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Cutting frequency and height on the quality of *Megathyrsus maximus* (cv. Gatton panic)

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Abstract

The aim of this study was to assess the nutritional quality of dry matter (DM) of the grass *Megathyrsus maximus* (cv. Gatton Panic). The work was carried out at "Cabaña Doña Anita," Chaco province, Argentina. A completely randomized design with a factorial arrangement with 2 cutting heights (H = 0.15 and 0.30 m), 3 frequencies (F = 30, 45, and 90 days), and 2 times (T = 90 and 180 days) was used with five replicates each (60 experimental units). The percentages of DM, crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), and digestibility (DG) were also determined. For CP, an interaction between the variables H x T and F x T was found. For the H x T interaction, the cuts carried out in less time showed a significant difference ($p < 0.05$) in both heights. For the F x T interaction in the 90 x 30 combination, there was a significant difference ($p < 0.05$) with respect to the remaining combinations. Regarding NDF, for the height variable, the content of the former increases when the grass height increases ($p < 0.05$) due to a higher elongation of stems and leaves. Concerning ADF ($p < 0.05$), differences between the T x H interaction values for 180 days with 0.15 and 0.30 m were observed. Further, significant differences were observed for digestibility ($p < 0.05$) in the H x T interaction. We conclude that the highest crude protein content was obtained with a frequency of 30 days. The NDF and ADF increased with pasture height.

Keywords: assimilable fiber, crude protein, digestibility, dry fodder, protein quality

Frecuencia y altura de corte sobre la calidad del *Megathyrsus maximus* (cv. Gatton panic)

Resumen

El estudio que se presenta a continuación tuvo como objetivo evaluar la frecuencia e intensidad de la calidad nutricional en la materia seca (MS) del pasto *Megathyrsus maximus* (cv. Gatton panic), y fue desarrollado en la Cabaña Doña Anita, provincia del Chaco, Argentina. Se empleó un diseño completamente al azar con un arreglo factorial de 2 alturas de corte (A = 0,15 y 0,30 m), 3 frecuencias (F = 30, 45 y 90 días) y 2 tiempos (T = 90 y 180 días) con cinco repeticiones para cada uno (60 unidades experimentales). Se determinó el porcentaje de MS, proteína bruta (PB), fibra detergente ácido (FDA), fibra detergente neutra (FDN) y digestibilidad (DI). En el caso de la PB, se encontró una interacción entre las variables A x T y F x T. Para la interacción T x A, los cortes realizados en menor tiempo presentaron diferencia significativa ($p < 0,05$) en las dos alturas. Para la interacción T x F en la combinación 90 x 30, hay diferencia significativa ($p < 0,05$) respecto a las restantes combinaciones. Respecto a la FDN, para la variable altura, el contenido de esta se incrementa al aumentar aquella ($p < 0,05$) debido a un mayor alargamiento de tallos y hojas. En cuanto a la FDA se observaron diferencias ($p < 0,05$) entre los valores para la interacción T x A para 180 días con 0,15 y 0,30 m. Para la digestibilidad, se encontraron las diferencias significativas ($p < 0,05$) en la interacción de T x A. Se concluye que el mayor contenido de proteína bruta se obtuvo con la frecuencia de 30 días. La FDN y la FDA aumentaron con el mayor tiempo y la altura de la pastura.

Palabras clave: calidad proteica, digestibilidad, fibra asimilable, forraje seco, proteína bruta

Introduction

Livestock activity is developed through grazing as the main food resource with native and naturalized species (Pirela, 2005), which occur mainly in natural grasslands composed of *abras* or terrains without trees, areas with continuous high pastures, and meadows. Likewise, in the center and north of Argentina, implanted pastures are being energetically incorporated, which have the capacity to produce a higher quantity of biomass and maintain forage quality for more extended periods of time compared to natural pastures, features that allow the intensification of livestock farming (De León, 2004). As occurs in all tropical forages, these grasses concentrate most of the dry matter (DM) production during the rainy periods (Van Soest, 1994).

