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FIBRAS DETERGENTE NEUTRO E ÁCIDO DE FORRAGEM DE *Brachiaria brizantha* ADUBADAS COM CAMA DE FRANGO E NPK MINERAL*

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**Trabalho proveniente de tese intitulada "produção e composição nutricional de cultivares de Urochloa brizantha sob adubação orgânica" apresentada no Instituto Federal Goiano, campus Rio Verde, GO.*

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1 RESUMO

O objetivo deste estudo foi avaliar os efeitos de diferentes doses de cama de frango e da adubação mineral NPK nos teores de fibra detergente ácido e fibra de detergente neutro de forragem das cvs. de *Brachiaria brizantha* Xaraés, BRS Paiaguás e Marandu, em um Latossolo Vermelho distroférrico de Cerrado. O estudo foi conduzido no Instituto Federal Goiano, Rio Verde - Goiás. O delineamento experimental foi o de blocos ao acaso, com 15 tratamentos e quatro repetições, em esquema fatorial 5 × 3. Os tratamentos foram cinco níveis de adubação orgânica ou mineral: Sem adubação (solo natural); 8 t ha^{-1} de cama de frango; 16 t ha^{-1} de cama de frango; e 24 t ha^{-1} de cama de frango; e 250 kg ha^{-1} do formulado NPK 08-28-16, e três cvs. de *Urochloa brizantha*: cv. Marandu, cv. BRS Paiaguás e cv. Xaraés. Os tratamentos foram avaliados no período das águas e da seca, em seis cortes consecutivos, aos 83, 111, 139, 167, 213 e 268 dias após a emergência das plantas, mediante o corte a altura de 0,20 m do solo. Foi avaliado as variáveis de fibra de detergente ácido (FDA) e fibra de detergente neutro (FDN). A cultivar Marandu apresenta os mínimos teores de FDA nas doses de aproximadamente 12 t ha^{-1} de cama de frango. O capim-Marandu no primeiro, segundo e quarto corte apresenta os máximos teores de fibra detergente neutro até aproximadamente a dose de 17 t ha^{-1} de cama de frango.

Palavras-chave: *Brachiaria brizantha,* BRS Paiaguás, Marandu, nitrogênio, Xaraés

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NEUTRAL DETERGENT AND ACID FIBERS FROM *Brachiaria brizantha* FORAGE FERTILIZED WITH CHICKEN LITTLE AND MINERAL NPK

2 ABSTRACT

The objective of this study was to evaluate the effects of different doses of chicken litter and NPK mineral fertilizer on the acid detergent fiber and neutral detergent fiber content of forage in cvs. of *Brachiaria brizantha* Xaraés, BRS Paiaguás and Marandu, in a distroferric Red

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Latosol from Cerrado. The study was conducted at the Instituto Federal Goiano, Rio Verde - Goiás. The experimental design was randomized blocks, with 15 treatments and four replications, in a 5 × 3 factorial scheme. The treatments were five levels of organic or mineral fertilizer: No fertilization (natural soil); 8 t ha^{-1} of chicken litter; 16 t ha^{-1} of chicken litter; and 24 t ha^{-1} of chicken litter; and 250 kg ha^{-1} of formulated NPK 08-28-16, and three hp. from *Urochloa brizantha*: cv. Marandu, cv. BRS Paiaguás and cv. Xaraés. The treatments were evaluated during the rainy and dry periods, in six consecutive cuts, at 83, 111, 139, 167, 213 and 268 days after plant emergence, by cutting at a height of 0.20 m from the ground. The variables of acid detergent fiber (ADF) and neutral detergent fiber (NDF) were evaluated. The Marandu cultivar presents the minimum ADF levels at doses of approximately 12 t ha^{-1} of chicken litter. Marandu grass in the first, second and fourth cuts presents the maximum levels of neutral detergent fiber up to approximately a dose of 17 t ha^{-1} of chicken litter.

Keywords: *Brachiaria brizantha,* BRS Paiaguás, Marandu, nitrogen, Xaraés.

3 INTRODUCTION

Grasses of the genus *Brachiaria* represent the majority of cultivated pastures in Brazil, primarily because they have adapted well to local soil and climatic conditions and exhibit good tolerance to grazing. According to Santos *et al.* (2011), these plants adapt to a variety of soil and climatic conditions, with a large number of species adapted to low and medium soil fertility.

