

Forage mass, botanical composition and stocking density of bermudagrass overseeded with forage legumes¹

Amanda Nunes Assis dos Anjos², Clair Jorge Olivo^{3*}, Denise Pereira Leme⁴, Priscila Flôres Aguirre², Franciane de Almeida Pires⁵, Débora Ribeiro Falk⁵

10.1590/0034-737X201764050007

ABSTRACT

Pastures of the genus *Cynodon* are being cultivated alone in conventional production with high rates of nitrogen fertilizer. Information and research about its use on mixed-pasture system is scarce. The objective of this study was to evaluate three grazing systems with coastcross-1 (CC) + 100 kg N ha⁻¹ year⁻¹ + common vetch; CC + 100 kg N ha⁻¹ year⁻¹ + arrowleaf clover; and CC + 200 kg N ha⁻¹ year⁻¹. The experiment was carried out from May 2013 to April 2014. The sward height, forage mass, botanical composition, leaf:stem ratio, and animal stocking density were evaluated. Experimental design was completely randomized with three treatments (grazing systems) and three replicates (paddocks) in completely split-plot time (grazing cycles). The average stocking rate was 7.0, 6.8, 6.8 cows ha⁻¹ day⁻¹ for the respective forage systems. Better results were found with coastcross-1 mixed with common vetch + 100 kg N ha⁻¹ year⁻¹ in winter and spring and coastcross-1 alone + 200 kg N ha⁻¹ year⁻¹ in autumn.

Key words: coastcross-1; *Cynodon dactylon*; lactating cows; rotational grazing; *Trifolium vesiculosum*; *Vicia sativa*.

RESUMO

Massa de forragem, composição botânica e taxa de lotação em pastagem de capim bermuda consorciada com leguminosas forrageiras

As pastagens do gênero *Cynodon* têm sido cultivadas de forma singular, na estratégia convencional, sendo usadas elevadas taxas de fertilização nitrogenada. Informações e pesquisas sobre a sua consorciação com leguminosas são escassas. O objetivo desse estudo foi avaliar três sistemas forrageiros com Coastcross-1 (CC) + 100 kg N ha⁻¹ ano⁻¹ + ervilhaca; CC + 100 kg N ha⁻¹ ano⁻¹ + trevo vesiculoso; e CC + 200 kg N ha⁻¹ ano⁻¹. O experimento foi conduzido de maio de 2013 a abril de 2014. Foram avaliadas a altura do dossel, massa de forragem, composição botânica, relação folha/colmo e a taxa de lotação. O delineamento experimental foi o inteiramente casualizado com três tratamentos (sistemas forrageiros), três repetições (piquetes) em parcelas subdivididas no tempo (ciclos de pastejos). As médias de taxa de lotação foram 7,0; 6,8 e 6,8 vacas ha⁻¹ dia⁻¹ para os respectivos sistemas forrageiros. Melhores resultados foram encontrados no sistema constituído por Coastcross-1 em consórcio com ervilhaca, no inverno, e na pastagem de Coastcross-1 em cultivo singular + 200 kg N ha⁻¹ ano⁻¹, no outono.

Palavras-chave: *Cynodon dactylon*; pastejo rotacionado; *Trifolium vesiculosum*; vacas em lactação; *Vicia sativa*.

¹ Submitted on June 18th, 2015 and accepted on September 15th, 2017.

¹ This research is part of the first author master's thesis.

² Universidade Federal de Santa Maria, Programa de Pós-Graduação em Zootecnia, Santa Maria, Rio Grande do Sul, Brazil. assiszoot@yahoo.com.br; priscilafloresaguirre@yahoo.com.br

³ Universidade Federal de Santa Maria, Departamento de Zootecnia, Santa Maria, Rio Grande do Sul, Brazil. clairolivo@yahoo.com.br

⁴ Universidade Federal de Santa Catarina, Departamento de Zootecnia e Desenvolvimento Rural, Florianópolis, Santa Catarina, Brazil. denise.leme@ufsc.br

⁵ Universidade Federal de Santa Maria, Programa de Pós-Graduação em Zootecnia, Santa Maria, Rio Grande do Sul, Brazil. franciane-ap@hotmail.com; debora.dedi02@hotmail.com

*Corresponding author: clairolivo@yahoo.com.br

INTRODUCTION

The cultivar coastcross-1 (*Cynodon dactylon* L. Pers.) has been highlighted for its elevated forage potential, response to fertilization, great adaptability to diverse environments, and flexibility of use as pasture, hay, and silage (Branco *et al.*, 2012).

