

Forage intake by heifers on alexander grass (*Urochloa plantaginea* (Link.) Hitch) fertilized with different levels of nitrogen

Ingestão de forragem por novilhas em Papuã (*Urochloa plantaginea* (Link.) Hitch) fertilizada com diferentes níveis de nitrogênio

Ingesta de forraje por vaquilla en *Urochloa plantaginea* fertilizada con diferentes niveles de nitrógeno

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Abstract

This work was conducted to study the efficiency of using nitrogen on Alexander Grass (*Urochloa plantaginea* (Link.) Hitch) through information about the characteristics of the pasture and forage intake of beef heifers. The experiment was carried out at the Federal University of Santa Maria (Universidade Federal de Santa Maria, UFSM) in Santa Maria, Rio Grande do Sul, Brazil, from January to April of 2014. The treatments consisted of doses of zero, 150, or 300 kg/ha nitrogen (N) in the form of urea. The study used a rotational pasture method and 16 Angus heifers with a mean initial age and body weight (BW) of 15 months and 276 ± 17.4 kg, respectively. Forage intake was evaluated by treating two picketed test heifers with chromium oxide (Cr_2O_3) for eleven days as an external indicator of fecal production. The experimental design was completely randomized, and the measurements were repeated over time with three treatments and two repetitions per area. Crude protein content was 3.4% higher under 300 kg/ha nitrogen fertilization compared to 150 kg/ha (18.7%). Independent of the N application rate, the heifers ingested 2.2 ± 0.09 kg DM 100/ kg BW of forage. Nitrogen fertilization of Alexander grass modified the structure of the pasture, increasing the quality and total production of the forage. Heifers pastured on Alexander grass fertilized with 300 kg/ha nitrogen

harvested forage with higher levels of crude protein. The structural change in the canopy let the heifers reduce their consumption of forage at the end of the Alexander grass life cycle.

Keywords: Angus; Bite mass; Chromium oxide; Grazing cycle; Nitrogen fertilization; Rotational stocking.

Resumo

Este trabalho teve como objetivo estudar a eficiência do uso de nitrogênio no papuã (*Urochloa plantaginea* (Link.) Hitch) por meio de informações sobre as características da pastagem e do consumo de forragem de novilhas de corte. O experimento foi conduzido na Universidade Federal de Santa Maria (UFSM) em Santa Maria, RS, Brasil, de janeiro a abril de 2014. Os tratamentos consistiram de doses de zero, 150 ou 300 kg/ha de nitrogênio (N) na forma de ureia. O estudo utilizou o método de pastejo rotativo e 16 novilhas Angus com média de idade inicial e peso corporal (PC) de 15 meses e $276 \pm 17,4$ kg, respectivamente. O consumo de forragem foi avaliado pelo tratamento de duas novilhas de teste com óxido de cromo (Cr_2O_3) por onze dias como indicador externo da produção fecal. O delineamento experimental foi inteiramente casualizado e as medidas foram repetidas ao longo do tempo com três tratamentos e duas repetições por área. O teor de proteína bruta foi 3,4% maior na dose de 300 kg/ha de nitrogênio em comparação com 150 kg/ha (18,7%). Independentemente da taxa de aplicação de N, as novilhas ingeriram $2,2 \pm 0,09$ kg MS/100 kg de PV de forragem. A fertilização com nitrogênio no papuã modificou a estrutura da pastagem, aumentando a qualidade e a produção total da forragem. Novilhas pastando em papuã adubado com 300 kg/ha de nitrogênio colheram forragem com maiores teores de proteína bruta. A mudança estrutural no dossel ocasionou a redução do consumo de forragem ao final do ciclo de vida do papuã.

Palavras-chave: Angus; Massa de bocado; Óxido de cromo; Ciclo de pastejo; Fertilização com nitrogênio; Lotação rotativa.