Growth occurs between the months of October to March in the southern hemisphere, and production is scarce or null when the temperature and humidity decreases in the remaining months of the year (Santos et al., 2014). The forage production achieved is a function of the interaction of climatic (rainfall, temperature, and luminosity), edaphic (physical, chemical, and biological soil characteristics), and anthropogenic factors (pasture implantation and management techniques) (Lara et al., 2010).

The province of Chaco, Argentina, is part of the Chaco region, which extends through several Argentinian provinces and, additionally, it covers large areas of Paraguay, Bolivia, and Brazil (Galmarini & Raffo, 1964). Within Argentina, the Chaco is found in the northeast region of the country; it limits with the provinces of Formosa to the north; to the east with Corrientes; to the south with Santa Fe, and, to the west with Salta and Santiago del Estero.

Among the factors that affect the nutritional value of forage are those that are specific to the plant (species, age, and morphology, among others), and environmental factors (temperature) (Lattanzi et al., 2004), such as solar radiation, precipitation, fertility, and soil type. Besides, there are biotic factors (undesirable plants, pests, and diseases), and management factors (seed selection, sowing, management, fertilization, diseases, frequency and grazing height, animal load, and time of occupation) that man exercises on the pasture (Avellaneda et al., 2008; Cano et al., 2004).

The development of the phenological stages establishes the decrease in the digestibility of the pastures, a fact that is accentuated during the reproductive development, due to the reduction in clumping, leaf-stem ratio (leaf: stem), and an increase in the concentration of structural carbohydrates (Verdecia et al., 2012). As the pasture age advances, an increase in plant biomass is observed in detriment of the nutritional quality of the forage. This occurs due to the accumulation of supporting tissues and changes in the internal organization of the cell wall that makes the forage less digestible (Agnusdei, 2013; Van Soest, 1994).

The majority of forage species suffer a decrease in their nutritional value with increasing re-growth age, resulting in a lower leaf: stem ratio, combined with increasing lignification of the cell wall. This can be controlled through grazing management or the forage cutting moment for its conservation (Verdecia et al., 2012). According to Van Soest (1994), the aging of the forage plant leads to an increase in the cell wall and a decrease in the plant cell content (Cano et al., 2004).

Megathyrsus maximus Jacq. (Poaceae)

Megathyrsus is a genus with around 470 species belonging to the Poaceae family. They are native to tropical regions around the world and considered perennial grasses of 1 to 3 m of height (Freckmann & Lelong, 2002; Milera et al., 2017). One of the most widely spread grasses in the tropics is the Guinea grass (*Megathyrsus maximus* (Jacq.) B. K. Simon and S. W. L. Jacobs) which is native to tropical Africa and was introduced more than a century ago to the Americas. It is a perennial plant that forms clumps with slightly creeping rhizomes. It needs well-drained and medium to high fertility soils, precipitation values between 800 mm and 3,500 mm/year, and it grows very well in high temperatures. It does not tolerate intense floods or droughts and responds well to nitrogen fertilization. The Gatton panic cultivar is original from Zimbabwe and was selected in trials around the years 1956 and 1964 in Queensland, Australia, and has vigorous growth and high self-seeding potential (Glatzle, 1999). It is a perennial, cespitose, and upright plant that can form dense vines or clumps; it has a deep and fibrous root system, and its stems reach a height between 0.6 and 1.5 m. It is also an apomictic species, so its cultivation does not produce crossbreeds with other cultivars and remains stable after generations (Glatzle, 1999). It is adapted to humid tropical and subtropical climates, it thrives well from the sea level up to 1,500 m a.s.l., and it grows in different types of soils.

Accordingly, the aim of this work was to evaluate the DM quality of Gatton panic Guinea grass and its interaction at different heights and cutting frequencies. The basic hypothesis is that DM quality is not modified by the changes in the heights and cutting frequencies.

Materials and methods

The work was carried out in the production unit at Cabaña Doña Anita, located in the Pampa Toloza area, General Güemes department, Chaco province (26°03'26.3'' S, 60°47'13.6'' W, at an altitude of 175 m a.s.l.). Rainfall averages 910 mm, most of it distributed during the months of November to April.