In most properties, bermudagrass is cultivated alone and demands high levels of chemical fertilizers. The use of fertilizers, especially nitrogen, increases the forage production and the nutritive value. In that practice, production costs are elevated and the distribution of forage is inadequate during the productive cycle. In this context, mixed grasses with forage legumes could improve the productivity of the system, in addition to balancing the allowance of forage, improving the diet of animals and reducing or eliminating the use of nitrogen fertilizer (Azevedo Junior *et al.*, 2012), besides extending the grazing seasons.

Even with this performance, normally expected for grass-legume association, there are few properties using mixed system, due to the slow establishment and low persistence of the legumes in the pastures (Olivo *et al.*, 2014). Also, there is some research to overcome these difficulties. Among forage legumes used for mixed system, the common vetch (*Vicia sativa* L.) and arrowleaf clover (*Trifolium vesiculosum* Savi) stand out. These forages feature considerable nitrogen fixation, forage production, and nutritional quality to compose the diet of the animals.

The objective of this study was to compare the performance of forage mass, botanical composition, and stocking density of three pasture-based systems: coastcross-1 and common vetch or arrowleaf clover mixture plus 100 Kg N ha⁻¹; and coastcross-1 plus 200 Kg N ha⁻¹.

MATERIAL AND METHODS

The study was conducted in the Central Depression region of the Rio Grande do Sul State, Brazil, at 29°43' S, 53°42' W, altitude 95 m. The soil type of the experimental area is classified as Hapludalf Paleudult (Smith, 2014) and, according to the results of soil analysis held in 2013, the following average values were obtained: pH-H₂O = 5.5; SMP pH = 6.1; clay = 21.5%; P = 26.75 mg/dm³; K = 140 mg/dm³; OM = 3.25%; Al = 0 cmolc/dm³; Ca²⁺ = 6.15 cmolc/dm³; Mg²⁺ = 2.95 cmolc mg/dm³; base saturation = 70.3% and Al saturation = 0%. The climate of the region is humid subtropical (Cfa), according to Köppen's classification.

The research was conducted from May 2013 to April 2014 (330 days). The monthly temperature and precipitation average were 14.7 to 25.7 °C and 130.7 mm⁻¹, respectively. The climate values for the respective period were 18.8 °C and 134.7 mm⁻¹, respectively. During the fall,

winter, and spring, seven, ten, and two frosts occurred, respectively. Meteorological data were obtained in the Meteorological Station of UFSM, located approximately 500 m from the experimental area. The grazing period was 247 days from August 15, 2013 to April 18, 2014.

For experimental evaluation, an area of 4691 m² subdivided into nine paddocks was used. The treatments were constituted of the following forage systems: bermudagrass (*Cynodon dactylon* L. Pers.), cv. coastcross-1 + 100 kg N ha⁻¹ year⁻¹ + common vetch (*Vicia sativa* L. cv. Comum); coastcross-1 + 100 kg N ha⁻¹ year⁻¹ + arrowleaf clover (*Trifolium vesiculosum* Savi), cv. Yuchi; and coastcross-1 + 200 kg N ha⁻¹ year⁻¹. The coastcross-1 of the area had already been manually deployed, using seedlings from the subdivision of the clumps, derived from an experimental area of the Dairy Cattle Laboratory. In three paddocks, the common vetch was overseeded on coastcross-1 (mid-May) by direct mechanized plantation, with seeding density of 60 kg ha⁻¹, pre-inoculated, with spacing planting of 17 cm between rows. In other three paddocks, in the same period, haul of the arrowleaf clover was distributed, being scarified and pre-inoculated using density of 10 kg seeds ha⁻¹. In all experimental areas, the development of natural annual ryegrass *Lolium multiflorum* L. Lam reseeding was allowed.

