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Efficiency of the use of ryegrass by heifers in response to the receival of supplement

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ABSTRACT. The intensity and frequency of defoliation of ryegrass (*Lolium multiflorum* Lam.) by beef heifers exclusively grazing or receiving corn grain or extruded commercial product with fat as supplement were evaluated. The grazing method was put-and-take stocking. The experimental design was completely randomized following a repeated measure arrangement, three treatments and two area replications. The phyllochron of ryegrass was 140.1 and 303.4°GD the leaf lifespan. The intensity (67.0 %) and the frequency of defoliation (6.4 days) were similar, regardless of supply or no of energetic supplement for grazing heifers. The defoliation frequency indicates that the heifers can return about 3.3 times to the same tiller during the leaf lifespan. Considering the different categories of leaf blades, the supply of extruded fat causes the heifers to remove higher proportion (66.5 %) of expanding leaf blades. On ryegrass pasture, the efficiency of forage use is not modified when heifers receive energetic supplement.

Keywords: frequency of defoliation, corn grain, extruded fat, intensity of defoliation, *Lolium multiflorum* Lam.

Eficiência do uso de azevém por bezerras em resposta ao recebimento de suplemento

RESUMO. Este estudo foi conduzido para avaliar a intensidade e a frequência de desfolhação de azevém (*Lolium multiflorum* Lam.) por bezerras de corte exclusivamente em pastejo ou recebendo grão de milho ou produto comercial extrusado com gordura como suplemento. O método de pastejo foi contínuo com número variável de animais. O delineamento experimental foi o inteiramente casualizado com medidas repetidas no tempo, três tratamentos e duas repetições por área. O filocrono do azevém foi de 140,1 e 303,4°GD folha^{-1} a duração de vida da folha. A intensidade (67,0%) e a frequência de desfolha (6,4 dias) foram semelhantes, independente do fornecimento ou não de suplemento energético para as bezerras em pastejo. A frequência de desfolhação indica que os animais podem retornar cerca de 3,3 vezes ao mesmo perfilho durante a duração de vida de uma folha. Considerando as diferentes categorias de lâminas foliares, o fornecimento de gordura extrusada faz com que as bezerras removam maior proporção (66,5%) de lâminas foliares em expansão. Em pastagem de azevém, a eficiência de uso da forragem não é modificada quando as bezerras de corte recebem suplemento energético.

Palavras-chave: frequência de desfolhação, grão de milho, gordura extrusada, intensidade de desfolhação, *Lolium multiflorum* Lam.

Introduction

The grazing management of forage plants has great impact on sward structure (Gastal & Lemaire, 2015) and it is the key structure of forage intake process. This management is defined by the different components of the defoliation process of leaf blades: intensity and frequency. These components affect the amount of leaves remaining in sward and determine the required time for pasture recovery (Lenzi, 2012).

Italian ryegrass (*Lolium multiflorum* Lam.), among grasses of temperate climate, is the most widely used in southern region of Brazil, since it allows adequate maintenance of forage in quantity and quality, in a period of low production of natural pasture. The supply of energetic supplement for grazing cattle can modify their forage intake and its magnitude depends on both: the forage supply and the type of supplement used. In most of supplementation programs, it is generally assumed that there is an increase in stocking rate when beef cattle are in continuous stocking grazing method (Pötter et al., 2010). The frequency of defoliation is directly related to the stocking rate used (Lemaire, Silva, Agnusdei, Wade & Hodgson, 2009). The defoliation intensity is conditioned by variables like phyllochron and leaf lifespan (Lemaire & Chapman, 1996). According to these authors, forage harvest efficiency is related to leaf lifespan and defoliation frequency.

The leaf blades play an important role in the ecology of pastoral systems, since they produce assimilates, which are necessary for the growth and maintenance of the plant. During the pasture management, it is required the maintenance of photosynthetically active leaf area and, at the same time, the opportunity for animals to harvest large quantities of high quality leaf tissue, in order to maximize the conversion efficiency of the forage produced. This understanding is essential when new variables, such as supplementation of the grazing animals, influence the choice of what and how to harvest.

Considering the importance of ryegrass on production systems in the southern region of Brazil, there are few studies on intensity and frequency of defoliation, when grazing animals are supplemented (Silva et al., 2015). This study was conducted aiming to characterize the grazing efficiency of beef heifers exclusively on ryegrass pasture or grazing and receiving supplement (corn grain or extruded commercial supplement with added fat).

