Heifers rearing on natural grassland under rotational grazing during warm season

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ABSTRACT: *This study aimed to evaluate the effect of two rest intervals between grazing on the structural characteristics of pasture and performance of beef heifers in Campos grassland under rotational grazing. The treatments were two intervals between 375 and 750 DD (degree-days) grazing, based on the cumulative thermal sum for leaf expansion of native grasses belonging to capture and conservation groups of resources dominant in a natural grassland. The experiment was conducted during 151 days from October 2015 to March 2016, and twenty-four Braford heifers tests mean age = 12 months; mean body weight = 220kg (± 27.8) were used. The pre-grazing total forage mass (FMt) was on average 3791 kgMSha⁻¹ and did not differ between treatments and season, the same occurred with the non-tussock FM. The average stocking rate was 469 kg ha⁻¹ in both treatments. The average daily gain varied only between seasons, 0.102 kg animal⁻¹ day⁻¹ during spring and 0.372 kg animal⁻¹ day⁻¹ during summer. During the 151 evaluation days, the gain per area was a 103 kgha⁻¹. The use of rest intervals between grazing based on the leaf elongation of dominant grasses, when applied to the areas of Campos grasslands, provided nutritional conditions to reach the target body weight for breeding 24 months old beef heifers.*
Key words: *Pampa biome, grassland, animal production.*

Recria de novilhas em pastagem natural sob pastoreio rotativo na primavera-verão

RESUMO: *O estudo objetivou avaliar o efeito de dois intervalos de descanso entre pastoreios nas características estruturais do pasto e desempenho de novilhas de corte em pastagens naturais manejadas em pastejo rotativo. Os tratamentos foram dois intervalos entre pastejos de 375 e 750 GD (graus dia), baseados na soma térmica da duração de elongação foliar média de gramíneas de grupos de captura e conservação dos recursos dominantes de uma pastagem natural. O experimento foi conduzido no período de outubro de 2015 a março de 2016, com duração de 151 dias e os períodos experimentais divididos em primavera e verão. Foram utilizadas 24 novilhas teste da raça Braford, com idade inicial na média de 12 meses, e de peso corporal médio de 220 kg (± 27,8). A Massa de forragem total (FMt) pré-pastejo foi em média de 3791 kgMSha⁻¹ e não diferiu entre tratamentos e estação, o mesmo ocorreu com a FM de estrato não touceira. A taxa de lotação média foi de 469 kgha⁻¹ em ambos os tratamentos. O ganho médio diário variou apenas entre estações, com médias de 0,102 kganimal⁻¹dia⁻¹ na primavera e 0,372 kganimal⁻¹dia⁻¹ no verão. O ganho por área durante os 151 dias de avaliação foi em média de 103 kgha⁻¹. As pastagens naturais submetidas a intervalos de descanso entre pastoreios baseados na elongação foliar de gramíneas dominantes, independente do tratamento utilizado, proporcionam ritmos de ganhos médios diários compatíveis com a meta de peso corporal, a ser atingida aos 24 meses, para que as novilhas possam ser acasaladas.*
Palavras-chave: *bioma Pampa, campo nativo, produção animal.*

INTRODUCTION

Grasslands are the predominant potential vegetation in Rio Grande do Sul and contain a great diversity of species. It is known that between 70 and 80% of the biomass is composed of grasses (GUIDO et al. 2016). Cruz et al., (2010) aiming to simplify management, proposed the construction of a typology of grasslands based on leaf attributes that could meet management criteria demanded by producers and technicians. Native grasses were thus classified into four functional groups (A, B, C, and D) according to leaf attributes such as specific leaf area and dry matter content. Groups A and B are composed of grasses characteristic of resource capture, represented mainly by *Axonopus affinis* and *Paspalum notatum*, while groups C and D are composed of grasses from resource conservation, such as *Aristida laevis* and *Saccharum trinii* (MACHADO et al., 2013).