According to the soil analysis of perennial pastures in summer cycle, 90 kg ha⁻¹ year⁻¹ were applied as base fertilizer by using P₂O₅ and K₂O. Nitrogen fertilization was subdivided into six applications, being the first held before grazing started and after one, four, six, eight, and ten grazing cycles. On November 27, after the 6th grazing, mowing of the experimental areas was performed to uniformize the stand areas.

The grazing method used was the rotational stocking, with one day of occupation and the criterion for the start of animal grazing was the sward heights of the various forage systems in the pasture. In the winter period, it was based on the height of the legumes (about 30 cm) and in the summer, it was the height of coastcross-1, close to 25 cm for all areas.

The forage allowance was 6 kg DM (dry matter) for each 100 kg of body weight throughout the year. For analysis, lactating Holstein cows were used, with an average weight of 567 kg and an average production of 19.3 kg milk/day, subjected to two daily milking sections at 07:30 and 17:00 h. After milking, the cows received supplementation concentrate, at 0.9% of body weight, considering the period of lactation and mean milk production, with *ad libitum* mineralized salt and water. The animals were kept on season grass pastures when they were not in the experimental areas.

At pre- and post-grazing, the forage mass was estimated by double sampling technique (Wilm *et al.*, 1944)

with twenty visual estimates and five cuts close to the ground per paddock. The forage from the destructive samples was weighed and then homogenized. A subsample was removed for estimating botanical composition of the pasture and structural composition of the coastcross-1. These structural and botanical components were dried in forced-air oven at 55 °C until reaching the constant weight for estimating dry matter, which was used to calculate the percentage of each fraction. For stocking rate, the value of instantaneous stocking density was divided by the number of the days of each grazing cycle. The subtraction of the pre- and post-grazing forage mass was calculated for the disappeared forage mass.

Data on parameters of grazing cycles in every season were used for statistical analysis, considering 2, 5, 4, and 2 grazing cycles in winter, spring, summer, and autumn, respectively. The experimental design was completely randomized with three treatments (grazing systems) and three replicates (paddocks) in completely split-plot time (grazing cycles). Data were subjected to analysis of variance of using PROC MIXED procedure of SAS (2002), using the Tukey's test for comparison of means. Significance was determined at $p \leq 0.05$.

The experimental design was approved by the Ethics Committee and Biosafety of the UFSM, the opinion 113/2011 under the Protocol 23081016073/2011.

RESULTS AND DISCUSSION

In the experimental period (330 days), thirteen grazing cycles were performed in both systems, as well in the forage system mixed with clover as singular cultivation. In the common vetch mixed system, twelve grazing cycles were performed. The mean interval between grazing was twenty-seven days and the occupation time was one day. Similar results were found by Azevedo Junior *et al.* (2012) with summer pasture related with better forage quality and animal performance.

For the pasture height in the beginning of the grazing (Table 1), in the evaluations for the winter, values were close to 30 cm ($p \leq 0.05$) for the mixed pasture system, which agrees with the methodology indicated. In the pastures constituted by coastcross-1, the height pasture was approximately between 20 and 30 cm in the other seasons ($p \leq 0.05$). The utilization of coastcross-1 with sward height around 20 cm was related with 95% luminous interception.

For forage mass (pre-grazing), there was a difference ($p \leq 0.05$) between forage systems in winter and in spring, with greater value for mixed system with common vetch. This result is due to the characteristics of this forage legume (Caballero *et al.*, 1995), which is precocious compared

with arrowleaf clover, confirmed by the high participation in the botanical composition of the pasture.

For the mixed system with arrowleaf clover, although the greatest participation was in the spring, there was no difference between the systems. During this time, there was a large competition between foragers, with greater participation of Coastcross-1. In the summer, the values were similar between forage systems, although the lower fertilization occurred in the mixed system. This result is due to the contribution of the legumes, releasing nitrogen to the system (Sarrantonio, 1992). Similar results were verified by Aguirre *et al.* (2016) in pastures with Coastcross-1 mixed with legumes of winter cycle fertilized with 100 kg N ha⁻¹ year⁻¹.