Material and methods

The experiment was conducted at the Federal University of Santa Maria (UFSM), which is located in the physiographic region of Depressão Central of Rio Grande do Sul. The region has a humid subtropical climate (Cfa) according Köppen classification. Climatological data were obtained from the Meteorological Station UFSM (Table 1).

Table 1. Historical and verified meteorological data during the trial period.

Month	Temperature (°C)		Rainfall (mm)		Insolation (hours)	
	1969-1990	2009	1969-1990	2009	1969-1990	2009
July	13.5	13.3	145.6	91.4	133.1	152.7
August	14.6	18.8	137.4	164.5	141.4	179.9
September	16.2	15.2	153.6	345.6	160.7	123.8
October	18.8	18.9	145.9	108.7	206.8	220.9

Source: Instituto Nacional de Meteorologia (INMET, 2009).

The soil of the experimental area is classified as Pauleudalf (Empresa Brasileira de Pesquisa Agropecuária [Embrapa], 2006). The chemical characteristics of the soil samples collected from 0 to 10 cm deep, are: pH-H_2O: 5.0; SMP ratio: 5.8; Clay: 19.2 m v^{-1}; P: 13.4 and K: 92 mg L^{-1}; MO: 2.7 m v^{-1}; Al: 0.2; Ca: 4.6 and Mg: 2.2 cmolc L^{-1}; base saturation: 56.6 and Al saturation: 3%.

The experimental area consisted of 4.9 hectares with six divisions of 0.8 ha. The ryegrass pasture (*Lolium multiflorum Lam.*) was established in May 2009, with a minimum tillage and broadcast seeding, using 40 kg ha^{-1} of seed. The fertilization consisted of 200 kg ha^{-1} of formula 5-20-20 (N-P-K), and in top-dressing 45 kg ha^{-1} of nitrogen, in the urea form, in two applications.

The test animals were three Angus heifers, with initial age of eight months and average weight of 154±4.2 kg. It was studied the frequency and intensity of defoliation when heifers were kept exclusively in Italian ryegrass or in Italian ryegrass receiving supplement: a commercial extruded product with fat, in a proportion of 0.20% of body weight (fat) or corn grain in a proportion of 0.78% of body weight (corn). The amount of each supplement, in percentage of the body weight was adjusted so that they were isolipidic and heifers ingest 0.02% ether extract in relation to body weight in both supplements tested. The crude protein and neutral detergent fiber were 9.2 and 14.6% and 12.8 and 29.6% for corn and fat, respectively. The supplements were given to the heifers daily at 2 pm. The amount provided was adjusted weekly, based on the stocking rate maintained in paddocks. The grazing method was continuous stocking with variable number of animals to keep the forage mass between 1200 and 1500 kg DM ha^{-1}. The forage mass (FM, kg DM ha^{-1}) was evaluated every 14 days, through visual estimation technique with double sampling. Subsamples with forage from the cuts were made, and later submitted to the separation of structural components and determined the percentage of leaf blades and stems. In the same locations used for estimation of FM the sward height measurements (cm) were performed.

The stocking rate (SR, kg BW ha^{-1}) for the period was calculated by the sum of the average weight of heifers with the average weight of each regulatory heifer multiplied by the number of days of their stay in the experimental unit and divided by the number of days of the trial period. The capacity (LA, ha^{-1} animals) per unit area was obtained by dividing the SR and the average weight of the test animals.

For the morphogenesis measurement in each paddock, it was marked 40 tillers of ryegrass, using the marked tiller technique (Confortin et al., 2010). It was considered a period of 14 days for the grazing heifers' adaptation on ryegrass and the receiving of supplements. Two weekly measurements were performed during three periods: first, from July 29 to August 13; second, from 22 August to 5 September; third, 9-29 of September. In all these periods, the ryegrass was in vegetative stage. The thermal sum (TS°C) of the period was calculated by the equation: TS = S (Tmd-5) in which Tmd are the average daily temperatures from this period and 5°C is the value that is considered as the base temperature for the growth of cold season forage species.