The essay was carried out over a period of 14 months, between the months of April 2011 and May 2012. The samples were taken during the rainy season, which was scarce; this caused a state of severe drought prevailing throughout the region. The grass *Megathyrsus maximus* cv. Gatton panic was eight years old and subjected to rotational grazing management; therefore, in March, it was allowed to rest to favor pasture re-growth. In November, a uniform cut was made at the height of 0.20 m with a motor scythe and the plot remained closed for the entry of animals until the completion of the work.

The plot was divided into 60 experimental units (3 x 3 m). The treatments consisted of two heights (H = 0.15 and 0.30 m), three cutting frequencies (F = 30, 45, and 90 days), and two times (T = 90 and 180 days) with five repetitions for each (giving a total of 60 experimental units). Once the cut was made, the forage was weighed (green matter = GM), packed, and labeled. Subsequently, the material was separated into leaf-blades and stem plus sheath, to obtain the proportion of each. The samples of each treatment were deposited in paper bags and placed into a forced air oven at 60 °C for a period of 48 to 72 hours until reaching a constant weight to establish the percentage (%) of DM and the aerial or aboveground biomass production in kg/ha of DM.

The chemical composition analyzes of the forage were carried out in the Physics and Chemistry laboratory of the Faculty of Agrarian Sciences of Universidad Nacional del Nordeste. The crude protein (CP) (total N x 6.25) of the forage was analyzed by the micro-Kjeldahl technique (Bateman, 1970); neutral detergent fiber (NDF) and acid detergent fiber (ADF), according to the Van Soest technique (Goering & Van Soest, 1970), and digestibility (DG) was established using the official analysis method (Association of Official Analytical Chemists [AOAC], 1995).

The data were analyzed using the statistical analysis software Infostat (Di Rienzo et al., 2017). For the analyzes of variance, repeated measures were used since all variables were measured sequentially in the same experimental units (plots) throughout the experimental period. A completely randomized design with a factorial arrangement of 2 cutting heights, 3 cutting frequencies, and 2 times, with five repetitions, was used; the additive linear model employed was the following:

$$Y_{ijkl} = \mu + \alpha_i + \beta_j + \delta_k + (\alpha\beta)_{ij} + (\alpha\delta)_{ik} + (\beta\delta)_{ik} + \varepsilon_{ikjl},$$

Where:

Y_{ijkl} is the response variable in the repetition or experimental unit "l," in the cut height "i," the cut frequency "j," and the cutting time "k"; μ is the common constant or population mean; α_i is the effect of the i-th level of the cutting height: 1, 2; β_j is the effect of the j-th level of the cutting frequency: 1, 2, 3; δ_k represents the effect of the k-th time: 1, 2; $(\alpha\beta)_{ij}$ is the effect of the interaction of the i-th level of the cutting height with the j-th level of the cutting frequency; $(\alpha\delta)_{ik}$ is the effect of the interaction of the i-th level of the cutting height 1, 2 with the k-th time 1, 2; $(\beta\delta)_{ik}$ is the effect of the interaction of the j-th cutting frequency level 1, 2, 3 with the k-th time 1, 2; and ε_{ikjl} represents the plot error with the i-th cutting height treatment, the j-th cutting frequency treatment, and the k-th cutting time effect.

Results and discussion

Crude protein

For crude protein (CP), an average of 10.2 % was found with significant effects ($p < 0.01$) of the cutting frequency and time, and the interactions of H x T and F x T (table 1). For the H x T interaction, the cuts made in less time showed significant differences in the two heights compared to those that were carried out after a longer time.

For the F x T interaction, in the 30 x 90 combination, there is a significant difference concerning the other combinations since a CP content of 10.7 % was obtained at the time of 30 x 90 (table 2). Pastures that are subjected to a high frequency of defoliation develop a structure with a high density of smaller clumps, to the extent that the intensity and time of defoliation are not too severe (Borrelli & Oliva, 2001).

Crude protein in this study is considered acceptable. Similar results have been reported in the literature (Casado & Cavalieri, 2016; Barrera-Álvarez et al., 2015; Milera et al., 2017; Verdecia et al., 2008) and may be due to the young material, which is composed mainly by leaf blades with low content of stems and dead material. As the regrowth age increases, the plant undergoes significant changes in soluble and structural components. Besides, due to its physiology, the plant translocates part of these compounds to reserve (root) or reproductive (flowers) organs, and thus, decreases its nutritional and digestibility value. However, Parceriza and Iribas (2008) found that the percentage of CP in four forage plants in *Brachiaria* only reached 7.69 %.