In the autumn, the value of forage mass was higher ($p \leq 0.05$) in the system without legumes due to the highest level of nitrogen fertilization, considering that the Coastcross-1 responds to nitrogen fertilization (Humphreys *et al.*, 2012). The lowest value observed in the autumn mixed system was probably due to the decreased residual effect of forage legumes, possibly due to competition between bermudagrass and legume. Also, the forage mass in locals with legumes may be smaller due to its morphological structure, which increase the vertical plane of the forage more than in exclusive grass cultivation, resulting in less forage mass. Thus, even with different morphological structures, Coastcross-1 emits its tillers vertically, which increases its vertical space more than when they are in exclusive cultivation. This probably occurred as a strategy of Coastcross-1 to avoid competition with other species (Barbero *et al.*, 2009).

In the botanical composition of the pasture, the participation of Coastcross-1 was approximately 20% in the winter. In the spring, the lowest value of the Coastcross-1 in the mixed system ($p \leq 0.05$) was due to the participation of the forage legumes that usually interferes with the development of the companion grass (Griew *et al.*, 2001). In the summer and autumn, the Coastcross-1 values were higher. For the annual ryegrass, values were similar in winter and differed between pasture systems in the spring, with lower value in the mixed system ($p \leq 0.05$), due to the presence of legumes that also affected the development of the grass. The average participation of forage legumes was 23.7 and 18.8% for common vetch and arrowleaf clover, respectively. It is noteworthy that the presence of arrowleaf clover is longer. According to Roberts (1974), the proportion of forage legumes in the pasture should oscillate between 20 and 40% for the occurrence of positive reflections in animal production. For the other species fraction, it was verified the presence of the spontaneous-growth species (*Cynodon spp.*, *Urochloa plantaginea* and *Paspalum spp.*) and the values were higher in the summer for all forage systems;

considering that the species are season-warm, the differences found confirm that the presence of legumes implies control of these species in the system. For the dead material fraction, values were higher ($p \leq 0.05$), especially in the winter due to the senescence material of the Coastcross-1, due the action of cold and frost.

For sward height of residual forage (post-grazing), it was observed that the height of the forage was lowered at approximately 50% in all seasons of the year (Table 2).

Comparing the seasons, there were differences ($p \leq 0.05$), with greater height in the summer and autumn, attributed to the exclusion areas because of the accumulation of feces.

There were no differences between the grazing systems for forage mass (post-grazing) (Table 2) due to the adjustment used for stocking density. Comparing the mean values of forage mass of pre- and post-grazing, the forage used (grazing efficiency) was approximately 48%. This result demonstrated that there was no intake limited per

Table 1: Sward height, pre-grazing forage mass and botanical composition of three pasture-based systems (SF) with Coastcross-1 (CC) + common vetch + 100 kg N ha⁻¹ year⁻¹ (CE); CC + arrowleaf clover + 100 kg N ha⁻¹ year⁻¹ (CT) and CC + 200 kg N ha⁻¹ year⁻¹ (CN). Santa Maria, RS, 2013/2014