The prospects for increased poultry farming activity are concomitant with the generation of organic waste. Therefore, there is a need to reuse poultry litter for other activities, such as its use in the agricultural sector as a source of nutrients, which benefits the restoration of soil fertility (PITTA *et al.*, 2012; PINTO *et al.*, 2012). Thus, studies on the use of poultry litter in the production and quality of forage biomass and how it affects soil chemical attributes can contribute to a more sustainable production system, both for poultry farmers and for agricultural activity (PITTA *et al.*, 2012).

Because it is rich in organic matter and nutrients, the use of organic waste in agriculture improves the physical and chemical properties of the soil–plant system. In addition to reducing the deficiency of pathogenic microorganisms, poultry manure compost contains the main nutrients (nitrogen, phosphorus, and potassium) at adequate concentrations for plant development (SILVA *et al.*, 2011). However, the search for sustainable systems has been constant; therefore, producers need new viable alternatives to mineral fertilizers from nonrenewable sources, which have a high share of production costs.

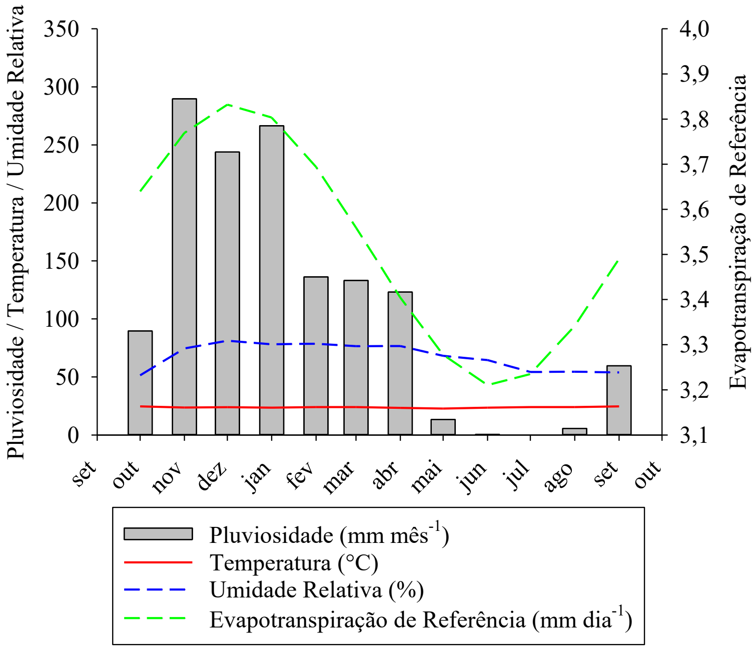
The objective of this study was to evaluate the effects of different doses of chicken manure and NPK mineral fertilizer on the acid detergent fiber and neutral detergent fiber contents of *Brachiaria brizantha cvs.* Xaraés, BRS Paiaguás and Marandu, in a dystroferric Red Latosol of the Cerrado.

4 MATERIALS AND METHODS

The experiment was conducted under field conditions in the experimental area of the Instituto Federal Goiano–Rio Verde Campus. The geographic coordinates of the installation site are 17°48'28" S and 50°53'57" W, with an average altitude of 720 m above sea level. The climate of the region is classified according to Köppen and Geiger (1928) as Aw (tropical), with rainy months from October to May and dry months from

June to September. The average annual temperature ranges from 20 to 35°C, rainfall ranges from 1,500 to 1,800 mm per year, and the relief is gently undulating (6% slope). The meteorological data for the municipality of Rio Verde and the reference evapotranspiration during the experiment are shown in Figure 1.

Figure 1. Meteorological data for the municipality of Rio Verde and reference evapotranspiration during the experimental period.



Source: INMET Normal Station – Rio Verde - GO.

The soil of the experimental area was classified as a dystroferric red latosol (LVdf) with a cerrado phase and a medium texture (Santos *et al., 2018). The area has a history of more than 15 years of Brachiaria decumbens* cultivation.

For soil determination, undisturbed soil samples were collected from Uhland rings measuring 6.34 cm in diameter and 5 cm in height, and disturbed samples were collected at depths of 0--20 cm and 20--40 cm for physical and chemical analyses of the soil.

