both. **Journal of Animal Science and Biotechnology**, v. 7, n. 1, p. 1-10, 2016. https://doi.org/10.1186/s40104-016-0069-9

SALES, K. C.; CABRAL, C. E.; ABREU, J. G.; BARROS, L. V.; SILVA, F. G.; CABRAL, C. H.A.; SANTOS, A.R.M.; SILVA JUNIOR, C.A.; CAMPOS FILHO, J. B. What is the maximum nitrogen in marandu palisadegrass fertilization? **Grassland Science**, v.66, n.3, p.153-160, 2020. https://doi.org/10.1111/grs.12266

SANTOS, M.E.R.; FONSECA, D.M. **Adubação de pastagens em sistemas de produção animal**. Viçosa, MG: Editora UFV, 2016. 311 p.

SANTANA, F.S.; CRUZ, N.T.; BACKES, A.A.; VALENÇA, R.L.; LIMA, L.K.S.; SOUSA, B.M.L.; FAGUNDES, J.L. Nutrição de ruminantes com uso do feno de capim elefante amonizado. **Revista Ciência Animal**, v.31, n.2, p.60-75, 2021.

SILVA, D. R. G.; COSTA, K. A. P.; FAQUIN, V., OLIVEIRA, I. P.; BERNARDES, T. F. Doses e fontes de nitrogênio na recuperação das características estruturais e produtivas do capim-marandu. **Revista Ciência Agronômica**, v.44, n.1, p.184-191, 2013. https://doi.org/10.1590/S1806-66902013000100023