SF	Season				Average	CV (%)
	Winter	Spring	Summer	Autumn		
Sward height (cm)						
CE	33 ^{Aa}	21 ^c	30 ^{Ab}	28 ^b	28	2.8
CT	34 ^{Aa}	21 ^c	27 ^{ABb}	26 ^b	27	2.8
CN	22 ^{Bbc}	21 ^c	28 ^{Ba}	29 ^a	25	3.1
CV (%)	3.0	4.3	3.1	3.2		
Forage mass (Kg of DM ha ⁻¹)						
CE	3416 ^{Ab}	3265 ^{Ab}	3880 ^a	2901 ^{Bb}	3366	3.4
CT	2676 ^{Bb}	2635 ^{Bb}	3583 ^a	2905 ^{Bb}	2950	3.8
CN	2783 ^{Bb}	2865 ^{Bb}	3644 ^a	3467 ^{Aa}	3190	3.5
CV (%)	4.4	4.5	3.5	4.2		
Botanical composition (%)						
Coastcross-1						
CE	16.7 ^c	27.9 ^{Bb}	45.4 ^a	48.5 ^{Aa}	34.7	5.2
CT	20.8 ^c	26.0 ^{Bb}	43.0 ^a	48.4 ^{Aa}	34.6	5.0
CN	21.5 ^c	33.2 ^{Ab}	51.0 ^a	44.9 ^{Bb}	37.7	4.5
CV (%)	11.2	7.0	4.5	4.6		
Annual ryegrass						
CE	33.4	25.3 ^a	-	-	29.4	12.3
CT	32.7	24.7 ^B	-	-	31.3	12.0
CN	35.7 ^b	35.2 ^{Aa}	-	-	37.6	9.5
CV (%)	9.2	8.7				
Legumes						
CE	28.1 ^{Aa}	19.2 ^b	-	-	23.7	11.5
CT	9.3 ^{Bb}	24.0 ^a	23.2 ^a	-	18.8	19.1
CV (%)	21.5	16.5				
Other species						
CE	11.0 ^c	17.5 ^b	50.8 ^{Aa}	47.5 ^{ABa}	31.7	5.8
CT	17.2 ^c	17.0 ^{bc}	29.6 ^{Ba}	45.3 ^{Ba}	27.3	6.2
CN	13.3 ^c	21.5 ^b	44.3 ^{Aa}	50.7 ^{Aa}	32.4	5.9
CV (%)	16.6	9.2	4.9	4.7		
Dead material						
CE	10.6 ^{Ca}	9.3 ^a	3.8 ^b	4.0 ^{Bb}	7.0	18.5
CT	19.9 ^{Ba}	8.3 ^b	4.2 ^b	6.3 ^{Ab}	10.0	12.0
CN	29.5 ^{Aa}	10.1 ^a	4.7 ^b	4.4 ^{Bb}	12.1	10.4
CV (%)	7.8	14.5	25.4	32.1		

Means followed by capital letters in the column and lowercase letters on the line differ ($p \leq 0.05$) by the Tukey's test. CV = coefficient of variation, DM = dry matter.

animal, which normally occurs when the value exceeds 50% (Delagarde *et al.*, 2001).

For the botanical composition of residual forage mass, the values of Coastcross-1 were lower than those obtained in the pre-grazing (approximately 32%). This result indicates that the Coastcross-1 was more consumed than other plants, with great participation in the botanical composition of the pasture. For the annual ryegrass and forage legumes, the values were proportionally lower ($p \leq$

0.05) due to the greater use of animals, related to the best nutritive value of these forages (Olivo *et al.*, 2014). For other species, the participation value was similar to the initial forage mass value, showing a trend of lower intake due to the composition of this fraction by species of summer cycle. Some plants of the genus *Paspalum* spp. can be consumed in a similar way to the genus *Cynodon* spp. due to the similarity of nutritional value. However, as the management was oriented to the pasture of

Table 2: Sward height, post-grazing forage mass and botanical composition of three pasture-based systems (SF) with Coastcross-1 (CC) + common vetch + 100 kg N ha⁻¹ year⁻¹ (CE); CC + arrowleaf clover + 100 kg N ha⁻¹ year⁻¹ (CT) and CC + 200 kg N ha⁻¹ year⁻¹ (CN). Santa Maria, RS, 2013/2014