Resumen

El objetivo de este trabajo fue estudiar la eficiencia del uso de nitrógeno en *Urochloa plantaginea* teniendo en cuenta las características del pasto y la ingesta de forraje de añejos de aptitud cárnica. El trabajo se llevó a cabo en la Universidad Federal de Santa Maria (UFSM) en Rio Grande do Sul, Brasil, de enero a abril de 2014. Los tratamientos consistieron en dosis de 0, 150 ó 300 kg/ha de nitrógeno (N) en forma de urea. El ensayo se realizó con el método de pastoreo rotativo y se emplearon 16 hembras de la raza Angus con una edad inicial media y peso corporal (PC) de 15 meses y $276 \pm 17,4$ kg, respectivamente. La ingesta de forraje se calculó realizando la prueba del óxido del cromo (Cr_2O_3) como indicador externo de producción fecal, durante 11 días a 2 animales. El diseño experimental fue aleatorizado con medidas repetidas a lo largo del tiempo con tres tratamientos y dos repeticiones por área. El nivel de proteína bruta fue un 3,4 % mayor en el tratamiento de 300 kg/ha de nitrógeno en comparación con el tratamiento de 150 kg/ha. Independientemente de la tasa de aplicación del N, los animales ingirieron $2,2 \pm 0,09$ kg MS/100 kg del PV de forraje. La fertilización con nitrógeno modificó el pasto de *U. plantaginea*, aumentando la calidad y producción total del forraje. El ganado que pastoreó en la zona de pasto de *U. plantaginea* fertilizada con 300 kg/ha de nitrógeno presentó mayores niveles de proteína bruta. El cambio estructural en la altura del pasto (dosel) permitió que el ganado redujera el consumo de forraje al final del ciclo de vida de *U. plantaginea*.

Palabras clave: Angus; Masa de mordedura; Óxido de Cromo; Ciclo de pastoreo; Fertilización con Nitrógeno; Rotación de pastos.

1. Introduction

Brazil has principally distinguished itself on the world agribusiness stage through its livestock production sector, and it possesses the second largest cattle herd in the world with approximately 213 million cattle (IBGE, 2016). One-hundred and sixty million hectares of pasture are dedicated to this herd, which makes the stocking rate 1.3 animals/ha (IBGE, 2014).

In the search for greater beef cattle production efficiency, Alexander grass (*Urochloa plantaginea* (Link.) Hitch) is a forage alternative with great production potential that provides suitable feed for post-weaning heifers (Costa et al., 2011), and it is possible to raise 2.3 extra heifers per hectare when the Alexander grass is fertilized with nitrogen (Salvador et al., 2016).

Nitrogen-fertilized Alexander grass has been studied by various authors; however, until now, there has been no study about its relationship with consumption by cattle. Using N reduces the time to appearance of leaves, increases production of new cells and the number of leaves per plant. Provides tiller development and, consequently, in forage production, by be part of proteins and nucleic acids (Silva et al., 2013).

The pasture structure, especially in tropical species, plays a crucial role in the forage selection and apprehension process. The relationship between plants and animals is important for an efficient use of pasture, as it influences behavior

ingestive, forage consumption and performance of ruminants (Januszkewicz et al., 2017)). In this context, the assessment of forage intake becomes necessary, as animal performance is directly dependent on daily forage consumption (Paula et al., 2012). This result is associated with the animal, the pasture, or even abiotic factors (Carvalho et al., 2009).

This study was conducted with the objective of studying the effects of nitrogen use on Alexander grass through information about the characteristics of the canopy and forage intake by beef heifers.

2. Methodology

The experiment was implemented at the Federal University of Santa Maria (Universidade Federal de Santa Maria, UFSM) from January to April of 2014 in the Central Depression of Rio Grande do Sul physiographic region located at 29°43' S, 53°42' W at an elevation of 95 meters above sea level. The climate of the region is Cfa, 'humid subtropical', according to the Köppen classification system (Moreno, 1961). Chemical analysis of the soil from the experimental area showed the following average values: pH-H₂O: 5.82; % clay: 21 m/V; P: 14.4 mg/L; K: 128.3 mg/L; % MO: 2.52 v/v; AL: 0.7 cmol/L; Ca: 5.3 cmol/L; Mg: 2.57 cmol/L; and CTC pH7: 9.25. Meteorological data for temperature, which averaged 24.1°C, and precipitation, which was 243.3 mm, for the period of the experiment were obtained from the UFSM meteorological station.