In tillers it was measured the length (cm) and the number of leaf blades fully expanded and in expansion, besides their condition (intact or grazed). To determine the intensity (%), average removal of leaf blades (INT ratio of the removed leaf length), the grazed leaf blades were identified, and this evaluation was carried out every three or four days, using the formula: INT = [(initial length-final length)/initial length]*100. The probability of defoliation (PROB) was estimated by daily observations in the afternoon shift, and calculated by the formula: PROB = number of touches in the days of grazing/ (number of possible touches x evaluation length). The frequency of defoliation (FREQ; days) was calculated by the formula: FREQ = 1/ probability of defoliation. The intensity and frequency of defoliation were calculated considering the average of all leaves (intensity and overall frequency) and, separately, for expanded leaves and leaves in expansion (Machado, Rocha, Moraes, Confortin & Oliveira Neto, 2012). The percentage of leaf blades removed per day was calculated by the ratio between INT and FREQ. The frequency, in °C, was obtained by the product of defoliation frequency, in number of days for the return of same tiller to the average temperature of the period. To determine the size of the daily used area by grazing heifers (animal grazing area; AGA), it was made the division of the paddock area (considered as 100%) by the frequency of defoliation, in days. The grazing area per animal, in m^2, was obtained by the formula: AGA = (PA/ NA) * 100, where AGA = grazing area per animal; PA = paddock area; NA = number of animals per paddock.

The rate of leaf appearance (number of leaf $tiller^{-1}$ day^{-1}) was determined by the division of the number of emerged leaves in the period of evaluation by the number of days in the period. Phyllochron (°GD) was determined by simple linear regression between the variation in the initial and final number of leaves and the accumulated thermal sum of each period. The leaf lifespan was calculated by multiplying the number of the tiller's green leaves and the observed phyllochron in the evaluation period. Forage harvesting efficiency was calculated by the removed percentage of the leaf initial length after the defoliation events, during the leaf lifespan (Lemaire & Agnusdei, 2000).

The experimental design was completely randomized following a repeated measure arrangement. three treatments and two area repetitions. Graphical analysis of residue was performed in order to verify linearity deviations. The data were analyzed with Statistical Analysis System (SAS, 2004) statistical software, version 8.2, and they were subjected to analysis of variance and F test at 10% probability, using the Mixed procedure and, when detected differences, the averages were compared using the *lsmeans* procedure. The variables were submitted to contrast analysis, with 10% level of probability.

Results and discussion

Meteorological data regarding the experimental period (Table 1) show that the monthly average temperature and insolation are similar to historical values. The average rainfall in the month of September was 2.25 times higher than the historical average and it was also the wettest month.

The forage mass (1380.2 ± 46.8 kg DM ha^{-1}; p = 0.7385) and sward height (10.8 ± 0.5 cm; p = 0.3124) were similar when heifers were held exclusively on pasture or grazing and receiving supplement. The forage mass values indicate that there was no restriction on DM intake for grazing heifers (Roman et al., 2007) and also the sward height did not restricted the consumption (Silva et al., 2015). The leaf mass (736.4 ± 29.8 kg DM ha^{-1}; p = 0.4112), culms (315.4 ± 24.1 kg DM ha^{-1}; p = 0.1867) and dead material (130.4 ± 24.7 kg DM ha^{-1}; p = 0.2449) were similar, regardless of the evaluated feeding system. Thus, similar pasture management enabled that heifers, in different options of supplements, were kept in similar sward structure.

The supply of corn grain allowed a stocking rate 16.2% higher than stocking rate in other feeding systems (1127.4 kg ha^{-1}), which were all similar. This indicates that a substitution process (Pötter et al., 2010) of forage consumption by corn grain consumption.

The amount (67 ± 2.19%; p = 0.8642) and the frequency of defoliation (6.4 ± 0.4 days; p = 0.2928) were similar, regardless the supplying or not of energetic supplement for grazing heifers. The intensity of defoliation, with values between 50 and 55%, tends to be relatively constant, regardless of the adopted management (Lemaire et al., 2009). Silva et al. (2015), when providing corn grain to grazing heifers on ryegrass, observed that the intensity of defoliation was 60.9%.

The frequency of defoliation is strongly linked with the stocking rate (Lemaire et al., 2009). The increase of 182.8 kg BW ha^{-1} in stocking rate when corn grain was given, however, was not enough for this variable to change. For the observed interval of 6.4 days between defoliation, the daily probability of the removal of leaf blades from this tiller was 16; while 84% of these leaves remained without being

grazed. Even if the intensity value had been 12% higher than that reported by Lemaire, Silva, Agnusdei, Wade and Hodgson (2009), in the grazed leaf blades, only 10.9% of its length was removed at each grazing event.