Table 1. Analysis of variance for crude protein, neutral detergent fiber, acid detergent fiber and digestibility in the grass *Megathyrsus maximus* cv. Gatton panic in the northeast of the Chaco, Argentina

Variation source	DF	Crude protein		Neutral detergent fiber		Acid detergent fiber		Digestibility	
		F-value	P-value	F-value	P-value	F-value	P-value	F-value	P-value
Height (H)	1	0.12	n.s.	7.90	0.009	0.00	n.s.	0.00	n.s.
Frequency (F)	2	516.9	0.001	1.14	n.s.	0.18	n.s.	0.18	n.s.
Time (T)	1	69,791	0.001	73.45	0.001	57.86	0.001	57.79	0.001
H x F	2	0.88	n.s.	0.40	n.s.	1.08	n.s.	1.08	n.s.
H x T	1	37,053	0.001	1.32	n.s.	4.63	0.040	4.62	0.041
F x T	2	44,441	0.001	1.81	n.s.	1.77	n.s.	1.77	n.s.

DF = degrees of freedom; n.s. = not significant; F-value = value of F; P-value = probability value.

Source: Elaborated by the authors

On the other hand, Ramírez (2007) expressed that an increase in temperature can have a positive effect on forage quality by increasing the CP concentration. In turn, Patiño Pardo et al. (2018) described in their work that the trend of CP content increased as the cutting height decreased. For their part, Lucena et al. (2004) found in *Brachiaria brizantha* cv. Marandú, significant differences for the frequency of 21 days, regardless of the cutting height.

Other authors found similar results with the same age, but on different cultivars. For example, Martínez (2001), when evaluating *M. maximum* cv. Tobiatá compared to cv. Tanzania, at a cutting time of 28 days, found higher content of CP in cv. Tobiatá. Likewise, Baldelomar et al. (2004) reported in *M. maximum* cv. Gatton panic and cv. Tanzania, the highest content of CP at a cutting time of 20 days and, later, a detriment in this content as age increased. For their part, Romero and Mattera (2011) found for *M. maximum* cv. Gatton panic significant differences with cutting times at 28, 35, and 42 days, and whose highest frequency was the one with the highest CP content.

Table 2. Crude protein content, neutral detergent fiber, acid detergent fiber, and digestibility in the grass *Megathyrsus maximus* cv. Gatton panic in northeast Chaco, Argentina

Treatment	Crude protein	Neutral detergent fiber	Acid detergent fiber	Digestibility
Height (m)				
0.15	10.2 ± 0.04 [a]	61.6 ± 0.29 [b]	31.9 ± 0.76 [a]	67.1 ± 0.61 [a]
0.30	10.2 ± 0.08 [a]	62.8 ± 0.29 [a]	31.9 ± 0.76 [a]	67.1 ± 0.61 [a]
Frequency (days)				
30	11.9 ± 0.11 [a]	61.3 ± 0.19 [a]	31.1 ± 0.23 [a]	67.5 ± 0.52 [a]
45	10.1 ± 0.05 [b]	62.3 ± 0.19 [a]	31.5 ± 0.23 [a]	66.7 ± 0.52 [a]
90	8.7 ± 0.04 [c]	62.9 ± 0.18 [a]	31.6 ± 0.25 [a]	64.7 ± 0.52 [a]
Time (days)				
90	11.1 ± 0.04 [a]	60.6 ± 0.28 [b]	29.3 ± 0.54 [b]	69.2 ± 0.43 [a]
180	9.4 ± 0.04 [b]	63.8 ± 0.28 [a]	34.4 ± 0.54 [a]	65.1 ± 0.43 [b]

a, b, c in the same column and row are significantly different ($p < 0.05$)

Source: Elaborated by the authors

Neutral detergent fiber

For the neutral detergent fiber (NDF) variable, the height and the cutting time significantly affected ($p < 0.01$) this variable. However, none of the interactions was significant ($p > 0.05$; table 1). For the variable "height," the NDF content increased with increasing height, which is attributable to the increase in aerial biomass, with a higher lengthening of stems and leaves to capture sunlight.