SF	Season				Average	CV (%)
	Winter	Spring	Summer	Autumn		
Sward height (cm)						
CE	12 ^{Bb}	12 ^b	17 ^{Aa}	17 ^a	14	3.0
CT	13 ^{Bb}	13 ^b	15 ^{Ba}	16 ^a	14	3.0
CN	15 ^{Ab}	13 ^c	17 ^{Aa}	17 ^a	15	2.8
CV (%)	3.7	4.0	3.0	3.0		
Forage mass (Kg of DM ha ⁻¹)						
CE	2161 ^a	1987 ^{ab}	1767 ^b	1761 ^b	1919	5.2
CT	1886 ^a	1676 ^b	1736 ^{ab}	1913 ^a	1802	5.5
CN	2042 ^a	1731 ^b	1705 ^b	1838 ^{ab}	1829	5.4
CV (%)	5.6	6.4	6.6	6.2		
Botanical composition (%)						
Coastcross-1						
CE	17.6 ^b	36.1 ^{Aa}	38.6 ^a	33.3 ^{Ba}	31.4	6.9
CT	22.9 ^{bc}	28.6 ^{Bc}	36.4 ^a	39.2 ^{Abc}	31.8	6.8
CN	20.3 ^b	39.0 ^{Aa}	41.4 ^a	41.5 ^{Aa}	35.5	6.1
CV (%)	12.4	7.2	6.4	6.6		
Annual ryegrass						
CE	22.9	28.5	-	-	25.7	19.9
CT	25.4	27.9	-	-	26.6	19.2
CN	25.4	28.1	-	-	26.7	19.1
CV (%)	17.0	14.8				
Legumes						
CE	26.9 ^A	13.3	-	-	20.1	12.6
CT	6.2 ^{Bb}	17.8 ^a	21.8 ^a	-	15.3	16.6
CV (%)	18.7	19.9				
Other species						
CE	7.1 ^{Bc}	20.5 ^b	53.8 ^a	58.7 ^{Aa}	35.0	6.8
CT	13.0 ^{Ac}	22.4 ^b	50.9 ^a	49.5 ^{Ba}	33.9	7.1
CN	12.4 ^{Ac}	22.7 ^b	50.5 ^a	48.7 ^{Ba}	33.6	7.1
CV (%)	25.6	12.7	5.3	5.3		
Dead material						
CE	25.3 ^{Ba}	12.3 ^b	7.5 ^{Bb}	8.0 ^{Bb}	13.2	27.4
CT	32.3 ^{ABa}	15.2 ^b	18.4 ^{Ab}	11.2 ^{Ab}	19.3	18.8
CN	41.7 ^{Aa}	19.8 ^b	8.0 ^{Bb}	9.7 ^{Bb}	19.8	18.4
CV (%)	12.7	26.6	27.2	30.0		

Means followed by capital letters in the column and lowercase letters on the line differ ($p \leq 0.05$) by the Tukey's test. CV = coefficient of variation, DM = dry matter.

Coastcross-1, certainly harming intake of *Paspalum* spp., *Cynodon* spp. and *Sida santaremnensis* were less consumed by animals compared with the pasture with Coastcross-1. For dead material, the values were higher in relation to the pre-grazing, as expected, due to the selection of animals by the green forage mass, especially of leaf blades (Table 3) and the damage caused by trampling.

The relation between leaf blade/stem + sheath of Coastcross-1 in the pre-grazing (Table 3) presented no difference between pasture systems, demonstrating that the inclusion of forage legume did not interfere in the structure of the Coastcross-1 plants. Despite the low forage availability in the winter, there was a high value of leaf blades (Table 1). In the other seasons, the values were uniform, indicating that forage can have a strategic importance in the southern region of Brazil, especially in the autumn, period with shortage of forage.

Similarly, for the values of post-grazing, the relation between leaf blade/stem + sheath, there was no interference due to the presence of forage legume. The data of post-grazing were more uniform compared with pre-grazing due to the adjustment of stocking density.

The obtained average value of 0.54 was suitable for the recovery of the pasture, providing high number of grazing cycles.

In the average stocking density (Table 4), the results were related to the initial forage mass, with difference ($p \leq 0.05$) between the systems. The higher values were found in the winter and spring for the mixed system with vetch, due to the contribution of this forage legume in forage mass (Table 1). In the summer, there was superiority ($p \leq 0.05$) of this mixture system, attributed to the residual effect of this forage legumes to the system, with the degradation of nodules and plant parts (Bordeleau & Prévost, 1994; Butler *et al.*, 2012), implying more forage mass and, consequently, more stocking density. In the fall, the highest stocking density was observed in the pasture without forage legumes, demonstrating that the nitrogen fertilization effect was more effective in this period.