The soil density was determined via the volumetric ring method according to Teixeira *et al.* (2017). The particle density (Dp) was determined via distilled water and vacuum elimination of air from the pycnometer according to Blake and Hartge (1986); the total porosity (TP) was obtained from the values of soil density (Ds) and particle density (Dp) via the equation proposed by Vomocil and Floker (1961).

Microporosity (Micro) was determined considering the water content retained at a matric potential of 6 kPa; acroporosity (Macro) was calculated on the basis of the difference between total porosity and microporosity; and granulometric analyses were performed via the pipette method (TEIXEIRA *et al.*, 2017). The physical–chemical characteristics of the soil are shown in Table 1.

Table 1. The physical, water and chemical characteristics of the soil in the experimental area, 0–20 cm deep and 20–40 cm deep, before the experiment began.

Physical-water characteristics							
Layer	**Granulometry g kg $^{-1}$**			**θ_{CC}**	**θ_{PMP}**	**Ds**	**PT**
m	**Sand**	**Silt**	**Clay**	**-- m^3 m^{-3} --**		**g cm^{-3}**	**cm^3 cm^{-3}**
0.0–0.2	458.3	150.2	391.5	51.83	30.5	1.27	0.55
0.2–0.4	374.9	158.3	466.8	55	31,33	1.28	0.51

Chemical characteristics										
Layer	**pH**	**MO**	**P**	**K**	**Here**	**Mg**	**Al**	**H+Al**	**CTC**	**V**
m	**H_20**	**g kg $^{-1}$**	**mg dm $^{-3}$**	**--------------- mmol $_c$ dm $^{-3}$ ---------------**						**%**
0.0–0.2	6.2	53.4	7.1	2.0	20.4	16.8	0.0	57.8	99.6	42
0.2–0.4	6.6	44.4	2.7	4.1	14.4	13.2	0.0	44.5	76.2	41

θ_{CC}, field capacity (10 kPa); θ_{PMP}, permanent wilting point (1,500 kPa); Ds, soil bulk density; PT, total porosity; pH in distilled water. P and K, Mehlich extractant $^{-1}$. MO - Organic matter. V - Base saturation.

Initially, the area was cleared with a brush cutter attached to a tractor. The initial soil preparation was subsequently carried out through preharrowing to eliminate existing vegetation. The dolomitic limestone was then distributed at a rate of 2.0 t ha $^{-1}$, on the basis of the soil analysis results, with the goal of increasing the base saturation to 60% (SOUSA; LOBATO, 2004). The amendment was applied via a tractor-driven limestone spreader, and then another harrowing operation was carried out to incorporate the limestone and break up the soil. Finally, leveling was performed.

The experimental design was randomized blocks, with 15 treatments and four replicates, analyzed in a 5 × 3 factorial scheme. The treatments included combinations of five levels of organic or mineral fertilization: no fertilization (natural soil); 8 t ha $^{-1}$ poultry litter; 16 t ha $^{-1}$ poultry litter; 24 t ha $^{-1}$ poultry litter; 250 kg ha $^{-1}$ formulated NPK 08--28--16; and three cvs. of *Urochloa brizantha*: cv. Marandu, cv. BRS Paiaguás and cv. Xaraés. Each experimental unit (plot) was 5 m wide by 8 m long.

Prior to the application of the chicken litter doses, analyses of the macro- and micronutrient contents in the residue were carried out, the results of which are presented in Table 2.

Table 2. Physicochemical characteristics of the chicken litter used in the experimental evaluation.

Determinations	Results	
	Dry Base (65°C)	**Wet Base**
pH ($_{0.01}$ M CaCl2)	-	8.5
Density (Organic Residue)	-	0.56 g cm ^{3}
Humidity (Organic Residue) 60 - 65° C	-	13.56%
Humidity (Organic Residue) 110°C	-	3.02%
Total Organic Matter (Combustion)	53.37%	46.13%
Organic Carbon	28.07%	24.26%
Total Mineral Residue (TMR)	43.14%	37.29%
Mineral Residue (MR)	40.06%	34.63%
Insoluble Mineral Residue (IMR)	3.08%	2.66%
Total Nitrogen	2.44%	2.11%
Phosphorus (P_2O_5) Total	3.17%	2.74%
Potassium (K_2O) Total	4.28%	3.70%
Total Calcium (Ca)	13.12%	11.34%
Total Magnesium (Mg)	1.86%	1.61%
Total Sulfur (S)	0.62%	0.54%
C/N ratio	-	11
Total Copper (Cu)	515 mg kg $^{-1}$	445 mg kg $^{-1}$
Manganese (Mn) Total	848 mg kg $^{-1}$	733 mg kg $^{-1}$
Total Zinc (Zn)	711 mg kg $^{-1}$	615 mg kg $^{-1}$
Total Iron (Fe)	14430 mg kg $^{-1}$	12473 mg kg $^{-1}$
Total Boron (B)	16 mg kg $^{-1}$	14 mg kg $^{-1}$
Total Sodium (Na)	8459 mg kg $^{-1}$	7312 mg kg $^{-1}$