Grasslands are often considered poorly productive mainly because of the lack of knowledge on their adequate management, which generates

low reproductive performance of bovine herds, with low birth rates and low pregnancy recurrence rates, especially in primiparous females. The base of the breeding herd structure, which is female rearing, ends up being marginalized in most of the properties because it does not generate economic return immediately. According to Nabinger et al. (2009); although , grasslands have a lower support capacity when compared to cultivated pastures, they are still the most economical way to produce beef cattle in this region of the country, provided they are properly managed. Thus, it is necessary to seek alternatives to increase production rates and enable a better use of the natural forage resource.

The use of rest intervals between pastures is one of the alternatives related both to the physiological mechanisms of the plants and to the productive parameters of the pasture. Many studies have been proposed, and some have indicated a greater capacity to support grasslands of rotational grazing (BRISKE et al., 2008). In rotational grazing, the rest interval defines the frequency of defoliation, and the intensity of grazing (load, stocking, etc.) defines the intensity of defoliation, which can directly affect the individual performance of the animals (PEDREIRA, 2011; SILVA e NASCIMENTO JUNIOR, 2007).

Leaf elongation duration (LED) is a new criterion for defining the grass rest interval. It considers that leaf laminas (leaf) in elongation are the most efficient in terms of photosynthesis, maintaining their nutritional value high both in C3 and C4 species (CONFORTIN et al., 2010; QUADROS et al., 2011). Based on the thermal sum of the LED of dominant grass groups Barbieri et al., (2014) and Soares et al., (2015), this study aimed to evaluate the performance of heifers managed in a grassland under rotational grazing with two rest intervals between grazing.

MATERIALS AND METHODS

The experiment was conducted in an experimental area of the Department of Animal Science of the Federal University of Santa Maria, located in the Central Depression of the Rio Grande do Sul State, with geographical coordinates 29°43' S, 53°42' W and an altitude of 95 m above sea level. Treatments were two different pasture rest intervals considering as rest the mean LED of the two functional types of grasses: resource capture (functional groups A and B) and resource conservation (functional groups C and D) (acoording to the functional grouping of CRUZ et al., 2010).

Treatments were rest intervals of 375 and 750 degree-days (DD) between grazing. The 375 DD treatment was based on the thermal sum of the mean elongation of two and a half leaves of grasses from groups A and B (*Axonopus affinis, Paspalum notatum*). The 750 DD treatment was based on the elongation of one and a half leaves of groups grasses from C and D (*Aristida laevis, Saccharum trinii*) (MACHADO et al., 2013). The occupation period of each paddock was defined by dividing the accumulated thermal sum of each treatment by the number of resting paddocks of each experimental unit. Daily mean temperatures were obtained from the INMET website (Figure 1).
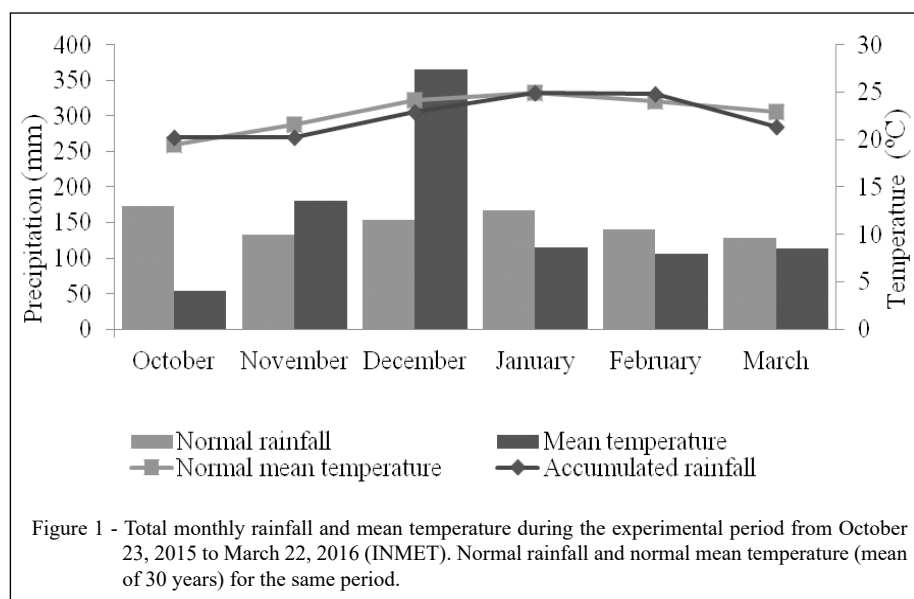
Treatments were arranged in an experimental area of 22.5 hectares in a randomized block design with three replicates. The blocking criterion was the position in the relief, which comprised hilltops, hillslopes, and foot slopes. Each block was divided into sets of experimental units (paddocks), one with seven and the other with eight subdivisions (for the 375 and 750 DD treatments, respectively) of approximately 0.5 ha per subdivision.