The 4.8-hectare experimental area was divided into six units (paddocks). Each paddock was further divided into four parcels of 0.2 hectares each. The Alexander grass pasture (*Urochloa plantaginea* (Link.) Hitch) had been established in December 2013 using an existing seed bank in the area. Two harrowings and one pass of a rolling compactor were performed to prepare the soil. Phosphorus and potassium fertilizers were applied at rates of 90 kg/ha-P₂O₅ and 60 kg/ha K₂O, respectively. The paddocks were mowed at uniform height 15 days before the start of the experiment.

The fertilizer applications consisted of doses of zero, 150, or 300 kg/ha nitrogen (N) in the form of urea. The quantities were divided into three applications as follows: the first (30% of the total dose) on January 8, 2014, and the others on February 10 and February 26, 2014.

The stocking method was rotational stocking. The rest period used was 210 day-degrees, which is the thermic accumulation equivalent of two phyllochrons of Alexander grass (Eloy et al., 2014). The first three cycles lasted 16 days each (12 days of rest plus four days of occupation), which was based on the daily average temperature for the months of January and February of 26.4 °C. The two final cycles lasted 24 days each (18 days of rest and six days of occupation) based on the average daily temperature for March and April of 21.7°C. The thermic sum (TS) was calculated by the equation: $TS = \sum (ADT) - 10^{\circ}C$ in which the ADTs are the average daily temperatures of the cycle and ten is the base temperature of Alexander grass growth. The period of occupation of the parcels plus the interval between pasturing constituted a grazing cycle. The grazing cycle dates were as follows: Jan 21 to Feb 5; Feb 6 to Feb 21; Feb 22 to Mar 9; Mar 10 to Mar 25; and Mar 26 to Apr 10 (all 2014) for a total of 96 days.

Sixteen Angus test heifers with an average initial age and body weight (BW) of 15 months and 276.0 ±17.4 kg, respectively, were utilized. To maintain a canopy height of 30 cm ± 10% upon exit of the animals from a parcel, 22 control heifers were used.

The canopy height was measured at 30 points at the time of the heifers entry and exit from the parcels. The parcels herbage mass was measured using two cuts at the time of entry and exit from squares with an area of 0.25 m² at two locations that were representative of the canopy height. Using the forage coming from the cuts, the dry matter (DM) and the structural composition of the Alexander grass were estimated by manually separating the leaf, stem, senescent material, and inflorescent components. The average of the leaf blade mass/ha (kg of DM/ ha) from entrance to exit, the stem mass/ha (kg of DM/ ha) from entrance to exit, and the senescent material/ha (kg of DM/ ha) from entrance to exit constituted the mass of leaf blades, stem, and senescent material.

The animals were weighed at each grazing cycle and were fasted (no solids or liquids) for 12 hours prior to the first and last pasture cycles. The stocking rate (kg of BW/ ha) per grazing cycle was obtained from the sum of the average weights of the test heifers plus the sum of the average weights of the control heifers multiplied by the number of days they were maintained in the paddock and divided by the length of the grazing cycle in days.

The herbage allowance (HA) was calculated using the ratio of forage availability to stocking rate. The leaf blade supply (LBS) was obtained by multiplying the forage supply by the percentage of leaf blades in the mass of forage.

The pasturing simulation was carried out according to the methodology (Euclides et al., 1992), i.e., done on the same day as the ingestive behavior evaluation. The forage samples were taken to a greenhouse at 55°C for 72 hours and ground in a Willey mill to determine the crude protein (CP), neutral detergent fiber (NDF) and in situ dry matter digestibility (ISDMD). The dry matter content of the samples was determined by drying them in the greenhouse at 105°C for a minimum of 8 hours.