In the mixed system with arrowleaf clover, it was observed that between seasons the presence of this forage legume implied stocking density values similar to the system without forage legume. Considering the period of

Table 3: Leaf blade/stem plus sheath of three pasture-based systems (SF) with Coastcross-1 (CC) + common vetch + 100 kg N ha⁻¹ year⁻¹ (CE); CC + arrowleaf clover + 100 kg N ha⁻¹ year⁻¹ (CT) and CC + 200 kg N ha⁻¹ year⁻¹ (CN). Santa Maria, RS, 2013/2014

SF	Season				Average	CV (%)
	Winter	Spring	Summer	Autumn		
Coastcross-1						
Pre-grazing						
CE	1.56 ^a	0.98 ^a	0.91 ^b	0.93 ^{ab}	1.09	19.0
CT	1.38 ^a	0.85 ^b	0.92 ^a	0.87 ^{ab}	1.01	20.7
CN	1.00 ^a	0.88 ^b	0.94 ^a	0.93 ^a	0.94	22.2
CV(%)	18.3	26.6	26.0	26.0		
Post-grazing						
CE	0.39 ^b	0.61 ^a	0.61 ^a	0.62 ^a	0.56	8.7
CT	0.49 ^b	0.62 ^a	0.56 ^a	0.60 ^a	0.57	9.1
CN	0.36 ^b	0.60 ^a	0.73 ^a	0.52 ^b	0.51	9.5
CV(%)	13.7	9.2	9.7	9.8		

Means followed by different letters in column differ ($p \leq 0.05$) by the Tukey's test. CV = coefficient of variation.

Table 4: Stocking density of three pasture-based systems (SF) with Coastcross-1 (CC) + common vetch + 100 kg N ha⁻¹ year⁻¹ (CE); CC + arrowleaf clover + 100 kg N ha⁻¹ year⁻¹ (CT) and CC + 200 kg N ha⁻¹ year⁻¹ (CN). Santa Maria, RS, 2013/2014

SF	Season				Average	CV (%)
	Winter*	Spring*	Summer*	Autumn*		
Stocking density (AU ha ⁻¹ d ⁻¹)**						
CE	171 ^{Ab}	169 ^{Ab}	181 ^{Aa}	129 ^{Bc}	163	3.5
CT	120 ^{Bc}	133 ^{Bb}	169 ^{Ba}	129 ^{Bb}	138	4.2
CN	110 ^{Bc}	148 ^{ABb}	168 ^{Ba}	152 ^{Ab}	144	4.0
CV (%)	4.9	4.4	3.8	4.9		

Means followed by uppercase letters in the column and lowercase letters in the line differ ($p \leq 0.05$) by the Tukey's test. CV = coefficient of variation; AU = animal unit. * Number of grazing cycles per SF (13 in CT and CN; and 12 in CE, respectively). ** Mean per season; AU ha⁻¹d⁻¹ per grazing cycle.

the introduction of forage legumes at the end of pasture usage, the mean of the stocking density of the forage systems was 7 cows ha⁻¹, ranging from 5.6 in the winter and 9.1 in the summer. In a study of Coastcross-1 subjected to irrigation and fertilization with 300 kg N ha⁻¹ year⁻¹, using Holstein cows, supplemented with 6 kg of concentrate day⁻¹, Alvim *et al.* (1997) observed stocking density of 3.7 cows ha⁻¹ in the dry season and 6.4 cows ha⁻¹ during the rainy season. Scaravelli *et al.* (2007) found stocking density of 5.05 AU ha⁻¹, assessing pastures of Coastcross-1, from January to May, with nitrogen fertilization of 80 kg N ha⁻¹.

CONCLUSION

The inclusion of the common vetch plus 100 Kg N ha⁻¹ resulted in the highest forage mass and stocking density in winter and spring. For Coastcross-1 without forage legume and receiving 200 Kg N ha⁻¹, the best performance was found in the autumn. The inclusion of the forage legumes did not affect the structural composition of Coastcross-1.