The experimental period was 151 days, from October 23, 2015 to March 22, 2016, and periods were divided into seasons. Spring season were considered from October 23, 2015 to December 21, 2015 and summer season from December 22, 2015 to March 22, 2016. Twenty-four Braford test heifers with an initial mean age of 12 months and a mean body weight of 220 kg (± 27.8) were used. The animals were preferably distributed so that each experimental unit received four test animals.

The pasture was under rotational grazing with variable stocking rate. A variable number of animals of the same category and sex, with a mean weight of 189 (± 26) kg, was used for adjusting the stocking rate. The mean stocking rate (MSR) was obtained by dividing the ISR by the total area of each experimental unit of each treatment. The animal stocking rate was adjusted for the consumption of 70% of the leaf mass greater than 1000 kg ha^{-1} during the occupation of each paddock. The following equation, which considers a forage disappearance of 4.5% of body weight (BW) (HERINGER & CARVALHO, 2002), was used for adjusting the instantaneous animal stocking (ISR = kg of live weight /ha in the occupied paddock):

$$ISR = ((TotalFM-1000)^* (\% green \, leaves^* 0.7))/0.045/2/$$
number of days of occupation (3 or 5).

Forage mass (FM) was determined using the visual estimation technique by comparing standards, and it was calibrated using the double sampling proposed by Haydock and Shaw (1975). Each of the subdivisions (6) of the treatment was

Figure 1 - Total monthly rainfall and mean temperature during the experimental period from October 23, 2015 to March 22, 2016 (INMET). Normal rainfall and normal mean temperature (mean of 30 years) for the same period.

evaluated in the blocks with 30 visual estimates and 10 sections using a metal frame with an area of 0.25 m². In each of the tables of the 30 estimates, three canopy heights were measured using a graduated ruler (in cm), and the structures were classified as tussock and non-tussock. Density was obtained by dividing the forage mass by the average height of each strata.

From the ten cuts made, three representative samples of the evaluated subdivision were chosen; these samples were sent for botanical and structural separation, in which the leaf and stems/grass roots, dead material (in senescence), and other non-grasses species present in the vegetation were separated. To determine the dry matter (DM) of the sample, the other cuts were taken to the oven with forced air circulation at 60 °C until they reached constant weights.

In order to estimate the post- grazing FM and disappearance of the forage, after the animals had left the representative subdivisions, six cuts were made in the stratum without tussock in order to collect the representative samples. Samples were dried in oven with forced air circulation until reaching constant weight and were used in the calculation of the output FM. The difference of the disappeared forage was obtained by subtracting the output FM from the input FM of the lower layer of the pasture. The disappearance rate was calculated from the difference in FM divided by the instantaneous stocking rate and by the mean number of days of occupation of each representative subdivision.

The mean daily weight gain (MDG) was obtained by the difference of the animal's weight among the weightings, divided by the day number among the weightings. Animals had a 12 hours total fasting period approximately each 28 days.