Forage intake was evaluated in the periods of Jan 21 to Feb 1, Feb 22 to Mar 5, and Apr 3 to Apr 14 of 2014, which were the first, second, and third cycles, respectively. Two test heifers per paddock were dosed with chromium oxide (Cr₂O₃) for 11 days (seven days for adaptation and four days for fecal collection) as an external indicator of fecal production. Each heifer received a 10-g dose of chromium oxide orally at 9 am daily. Feces were collected according to the following schedule: at 12 PM and 12 AM, 3 PM and 3 AM, 6 PM and 6 AM, and 9 PM and 9 AM. The level of chromium in the dried feces was determined through atomic absorption spectrophotometry using the adapted technique (Kozloski et al., 1998). To estimate fecal production (FP, in kg of DM/day), the following formula was used: $FP = \text{chromium administered (g/day)} \div \text{chromium in feces (g of DM/ kg)}$. To determine the forage intake (FC, in kg of DM/day), the following formula was used: $FC = \text{fecal production} \div (1 - \text{forage digestibility})$. Starting from these data, forage intake, NDF intake, and CP intake, as % of BW, were calculated.

Direct visual observation of the two test heifers in each paddock was carried out for 24 hours to evaluate the ingestive behavior and durations of grazing, rumination, and other activities. The highest incidence of activity was recorded at the end of 10-minute intervals (Jamieson and Hodgson, 1979). To calculate the bite rate (bites minute⁻¹), the time needed for the heifers to take 20 bites was recorded for the maximum possible number of times in both the morning and afternoon using a chronometer, which was performed along with grazing activity observation (Hodgson, 1982). The number of bites daily (bites/day) was obtained by multiplying the bite rate by the daily grazing time (minutes /day). Values for the mass per bite (g of DM/ bite) were estimated by dividing the forage intake (g of DM) estimated on the ingestive behavior days by the number of bites (Forbes, 1988).

The experimental design was completely randomized with measurements repeated in time and over three applications and two repetitions per area. To evaluate the intake, four repetitions per application—in which each animal was considered an experimental unit—were done. Graphical residue analysis was performed to check for deviations from linearity. The data were analyzed with the statistics program SAS, version 9.4, using variance analysis and the F-test at the 10% level via the MIXED procedure, and when differences were detected, the measurements were compared using the lsmeans procedure. The interaction between applications and evaluation cycles was determined at the 5% probability level. To select the most appropriate covariance structure for each variable, a test that considered the Bayesian information criterion (BIC) was completed. The variables were also submitted to linear correlation analysis. To identify the independent variables with influence over the response variables, a stepwise procedure was used in a multiple regression analysis.

3. Results

There was no interaction ($P > 0.05$) between the N dose \times grazing cycles with the variables for herbage mass, leaf blades, stems, and dead material; with the canopy height at exit; and with the stocking rate. The canopy height at exit was

similar between nitrogen doses (28.2 ± 0.84 cm) according to the adopted handling criterion. The herbage mass, leaf blades, and stems in the paddocks providing 300 kg ha^{-1} nitrogen were 23.7%, 18.6%, and 28.8% higher, respectively, compared to the unfertilized paddocks, whereas the values for the 150-kg ha^{-1} nitrogen dose were intermediate (Table 1). The stocking rate at the 300-kg ha^{-1} nitrogen level was $2722.5 \text{ kg of BW/ ha}$, which was 23.6% higher than the zero 150 kg of N/ha levels ($2079.7 \text{ kg of BW ha}^{-1}$).

There was no interaction ($P>0.05$) between the doses of $\text{N} \times$ grazing cycles and the level of CP, level of NDF, or ISDMD. The levels of NDF ($63.9 \pm 3.3\%$) of the forage from the grazing simulation were similar when nitrogen fertilizer was used. With 300 kg of N/ha fertilization, the heifers consumed forage with an average CP level of 22.1%, a value that is 15.4% higher compared to the 150 kg/ ha application (18.7%), whereas the zero dose resulted in the lowest level at an average of 16.6% (Table 1).