Methods: pH in 0.01 M $_{CaCl2}$ potentiometric determination; density (m/v); humidity 60--65°C, humidity 110°C and total humidity determination by humidity; organic carbon (CO) dichromate oxidation followed by titration; total nitrogen sulfuric digestion (Kjeldahl); phosphorus (P2O5) determination via a spectrophotometer via the vanadomolybdic solution method; potassium (K2O) and sodium (Na) flame photometry; sulfur (S) gravimetric from barium sulfate; calcium (Ca), magnesium (Mg), copper (Cu), manganese (Mn), zinc (ZN), and iron (Fe) extraction with HCl via an atomic absorption spectrophotometer; Boron (B) spectrophotometry of azomethine-H; C/N ratio calculation of total organic matter; insoluble mineral residue (IMR); mineral residue (MR); and total mineral residue (TMR) via combustion in a muffle furnace (Alcarde, 2009).

To calculate the quantities of poultry litter to be applied to the soil, the respective contents of total nitrogen and available N (N-NH $_{4+}$ and N-NO $_{3-}$) were considered, in which only 50% of the N was considered available in the first year, 20% in the second year and the remaining 30% in subsequent years (ARRUDA *et al.*, 2014), with the aim of providing 50, 100 and 150 kg ha $^{-1}$ of N in the first year of pasture. These doses are equivalent to approximately 50%, 100% and 150% of the mineral N dose recommended for forages in the demanding group (SOUSA; LOBATO, 2004).

The poultry manure was distributed mechanically one week before grass sowing, and the respective residue dose was applied to each plot according to the treatment. The residue was then incorporated into the soil via a closed leveler. Mineral fertilizer (NPK 08-28-16 formula at a dose of 250 kg ha $^{-1}$) was also broadcast and then incorporated into the soil, similar to the procedure described for organic residues, one week before grass sowing.

Sowing of the Urochloa brizantha cultivars Marandu, BRS Paiaguás, and Xaraés was carried out by distributing a quantity of seeds according to the recommendations for each cultivar and the cultural value of the seeds. The seeds were subsequently incorporated into the soil.

Forty days after emergence (DAE), a uniform cut was made throughout the experimental area at a height of 10 cm to stimulate tillering and initiate regrowth periods. At the end of six consecutive regrowth periods, the material was subsequently harvested to measure dry matter mass productivity. The cuts were made at two random points in the useful area of each plot, using a 0.5 × 0.5 m metal frame (SALMAN; SOARES; CANESIN, 2006), with the plants being cut at a height of 0.20 m from the ground (EUCLIDES *et al.*, 2009), with the aid of a cleaver.

During the rainy season (January to April), cuts were made at 28-day intervals after the first cut, which was performed at 83 DAE, whereas during the dry season (May to September), cuts were made at 56-day intervals, except for the fifth cut, which was performed 46 days after the previous cut, which encompasses common grazing intervals in the region of interest (COSTA *et al.*, 2007; EUCLIDES *et al.*, 2009). Therefore, evaluations were performed at 83, 111, 139, 167, 213, and 268 DAE.

The collected material was placed in paper bags, dried in forced air circulation and exchanged at 55°C until it reached a constant mass. Two representative subsamples were then taken from each plot. These samples were ground in a Willey mill with a 1 mm sieve and placed in properly labeled, airtight-capped polyethylene bottles.