Similarly, for the time variable, a significant effect ($p < 0.05$) was found for the NDF content, and the cutting time of 180 days was the one that showed the highest difference (table 2).

Neutral detergent fiber is a fraction whose increase is associated with the progress of the phenological state of the plant (Barrera-Álvarez et al., 2015; Casado & Cavalieri, 2016; Veneciano et al., 2006; Verdecia et al., 2008). However, as plants mature and produce thickening, lignification of the walls and reduction of cell content, the concentration of protein, energy, calcium, phosphorus, and digestible dry matter in the plant decreases, while the concentration of NDF increases. As the NDF increases, the lignin content increases, which makes carbohydrates less available for the rumen microorganisms (De Almeida- Rego et al., 2003; Ramírez, 2007; Rego et al., 2003).

For their part, Rincón et al. (2008) and Rezende et al. (2012) reported that the different defoliation heights in *Brachiaria decumbens* and *B. brizantha* did not affect the quality of the pastures ($p > 0.05$); moreover, they also did not obtain differences in the NDF content. Similarly, Oliveira et al. (1998) found no differences in the NDF content in cultivars of *M. maximum.*

The variable time (180 days) affected the content of the NDF. This could be due to the competition that occurs between the same clumps, which results in plants with extensive internodes and more thickened stems, and with a strong component of supporting tissues (Costa et al., 2006; De Almeida-Rego et al., 2003). On the contrary, Jiménez et al. (2010) found differences in the NDF content of *Brachiaria humidicola* with the lowest frequency.

Acid detergent fiber

For the acid detergent fiber (ADF) variable, differences were observed ($p < 0.05$) due to harvest time and the height x time interaction. The cutting time of 180 days and the heights of 0.15 and 0.30 m showed differences with respect to the cutting time of 90 days (table 2).

As expected, acid detergent fiber (ADF) increased with the longest time (180 days). In general, in the highest precipitation period, the increase in light intensity and temperature, associated with the availability of humidity, favored the rapid increase in metabolic activity, which reduced the assimilates and the cellular content of metabolites. Therefore, photosynthesis products are converted into structural tissues such as cellulose, hemicellulose, and lignin, which leads to a reduction in the content of CP and *in vitro* digestibility of DM (Carvalho & Pires, 2008; Van Soest, 1994; Ramírez, 2007).

For their part, Patiño et al. (2018) pointed out that the ADF content increased linearly ($p = 0.04$) as a function of the increase in cutting height.

Digestibility

Finally, for the digestibility variable, significant differences are observed ($p < 0.05$) for the time variable and the interaction of height x time, so the highest value was obtained at the cutting time of 90 days with heights of 0.15 and 0.30 m. For the 90 x 15 combination, there was a value of 68.6 %, and for the 90 x 30 combination, the digestibility reached 69.7 % (table 2).

The digestibility values observed in this work are similar to those reported in the literature (Juárez et al., 2009; Milera et al., 2017; Patiño et al., 2018; Ramírez, 2007).

At the beginning of the vegetative stage, protein and organic matter digestibility from tropical grasses are generally high. Santos et al. (2011) mentioned that the quality and productivity of the pastures are influenced by environmental factors (temperature, light, and humidity), in addition to the intrinsic properties of each plant.

Among the quality components of forage, digestibility is a very valuable indicator. Likewise, the protein and fiber contents also reveal the nutritional value of the pasture, since, when the former is higher and the latter is lower, the quality will be higher.

Conclusions

It can be concluded that under the conditions in which the current work was carried out, the highest crude protein content was obtained with the cutting frequency of 30 days. Similarly, neutral detergent fiber and acid detergent fiber increased with the longest time and height of the pasture. Finally, the highest digestibility was observed at the cutting time of 90 days and with both cutting heights.

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Disclaimers

All authors made significant contributions to the document, agree with its publication, and declare that there are no conflicts of interest in this study.

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