Table 1 – Characteristics of Alexander grass pasture grazed by beef heifers and fertilized with three doses of nitrogen.

Variables	N dose			p*	CV**
	0 ¹	150 ²	300 ³		
Herbage mass ⁴	3438.2 ^b	3808.5 ^{ab}	4256.0 ^a	0.0223	4.3
Leaf blade mass ⁴	867.2 ^b	911.0 ^{ab}	1029 ^a	0.0952	5.0
Stem mass ⁴	2004.5 ^b	2249.9 ^{ab}	2582.6 ^a	0.0295	5.5
Dead material mass ⁴	566.7	647.5	644.2	0.2604	5.8
Exit height ⁵	29.3	27.6	27.4	0.2652	2.9
Stocking rate ⁶	1866.6 ^b	2292.7 ^b	2722.5 ^a	0.0109	6.6
CP level ⁷	16.6 ^c	18.7 ^b	22.1 ^a	0.0025	1.8
NDF level ⁷	67.2	59.5	64.8	0.2839	2.2
ISDMD ^{7#}	70.2	70.9	71.8	0.4000	4.8

^{a, b} Values on the same line followed by different letters indicate differences in the Tukey test at the 10% level; * Probability; ** Coefficient of Variation; ¹ No N applied; ² $150 \text{ kg of N ha}^{-1}$; ³ $300 \text{ kg of N ha}^{-1}$; ⁴ kg of DM ha^{-1} ; ⁵ cm; ⁶ kg of BW ha^{-1} ; ⁷ % dry material; # in situ dry matter digestibility. Source: Authors.

The levels of NDF were similar between grazing cycles ($P=0.6790$; 63.9%). There was a difference in the levels of CP between the grazing cycles because the second cycle was 31.6% higher than the third, whereas the first cycle fell between the latter two cycles (Table 2). The ISDMD was higher in the first and second cycles with an average of 76.2%, which was 20.6% higher than the third cycle.

There was a difference between pasture cycles in the herbage mass, leaf blade, stems and dead material, the canopy height at exit, and capacity utilization (Table 2). The herbage mass measured for the first cycle was $4355.1 \text{ kg of DM/ ha}$, which was 35.9% greater than the second and third grazing cycles. In the grazing cycle, the first cycle for the leaf blade mass was $1234.2 \text{ kg of DM/ha}$, which was 16.4% and 56.1% higher than the second and third cycles, respectively. The stem mass of thatch in the second cycle was $2974.0 \text{ kg of DM/ ha}$, which was 17.5% and 52.6% above the respective values for the third and first grazing cycles. The mass of dead material in the third grazing cycle was $1151.9 \text{ kg of DM/ ha}$, which was 51.6% and 87.1% greater than the second and first cycles, respectively.

Table 2 – Characteristics of different grazing cycles for Alexander grass pasture grazed by beef heifers.

Variable	Cycle			P*	CV**
	Jan 21 to Feb 1	Feb 22 to Mar 5	Apr 3 to Apr 14		
Grazing time ¹	494.3 ^b	482.5 ^b	573.3 ^a	0.0133	4.2
Daily bites ²	15401 ^{ab}	14190 ^b	16895 ^a	0.0496	4.7
Bite rate ³	31.2 ^a	29.4 ^b	29.4 ^b	0.0805	2.0
Bite mass ⁴	0.5 ^a	0.5 ^a	0.4 ^b	0.0081	4.2
Forage intake ⁵	2.5 ^a	2.1 ^b	1.8 ^b	<.0001	4.1
NDF intake ⁵	1.7 ^a	1.4 ^b	1.2 ^b	<.0001	3.4

^{a, b} Values on the same line followed by different letters indicate differences in the Tukey test at the 10% level; * Probability; ** Coefficient of Variation; ¹ Zero nitrogen; ² 150 kg of N ha⁻¹; ³ 300 kg of N ha⁻¹; ⁴ kg of DM ha⁻¹; ⁵ cm; ⁶ kg of BW ha⁻¹; ⁷ % dry material; ⁸ in situ dry matter digestibility. Source: Authors.