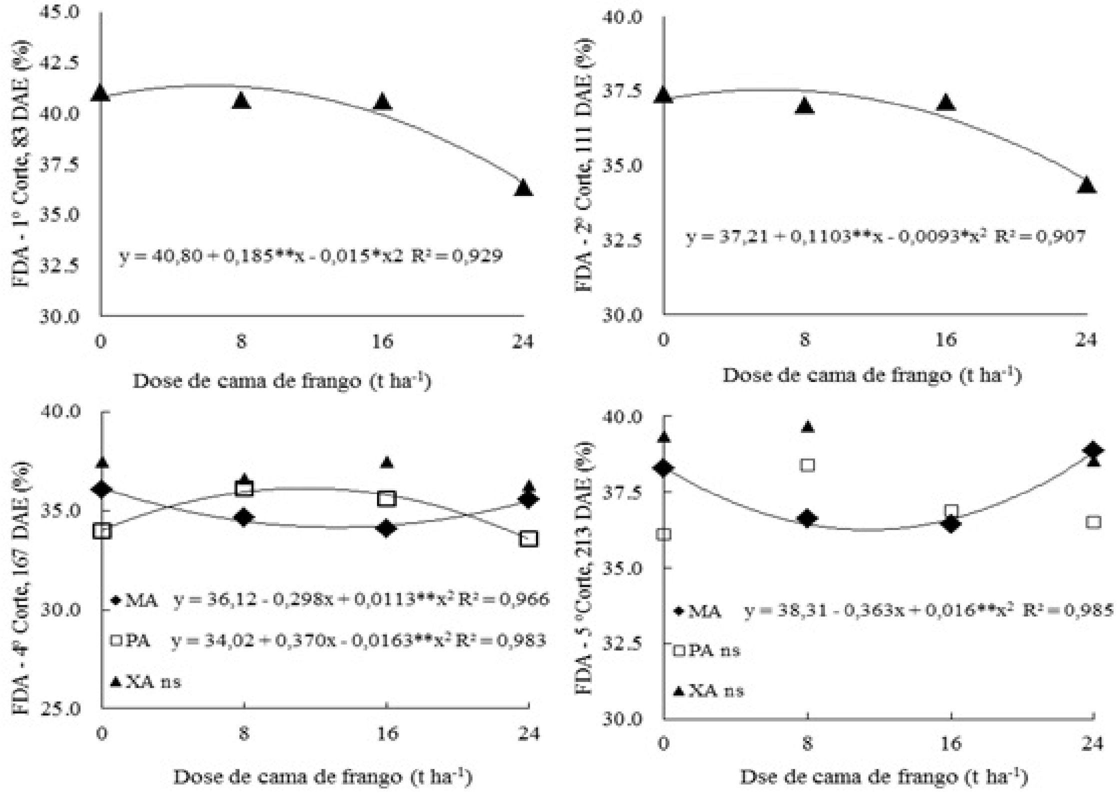
The chemical composition of the forages collected from the six cuts was subsequently determined via the Van Soest method (1965). The acid detergent fiber (ADF) and neutral detergent fiber (NDF) contents were determined via the sequential method (ROBERTSON; VAN SOEST, 1981). After each cut, all the vegetation present in each plot was cut with the aid of a brush cutter at the same cutting height to evaluate dry matter productivity (0.20 m). The material was subsequently removed from the experimental area.

The data obtained were subjected to analysis of variance, applying the F test at a 5% probability level. In the case of significance, the Tukey test was performed for the cultivar variable, and polynomial regression analyses were performed at the 5% probability level for the chicken litter dose factors. The statistical program used was the SISVAR (FERREIRA, 2011).