Live weight gain (LWG) per hectare (in kg ha^{-1}) was obtained by dividing the MSR by the mean weight of the test animals in each sample unit multiplied by the MDG of the test animals and by the number of days of the experiment (151 days). These values were subjected to analysis of variance and F test. The analysis of variance was performed using the Proc GLM procedure of the SAS® University Edition software (2016), with the inclusion of the effects of block, treatment, season, and treatment × season interaction into the model. The means were compared with LSMEANS considering a 5% significance level. The results were tested for normality.

RESULTS AND DISCUSSION

There was no interaction between treatments and periods for the variables related to pre-grazing forage mass (Table 1). The mean pasture height of the 750 treatment was 4.1 cm higher than that of the 375 treatment; a difference was observed between seasons: during the summer was higher than spring, with means of 20.8 and 21.10, respectively. The height of the non-tussock strata was higher for the 750 treatment than the 375 treatment, with means of 15.9 cm and 13.9 cm, respectively. The pasture height during the summer was 5.8 cm higher than during the spring season.

Table 1 - Mean daily gain (MDG), mean stocking rate (MSR), instantaneous stocking rate (ISR), total forage allowance (FAt), non tussock forage allowance (FAnt). Pre- grazing Height, Forage mass (FM), and % of structural components, of total biomass and non-tussock stratum (NT) in a natural grassland managed with rotational grazing method with two rest intervals (375 and 750 degree-day; DD).

Variables	Units	---Treatments---		--------Seasons------		-------Significance level (P)-------			
		375	750	Spring	Summer	Treatments	Seasons	TxS	CV
MDG	kg an^{-1} day^{-1}	0.198	0.276	0.102	0.372	0.323	0.002	0.638	77.93
MSR	kg ha^{-1}	474.0	465.0	516.1	423.8	0.802	0.161	0.206	20.89
ISR	kg ha^{-1}	1738	1777	1928	1586	0.766	0.014	0.156	
FAt	%	7.6	8.9	8.1	8.4	0.415	0.588	0.119	19.07
FAnt	%	5.0	5.6	5.0	5.7	0.151	0.113	0.633	20.69
Height	cm	18.90	23.39	20.82	21.1	0.001	0.002	0.523	15.56
FM	kg ha^{-1}	3485	4098	4083	3500	0.070	0.085	0.604	23.35
Leaf blade	%	0.36	0.36	0.31	0.41	0.830	0.0002	0.548	15.82
Stem	%	0.07	0.06	0.05	0.07	0.374	0.001	0.332	38.79
Dead material	%	0.49	0.51	0.59	0.41	0.426	<0.0001	0.795	23.73
Height (NT)	cm	13.9	15.97	12.00	17.84	0.036	<0.0001	0.112	16.25
FM (NT)	%	2310	2520	2484	2346	0.209	0.405	0.122	18.17
Leaf blade (NT)	%	0.41	0.45	0.37	0.5	0.229	0.0004	0.291	18.70
Stem (NT)	%	0.06	0.07	0.05	0.07	0.846	0.137	0.077	53.27
Dead material (NT)	%	0.43	0.39	0.51	0.31	0.226	<0.0001	0.107	26.11

The total FM (3791. kg ha^{-1}) was similar between treatment and seasons. Similarly, the FM of the non-tussock strata did not show any difference between treatments and seasons, with mean of 2415 kg ha^{-1}. The frequency of tussocks was similar between treatments (P = 0.774), with a mean of 41% and 42% of tussocks present in the 375 and 750 treatments, respectively.

Density of pre-grazing forage mass was similar between treatments (P = 0.8000) for both strata, with an average of 183 kg cm^{-1} ha^{-1} and 171.5 kg cm^{-1} ha^{-1} in the total forage mass and non-tussock strata, respectively. However, as the pasture height, it was different between the evaluated seasons (P <0.001). During the spring, the average density of the total forage mass was 214.5 kg cm^{-1} ha^{-1} while, during the summer, it was 153 kg cm^{-1} ha^{-1}. In the non-tussock stratum there was a reduction from 210.6 kg cm^{-1} ha^{-1} to 132.5 kg cm^{-1} ha^{-1}, from spring to the summer.