There was no interaction ($P > 0.05$) between the doses of N \times grazing cycles with grazing time, bite rate, daily bites, or bite mass. The grazing time (517.7 min) was similar between nitrogen doses (Table 3). Bite rate (30.0 bites/ min), daily bites (15,482 bites/ day), and bite mass (0.47 g) were also similar between nitrogen doses (Table 3).

Table 3 – Ingestive behavior, forage intake, and neutral detergent fiber (NDF) intake by beef heifers on an Alexander grass pasture fertilized with three different doses of nitrogen.

Variable	N Dose			p*	CV %**
	0 ¹	150 ²	300 ³		
Grazing time ⁴	535.2	520.1	497.7	0.4281	4.2
Daily bites ⁵	16058	15443	14945	0.5496	4.7
Bite rate ⁶	30.1	29.7	30.1	0.8778	2.0
Bite mass ⁷	0.45	0.46	0.50	0.4400	4.2
Forage intake ⁸	2.2	2.2	2.0	0.2260	4.1
NDF intake ⁸	1.5 ^a	1.4 ^b	1.3 ^b	0.0307	3.4

^{a, b} Values on the same line followed by different letters indicate differences in the Tukey test at the 10% level; *Probability; **Coefficient of Variation; ¹ Zero nitrogen; ² 150 kg of N ha⁻¹; ³300 kg of N ha⁻¹; ⁴ minutes; ⁵ bites day⁻¹; ⁶ bites minute⁻¹; ⁷ grams of dry matter bite⁻¹; ⁸ % body weight of dry matter. Source: Authors.

There was no interaction ($P > 0.05$) between doses of N \times grazing cycles with forage intake or NDF intake. Independent of the nitrogen dose that was used, the heifers achieved a similar forage intake at 2.1 ± 0.09 kg DM per 100 kg BW ($P = 0.226$). The heifers maintained on an Alexander grass pasture with 150 and 300 kg of N ha⁻¹ consumed the same quantity of NDF (1.35 kg of DM /100 kg of BW). These heifers consumed 10.0% (0.15 kg of DM/ 100 kg of BW) less NDF than the heifers maintained on unfertilized Alexander grass. The consumption of NDF was positively correlated with the mass of dead material ($r = 0.83$; $P = 0.0386$). The use of 300 kg of nitrogen per hectare in the pasture increased the leaf blade mass and reduced the percentage of dead material present in the herbage mass by 1.4% compared to the zero nitrogen dose. The heifers probably grazed on the higher layers—which lack dead material—and thus consumed less NDF.

In the first and second pasture cycles, the heifers stayed in the pasture for a similar amount of time, which was 488.4 minutes and was 84.9 minutes less than the third cycle (Table 4). The heifers took 2705 bites/ day (16.0%) more in the third grazing cycle compared to the second cycle. There was a difference ($P = 0.0081$) in bite mass between the cycles. The bites in the first and second cycles were 0.10 g larger compared to the third. This reduction resulted in lesser leaf mass in the third grazing cycle.

There was a difference between the grazing cycles and the forage intake as well as NDF intake variables. Forage intake was 20% greater in the first cycle (2.5% BW; Table 4) compared to the second and third cycles. The FDN intake of NDF in the first grazing cycle was 1.7% of BW, which was 0.4% of BW greater compared to the second and third cycles.

Table 4 – Ingestive behavior, forage intake, and NDF intake by beef heifers on Alexander grass pasture during different grazing cycles.