5 RESULTS AND DISCUSSION

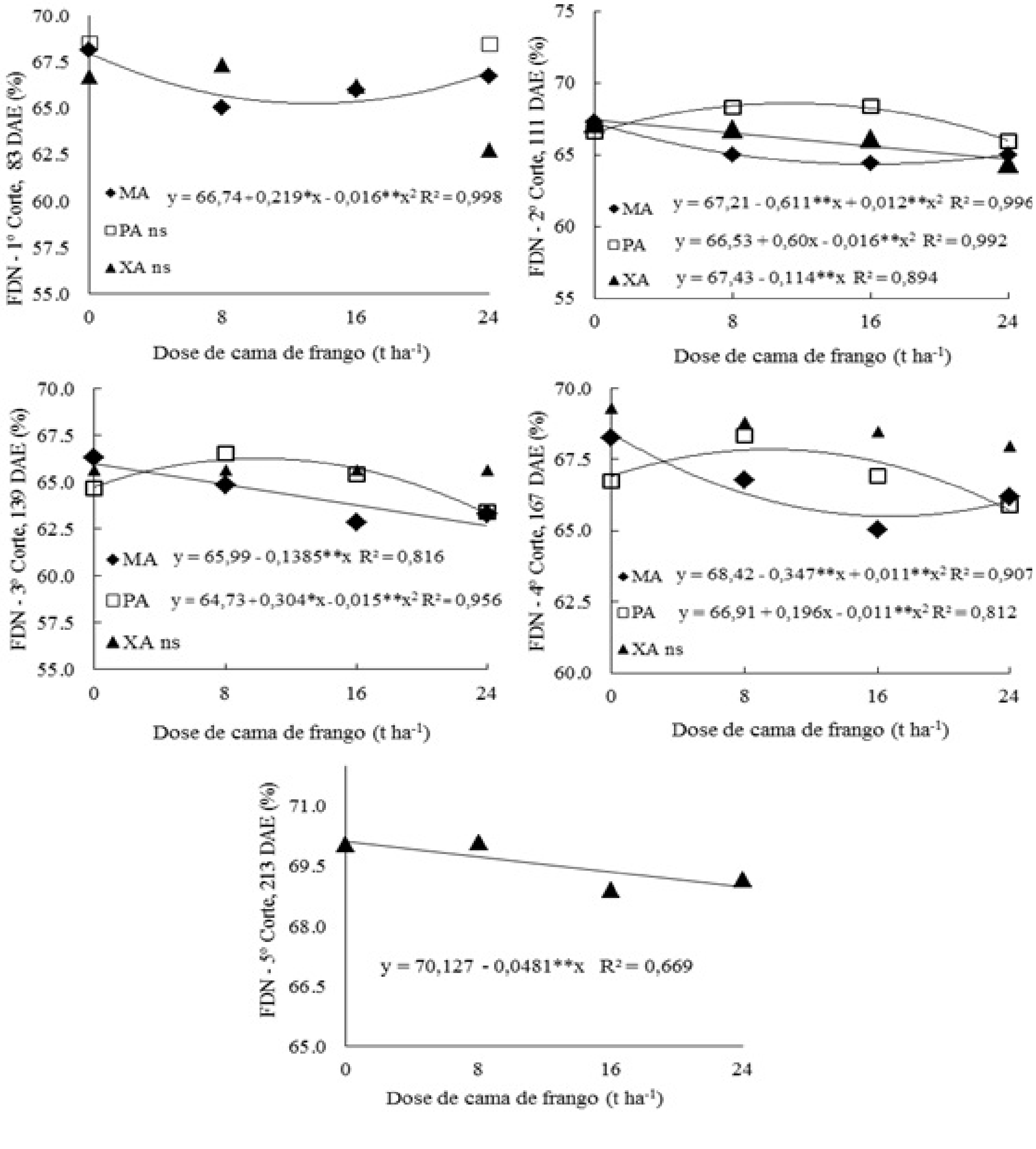
With respect to the acid detergent fiber (ADF) contents, in the first and second cuts, only a significant effect of chicken litter was observed, whose data fit the quadratic model in relation to the doses, whose maximum contents were estimated with doses of 6.16 (41.36%) and 5.93 (37.54%) t ha $^{-1}$ chicken litter (Figures 2A and 2B). In the third and sixth cuts, the data did not fit any of the tested models, whose overall means were 33.26% and 42.68%, respectively. In the fourth cut, the ADF content data in cvs. Marandu and BRS Paiaguás fit the quadratic model, whose minimum content (34.16%) for cv. Marandu was estimated at a dose of 13.16 t ha $^{-1}$ of chicken litter, whereas for cv. BRS Paiaguás, the maximum content (36.12%) was estimated at a dose of 11.35 t ha $^{-1}$ of poultry litter (Figure 2C). In the fifth cuttings, only the data from cv. Marandu fit the quadratic model, whose minimum content (36.25%) was estimated at a dose of 11.34 t ha $^{-1}$ poultry litter (Figure 2D). The NDF and ADF contents observed by Lana *et al.* (2010) showed small variations. The authors reported that the observed fiber values are considered normal for tropical forages, such as *Brachiaria.* The lowest observed fiber value was determined by the highest CF dosage, 12.5 t ha $^{-1}$ per year, whose value did not differ statistically from that of mineral fertilization.