REFERENCES

- Aguirre PF, Olivo CJ, Simonetti GD, Agnolin CA, Nunes JS, De Bem CM, Diehl MS, Sauter CP & Fernandes PR (2016) Valor nutritivo de pastagens de Coastcross-1 em consórcio com diferentes leguminosas de ciclo hibernal. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, 68:173-181.
- Alvim MJ, Viela D & Lopes RS (1997) Efeitos de dois níveis de concentrado sobre a produção de leite de vacas da raça holandesa em pastagem de coast-cross (*Cynodon dactylon* (L.) Pers). *Revista Brasileira de Zootecnia*, 26:967-975.
- Azevedo Júnior RL, Olivo CJ, De Bem CM, Aguirre PF, Quatrin MP, Santos MS, Bratz VF & Horst T (2012) Forage mass and the nutritive value of pastures mixed with forage peanut and red clover. *Revista Brasileira de Zootecnia*, 41:827-834.
- Barbero LM, Cecato U, Lugão SMB, Gomes JAN, Limão VA & Basso KC (2009) Produção de forragem e componentes morfológicos em pastagem de coastcross consorciada com amendoim forrageiro. *Revista Brasileira de Zootecnia*, 38:788-795.
- Branco AF, Viana KB, Castañeda RD, Prohmann PE, Coneglian SM & Mouro GF (2012) Chemical composition and crude protein fractions of Coastcross grass under grazing on winter, spring and summer in Southern Brazil. *Acta Scientiarum. Animal Sciences*, 34:183-187.
- Bordeleau LM & Prévost D (1994) Nodulation and nitrogen fixation in extreme environments. *Plant and Soil*, 161:115-125.
- Butler TJ, Biermacher JT, Kering MK & Interrante SM (2012) Production and Economics of Grazing Steers on Rye-Annual Ryegrass with Legumes or Fertilized with Nitrogen. *Crop Science*, 52:1931-1939.
- Caballero R, Goicoechea EL & Hernaiz PJ (1995) Forage yields and quality of common vetch and oat sown at varying seeding ratios and seeding rates of vetch. *Field Crops Research*, 41:135-140.
- Delagarde R, Prache S, D'Hour P & Petit M (2001) Ingestion de l'herbe par les ruminants au paturage. *Fourrages*, 166:189-212.
- Griew P, Lucero DW, Ardiani R & Ehleringer JR (2001) The mean depth of soil water uptake by two temperate grassland species over time subjected to mild soil water deficit and competitive association. *Plant and Soil*, 230:197-209.
- Humphreys J, Mihailescu E & Casey IA (2012) An economic comparison of systems of dairy production based on N-fertilized grass and grass-white clover grassland in a moist maritime environment. *Grass and Forage Science*, 67:519-525.
- Olivo CJ, Agnolin CA, Aguirre PF, De Bem CM, Araújo TLR, Diehl MS & Meinerz GR (2014) Forage mass and stocking rate of elephant grass pastures managed under agroecological and conventional systems. *Revista Brasileira de Zootecnia*, 43:289-295.
- Roberts CR (1974) Some problems of establishment and management of legume-based tropical pastures. *Tropical Grasslands*, 8:61-67.
- Sarrantonio M (1992) Opportunities and challenges for the inclusion of soil-improving crops in vegetable production systems. *HortScience*, 27:754-758.
- SAS Institute Inc. (2002) Statistical Analysis System user's guide. Version 9.0. Cary, Statistical Analysis System Institute. 513p.
- Scaravelli LF, Pereira LET, Olivo CJ & Agnolin CA (2007) Produção e qualidade de pastagens de Coastcross-1 e milheto utilizadas com vacas leiteiras. *Ciência Rural*, 37:841-846.
- Smith DW (2014) Soil Survey Staff: Keys to Soil Taxonomy. 12^{ed}. Washington, USDA-Natural Resources Conservation Service. 360p.
- Wilm HG, Costello DF & Klipple GE (1944) Estimating forage yield by the double-sampling methods. *Journal of American Society of Agronomy*, 36:194-203.