Variable	Cycle			P*	CV**
	Jan 21 to Feb 1	Feb 22 to Mar 5	Apr 3 to Apr 14		
Grazing time ¹	494.3 ^b	482.5 ^b	573.3 ^a	0.0133	4.2
Daily bites ²	15401 ^{ab}	14190 ^b	16895 ^a	0.0496	4.7
Bite rate ³	31.2 ^a	29.4 ^b	29.4 ^b	0.0805	2.0
Bite mass ⁴	0.5 ^a	0.5 ^a	0.4 ^b	0.0081	4.2
Forage intake ⁵	2.5 ^a	2.1 ^b	1.8 ^b	<.0001	4.1
NDF intake ⁵	1.7 ^a	1.4 ^b	1.2 ^b	<.0001	3.4

^{a, b} Values on the same line followed by different letters indicate differences on the Tukey test at the 10% level; * Probability; ** Coefficient of Variation; ¹ minutes; ² bites day⁻¹; ³ bites minute⁻¹; ⁴ grams of dry matter bite⁻¹; ⁵ % body weight of dry matter. Source: Authors.

There was an interaction ($P < 0.05$; Table 5) between the doses of N \times grazing cycles and the CP intake. In the first and third cycles, the heifers achieved similar CP intake that was independent of the doses of nitrogen applied and had averages of 0.46 and 0.29 kg DM/ 100 kg BW, respectively. In the second grazing cycle, the heifers achieved a similar consumption of CP for both the zero dose and the 150 kg of N/ ha dose at 0.43 kg DM/ 100 kg BW, which was 46.5% lower than the CP intake of the heifers maintained on Alexander grass treated with 300 kg of N/ ha. CP intake is positively associated with herbage mass ($r = 0.69$; $P = 0.0130$).

Table 5 – Crude protein (CP) intake by beef heifers after grazing on an Alexander grass pasture fertilized with different doses of N during different grazing cycles.

	N Dose	Cycle			CV**
		Jan 21 to Feb 1	Feb 22 to Mar 5	Apr 3 to Apr 14	
CP Intake ¹	0 ²	0.45	0.42 ^b	0.27	9.6
	150 ³	0.50	0.44 ^b	0.30	
	300 ⁴	0.44	0.63 ^a	0.30	
	p*	0.5074	0.0140	0.7269	

^{a, b} Values on the same line followed by distinct letters indicate differences in the Tukey test at the 10% level; * Probability; ** Coefficient of Variation; ¹ % body weight of dry matter; ² Zero nitrogen; ³ 150 kg of N ha⁻¹; ⁴ 300 kg of N ha⁻¹. Source: Authors.

4. Discussion

The structure of the vegetation influences the behavior of the grazing animal, mainly in terms of mass and bite rate, which can alter forage consumption (Soares Filho et al., 2015). Plant growth can be increased due to greater availability of N and luminosity intercepted by leaves. The increase in the availability of these resources can allow the maintenance of a higher density of tillers and, as a result, increase tissue accumulation in the plant (Irving 2015). The greater availability of N can increase the concentration of this nutrient in plant tissues and modify its morphogenesis, providing an increase in leaf size, production of dry matter and crude protein (Bernardi et al., 2018). Increased plant growth rate results in greater efficiency in the use of the forage produced, considering adequate pasture management (Gastal & Lemaire 2015). When nitrogen fertilizer was used, the similarity in the levels of NDF was similar to the result encountered by other authors, who observed an Alexander grass pasture under continuous managed grazing at 30 cm of height and found average levels of NDF of 62.5% (Costa et al., 2011). When NDF levels are over 55-60%, this restricts the consumption of forage because it interferes with the passage rate and volumetric capacity of the rumen (Van Soest, 1994). By evaluating the quality of millet pasture submitted to different doses of N, an increase in CP levels as the dose of applied N increased was also observed (Heringer & Moojen, 2002).