Figure 2. Acid detergent fiber (ADF) levels in the dry matter of *Urochloa brizantha forage* and cultivars Marandu (MA), BRS Paiaguás (PA) and Xaraés (XA) subjected to different doses of chicken litter in the first (A), second (B), fourth (C) and fifth cuts (D) after plant emergence (DAE), Rio Verde, Goiás.



The estimated neutral detergent fiber (NDF) contents in the DM of Marandu grass in the first, second, and fourth cuts conformed to the quadratic model in relation to the poultry litter doses, whose maximum contents were obtained, with doses of 6.87 (67.46%), 15.98 (64.33%), and 16.85 (65.50%) t ha $^{-1}$ poultry litter (Figures 3A, 3B, and 3D), respectively, whereas the third cut conformed to the decreasing linear model, with a decrease of 1.11% for each increment of 8 t ha $^{-1}$ poultry litter (Figure 3C). The NDF data of cv. BRS Paiaguás also conformed to the quadratic model; however, in the second, third, and fourth cuts, the maximum contents were obtained, with doses of 18.75 (72.16%), 9.98 (67.84%), and 9.50 (67.84%) t ha $^{-1}$ chicken litter, respectively (Figures 3B, 3C, and 3D). With respect to cv. Xaraés, the NDF data fit the decreasing linear model only in the second cut, with a decrease of 0.91% for each increment of 8 t ha $^{-1}$ of chicken litter (Figure 3B), whereas in the other cuts, the data did not fit any model tested.

Figure 3. Neutral detergent fiber (NDF) contents in the dry matter of *Urochloa brizantha forage;* cultivars Marandu (MA), BRS Paiaguás (PA) and Xaraés (XA); and chicken litter, first (A), second (B), third (C), fourth (D) and fifth cut (E), after plant emergence (DAE), Rio Verde, Goiás.



In the fifth cuttings, only the effect of poultry litter dose on NDF content was observed, and the data fit a decreasing linear model, with a 0.38% decrease in NDF content for each 8 t ha $^{-1}$ ^{increase} in NDF content in poultry litter (Figure 3E). In the sixth cuttings, there was no significant effect of treatment on the NDF content in dry matter, whose overall average was 73.87%. The NDF and ADF contents observed by Lana *et al.* (2010) showed small variations as a function of poultry litter dose, whose observed NDF values were considered normal for tropical forages, such as *Brachiaria decumbens,* in which the lowest observed NDF value was determined by the highest dosage (12.5 t ha $^{-1}$ per year), and this value did not differ statistically from that of mineral fertilization.

The results of this study show the opportunity to use chicken litter as an alternative for pasture fertilization, since responses close to the doses of this organic fertilizer with NPK were obtained, which is important for Brazil, which imports most of the mineral fertilizers used in the country, which are expensive, and generally, the resources of farmers are limited. In addition, the use of these residues can promote improvements in the physical, chemical and biological attributes of the soil, constitute nutrient recycling in the soil–plant system and provide a more appropriate destination for chicken litter (FERREIRA *et al.*, 2022; RAHMAN *et al.*, 2020; YU; LI; DOLUSCHITZ, 2020).

6 CONCLUSIONS

The acid detergent fiber (ADF) levels in the first and second cuts were the highest at doses of 6.16 (41.36%) and 5.93 (37.54%) t ha $^{-1}$ chicken litter, respectively.

The Marandu cultivar presented the lowest ADF content at a dose of approximately 12 t ha $^{-1}$ poultry litter. The BRS Paiaguás cultivar presented the highest ADF content (36.12%) at a dose of 11.35 t ha $^{-1}$ poultry litter.

Marandu grass in the first, second, and fourth cuts presented the highest neutral detergent fiber (NDF) levels, reaching approximately 17 t ha $^{-1}$ poultry litter. The NDF levels of the BRS Paiaguás cultivar in the second, third, and fourth cuts presented the best values at 10 t ha $^{-1}$ poultry litter. The NDF levels of the Xaraés cultivar tended to decrease with increasing poultry litter dose.

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