The percentage of leaf blades in the total FM increased over the seasons, starting with mean values of 31% in spring, and increasing to 41% in summer. The same occurred with the percentage of stems, which at the beginning of the experiment was 5%, and during the experimental period increased gradually, reaching 7% in summer (Table 1). In contrast, the percentage of dead material in forage decreased of 59% to 41%. The structural components evaluated in the non-tussock stratum had a similar behavior to the total FM throughout the experiment, with the percentage of leaves increasing from 37% in spring to 50% in summer, and the percentage of dead material decreasing from 51% to 31%. However, the percentage of stems was similar between treatments and seasons, with the average value of 6,2%.

The variables related to the post-grazing FM did not show any difference between seasons (P=0.5321). However, it was higher in the 750 DD (1436 kg DMha^{-1}) than 375 DD (1231 kg DMha^{-1}) The post grazing pasture height was 8.6 cm (P = 0.0.3752), for both treatments, it was different between seasons (P = 0.0001) increasing from 7.1cm in the spring to 10.19cm during the summer, the residual FM was 1307 kg DM.ha^{-1} (P = 0.655). The average disappearance rate was 7% for both treatments (P=0.0615). The mean time of paddocks occupation was 2.8 and 4.8 days of the 375 and 750 treatments, respectively. The mean resting intervals were 19 and 37 days for the 375 and 750 treatments, respectively. While the treatment with shortest resting interval allowed 11 grazing cycles, the treatment with longest resting interval allowed 6 grazing cycles.

The initial BW of the heifers (mean = 220 kg) was similar between the treatments (P = 0.479), as well as the weight at the end of the experiment (mean = 265.5 kg; P = 0.576). The weight gain of the experimental period was 40 kg per animal. Although, MDG was 0.246 kg an^{-1} day^{-1} and showed no difference between treatments (P = 0.0962), it was higher in the summer period (P = 0.00017) than in the spring, with gains greater than 0.300 kg an^{-1} day^{-1}. Body weight gain per area was also similar between treatments (P = 0.3559) with a mean of 103 kg ha^{-1}.

The MSR (469 kg ha^{-1}) was similar between treatments and seasons (P> 0.005). However, ISR was different between experimental periods (P 0.0139), with higher values during the first period (spring) compared to the following (summer), with average values of 1928.2 kg and 1585.9 kg, respectively. Total forage allowance (FAt) (%) (mean = 8.2%) showed no difference between treatments and seasons. Non-tussock forage stratum allowance (FAnt) (mean = 5.3%) also showed no differences between treatments and seasons.

The FM observed in the present study was higher than that observed by Trindade et al. (2016) when analyzing different forage allowances (4%, 8%, 12%, and 16%) in a grassland of the Pampa biome. Trindade et al. (2016) reported higher forage intake rates with a forage allowance of 12% and a FM of 1820–2280 kg DM.ha^{-1}, with a maximum percentage of tussocks of 30%. The higher values observed in the present research are because of the greater percentage of tussocks in the FM. The disappearance rate of the forage (7%) was higher than the recommended for cultivated pastures, which is 4.5% of the BW of the animals (HERINGER; CARVALHO, 2002).

The percentage of leaves increased over the seasons in both strata, while the percentage of senescent material decreased. This was because of the greater participation of C4 metabolic grasses, which have a high biomass production during the warm season and are responsible for the strong seasonal variation in production and forage quality (MODERNEL et al. 2016).

Pre-grazing height increased in the summer, where instantaneous stocking was lower than that of the first experimental period (spring). Although, the mean pre-grazing FM did not change over the seasons, the MDG was higher in the summer; this was due the increasing on pre-grazing pasture height, as well as the greater contribution of leaf blades and decrease of dead material, over this period.