The similarity of the levels of NDF between grazing cycles was observed for another authors. The authors did not observe differences in the NDF levels in different periods of millet pasture utilization; however, they did find values below 60% (Camargo et al., 2009). This increase in the CP level in the second grazing cycle could be related to the pasture regrowth process and the emergence of new tillers. With the advance in the age of the plant, there is a reduction in the proportion of potentially digestible nutrients and there was a marked decrease in digestibility (Van Soest, 1994).

The authors evaluated the biomass flows in the Alexander grass pasture and observed a daily reduction in the foliar growth flow across the utilization period of the pasture due to a fall in monthly temperature as well as in the temperature throughout the annual cycle of the pasture (Eloy et al., 2014). In rotational grazing, the tillers are larger and lower in number due to the rest period, whereas the increase in competition for light favors growth of sustaining tissue of the plant (Hodgson, 1990), which might have generated the greater stem masses and thatch masses in the second grazing cycling.

Searching patterns and food prehension strategies of the herbivore are based on the canopy structure. These strategies involve changes in ingestive behavior components, such as bite frequency and grazing time. In C4 grasses managed in a way that controls the development of stems, the canopy height is structurally variable with a greater ability to respond to ingestive behavior (Glienke et al., 2016). The authors, in determining pre-grazing heights, observed that the ideal height for fodder sorghum is 50 cm and that the ingestion rate is maximized over the reduction when it was no less than 40% (Fonseca et al., 2012). The herbage mass can present differences in pasture structure, e.g., the way the plant components are distributed in the vertical horizon of the canopy, which characterizes the environment as heterogeneous (Laca and Lemaire, 2000). The authors indicate that the way leaves are presented to the animal in the pasture layers is more important than the leaf percentage itself (Sollenberger et al., 1987).

Modifications to the pasture structure are directly related to the grazing time of the ruminants after they seek out an efficient way to select, apprehend, and collect the most nutritive parts of the plants (the leaves) (O'reagain & Mentis, 1989). The bite mass is the principal determinant of the quantity of forage ingested by the animal (Hodgson et al., 1994) and is considered to be the most important aspect of forage ingestion because it is directly connected to pasture structure (Laca et al., 1992). The animal can devise new behavioral strategies when exposed to alterations in the area or in bite depth. For example, there was a compensatory increase in bite rate to maintain the same consumption rate when the bite mass is reduced. Height is the primary structural characteristic and responds directly to bite depth, which in turn is the principal determinant of bite mass (Hodgson, 1990).

With the passage of time, plants move through different stages in which depositing nutrients in vegetative versus reproductive structures is prioritize (Garcia, 1995). The reduction of leaf blade mass as the physiological stages of the plant advance is directly connected to consumption by animals because the canopy structure is determined through the defoliation performed by the bovines. In addition, bovines prefer plants with a lower proportion of stem, a higher number of easy-to-collect leaves, and higher nutritional value (L'huillier et al., 1986; O'reagain & Mentis, 1989).

The way the plant parts (leaves, stem, and dead material) are distributed within the vertical structure in the strata available for grazing determines how nutritive the pasture is because the levels of crude protein diminish from the top to the bottom of the plant, which primarily occurs through the leaf-stem relationship as well as through the accumulation of dead material (Sollenberger et al., 1987). This last component is seen as a barrier to obtaining and consuming forage by ruminants due to the high availability of dry material (Brâncio et al., 2003). A prior study reinforces the importance of the selectivity of ruminants and of the effort the animal makes to maximize the proportion of leaves in its diet (Maggioni et al., 2009). Even when the percentage of dry material is very high in relation to the leaf blade percentage, ruminants can maintain a diet that is more than 80% leaves. The observed values were lower than the 2.3% of BW predicted for heifers of this category (NRC, 1996).

5. Conclusion

Alexander grass nitrogen fertilization, which is nitrogen dose independent, increase the leaf blades mass in the canopy without modifying the forage intake by heifers. Heifers pasturing Alexander grass fertilized with 300 kg of N/ ha collected a forage with higher crude protein levels. The change in canopy structure due to the number of days the pasture is utilized is independent of the use of nitrogen, diminishes their forage intake.

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