The leaf lifespam (303.4°GD) and phyllochron (140.1°GD; Table 2) are genetically determined characteristics and they are influenced by environmental variations such as temperature, nutrient supply and water (Lemaire & Chapman, 1996) and they were similar in the feeding systems used. The average temperature of the months of the evaluation period corresponded to 14.4°C. The duration of the leaf lifespan corresponded to 21.1 days and the frequency of defoliation indicates that the animals can return about 3.3 times to the same tiller before that the leaf initiated its senescence process. This defoliation interval also indicates that heifers returned to the same tiller before the emission of a new leaf blade, because the frequency of defoliation represented 65.8% (92.2°C) of the value of phyllochron. In grazed leaves, there was a daily removal of 67% of the length of these blades, which corresponds to 97% of forage crop efficiency. The value of this index, close to 100%, represents the potential of the produced forage that was consumed by heifers (Lemaire & Agnusdei, 2000).

Table 2. Values of phyllochron, leaf lifespan, intensity and frequency of defoliation of leaves in expansion and expanded in Ryegrass.

Items	Ryegrass	Corn	Fat	P[1]	SE[2]
Phyllochron[5]	145.26	142.74	132.33	0.2699	14.60
Leaf lifespan[6]	298.13	317.70	294.43	0.0646	18.84
Intensity: leaves in expansion[3]	63.35	60.48	66.52	0.1969	3.08
Leaves expanded[3]	68.56	63.98	65.72	0.5843	3.05
Frequency: leaves in expansion[4]	5.32	5.72	5.74	0.8642	0.36
Leaves expanded[4]	7.33	7.70	7.42	0.8642	0.49

Ryegrass = heifers exclusively grazing on ryegrass pasture (RP); Corn= heifers in RP receiving 0.78% BW of corn grain; Fat = heifers in RP receiving 0.20% BW of extruded commercial supplement; [1]Probability; [2]Mean standard error; [3]% of removal; [4]days; [5]°GD; [6]°GD^{-1}.

The frequency of 6.4 days for the return of the heifers to the same tiller, regardless of the feeding system, indicates that about 15.6% of the total paddock area was used daily by the heifers. The daily grazed area, when on continuous stocking grazing method, ranged from 6 to 20% of the total area (Lemaire & Chapman, 1996). The areas used daily by heifers were 189.1 m^2 day^{-1} when grazing exclusively, 201.3 m^2 day^{-1} when receiving fat and 175.8 m^2 day^{-1} when the supplement was corn grain. In perennial ryegrass, dairy cows used an area of 200 m^2 day^{-1} animal^{-1} (Lemaire et al., 2009). The smaller grazing area explored by corn fed heifers is related to the higher stocking rate used. The determination of the grazing area becomes important when the area of the pasture is restrictive and it is used mainly for temporary grazing. Sichonany et al. (2014) observed that when heifers receive fat as a supplement, they were less dependent on the proportion of leaf blades at the feeding station.

The evaluation of the defoliation rate by type of leaf shows that the heifers take more than 1.9 days to return to the expanded leaves when compared with leaves in expansion (5.6 days; $p < 0.0001$), indicating that the younger leaves are defoliated more often. This is in accordance with the statement that herbivores select the leaves located in the top stratum (Baumont, Cohen-Salmon, Prache, & Sauvant, 2004). The upper vertical position in the sward that these leaves occupy and how animals graze make these leaves seem more likely to be defoliated.

The intensity of defoliation on expanded leaves (66.1%; $p = 0.5843$) and in expansion (63.4%; $p = 0.1969$) and the frequency of defoliation of expanded leaves (7.5 days; $p = 0.8642$) and in expansion (5.6 days; $p = 0.6741$) were similar regardless of the feeding system to which the heifers were submitted. When performed contrast analysis (fat × maize; P 0.0731) the defoliation intensity of leaves in expansion was 6.0% higher when the heifers received fat, while the intensity of removal performed by heifers that were fed with corn grain was 60.5%. The daily removal of leaf blades in expansion is 10.9% when the heifers receive corn grain and 12.0% when they receive fat. This characterizes a more concentrated defoliation on the top part of the sward, if taken into account the higher location of leaves in expansion. According to Rosa et al. (2013), when fat is given for heifers grazing ryegrass, these perform a smaller number of bites per minute, which increases the time for selection of each bite and which could explain, then, the higher intensity of defoliation in leaves in expansion. In addition, Sichonany et al. (2014) observed that the animal displacement patterns along the feeding stations differ according to the type of supplement. In the vegetative stage of ryegrass, the daily removal of the expanded leaf blades was 8.8%, regardless of the feeding system.

Conclusion

Grazing beef heifers on Italian ryegrass receiving or not supplement (corn grain or commercial extruded supplement with added fat) do not alter the forage use efficiency. The supplementation with fat causes the heifers to remove higher proportion of leaf blades in expansion.

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