The MDG found in the summer corroborated previous studies with rotational grazing in grasslands such as those of Barbieri et al. (2014) in the spring–summer period, which observed gains of approximately 0.300 kg an^{-1} day^{-1}. When the results of the use of eco-physiological parameters for the rotational grazing of a grassland are compared to the conduction of continuous stocking with an allowance of 12%, the MDG value reported is in accordance with the 0.324 kg an^{-1} day^{-1} observed by Pinto et al. (2008) in the pasture growth season. However, these values are lower than the 0.6 kg an^{-1} day^{-1} found by Soares et al. (2005) for a continuous stocking with allowance of 12% also in a pasture of the Central Depression of Rio Grande do Sul.

The forage allowances used in this experiment were below those recommended by Maraschin (1998), who defines allowances between 11.5 and 13.5% LW as an optimal range for the use of grassland. Soca et al. (2013), analyzing brood cows, considered an allowance of 10% as high, which is a value close to those observed in the present study. However, it is important to note that pastures in Uruguay tend to have fewer structural limitations because of the lower percentage of tussocks in the total FM.

The total forage allowance over 8% in both the 375DD and 750DD treatments, were not limiting for the animals, as the desired residual FM of 1000 kg DM ha^{-1} was maintained in all periods. Long-term experiments with grassland (BREMM et al., 2012) have indicated that a percentage of tussocks above 34% may limit the forage intake rate of the animals, which may lead to low mean daily gains. The mean percentage of tussocks estimated in the present experiment was 42%.

The percentage of senescent material in total MF, especially in the spring (means = 59%) may also have been a limiting factor in the individual performance of the animals. The similarity in the gains in live weight per area observed in the treatments (103kg ha^{-1}) can be explained by the similarity in FM and % of structural components of the tussock and, non-tussock stratum in both treatments.

The LWG values obtained in the present study in the experimental period can be considered satisfactory if compared with the annual mean of the State, which rarely exceeds 70 kg ha^{-1} (CARVALHO et al., 2006). However, the values are lower than those obtained by Soares et al. (2005) and Mezzalira et al. (2012) in continuous grazing with forage allowances of 8% and 12%, respectively.

It is important to emphasize that the stocking rate used in the present study reduced by less than 50% (1031 kg. ha^{-1}) the non-tussock stratum FM, which disappeared (through consumption and

senescence) during the occupation period. Thus, it was possible to keep a mean residue of 1370 kg ha^{-1} in the tussock stratum. This can be considered as a moderate grazing intensity, favoring the regrowth of the pasture after the animals depart. Both the rest intervals of 375 and 750 DD ensured the expansion of the leaves. As there was probably no highly marked reduction in the proportion of leaves and the newly expanded or expanding leaves have greater photosynthetic capacity than mature leaves (PARSONS et al., 1988), the total photosynthetic capacity was not excessively affected.

Among the indicative of reproductive parameters, only the weight of the animals was measured, weight performance analysis showed that heifers gained 40 kg throughout the experiment. That is, they started with a mean BW of 220 kg, and at the end they had a BW of 260 kg. Heifers with this weight are not fit for mating because, according to PATTERSON et al. (1992), this value represents 65% of the adult weight of the breed. Considering that the adult weight of Braford females is 450 kg, heifers would be fit for mating when they reach a mean value of 292 kg. Thus, if the goal is to mate at 18 months of age, these animals should have gained 0.483 kg in the period observed. However, if the goal is to reach the target weight and mate at 24 months of age, they should have an MDG of 32 kg until the beginning of the mating period, that is, approximately 224 days.

CONCLUSION

The use of rotational grazing systems, based on the cumulative thermal sum for leaf expansion of native grasses belonging to capture and conservation groups with grazing intervals of 375DD or 750 DD, to manage Campos grasslands, provided nutritional conditions to reach the target body weight of 290 kg for breeding 24 months old beef heifers.

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ETHICS AND BIOSAFETY COMMITTEE

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DECLARATION OF CONFLICT OF INTERESTS

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

The authors contributed equally to the manuscript.

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