Scientific Paper

Yield and nutritional quality of the pastureland of the Ressacada farm in Florianópolis–SC, Brazil

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Abstract

Objective: To determine the yield and nutritional quality of the herbaceous community present in the pasturelands of the Ressacada farm, Florianópolis, Santa Catarina, Brazil, after the application of different doses of calcareous, phosphoric and potassium fertilizers.

Materials and Methods: The research was conducted in the cattle area belonging to the Ressacada farm, Federal University of Santa Catarina, according to a randomized block design, with four repetitions. The pastures were fertilized 2,5 years before the sample taking, according to the treatments T1) 0 calcareous, 0 P_2O_5 and 0 K_2O; T2) 0 calcareous, 0 P_2O_5 and 1 K_2O; T3) 0 calcareous, 1 P_2O_5 and 0 K_2O; T4) 0 calcareous, 1 P_2O_5 and 1 K_2O; T5) ½ calcareous, 0 P_2O_5 and 0 K_2O; T6) ½ calcareous, 0 P_2O_5 and 1 K_2O; T7) ½ calcareous, 1 P_2O_5 and 0 K_2O; T8) ½ calcareous, 1 P_2O_5 and 1 K_2O; T9) 1 calcareous, 0 P_2O_5 and 0 K_2O; T10) 1 calcareous, 0 P_2O_5 and 1 K_2O; T11) 1 calcareous, 1 P_2O_5 and 0 K_2O y T12)1 calcareous, 1 P_2O_5 and 1 K_2O. The forage cutting was done through the 0,25-m^2 frame method, which was replicated four times in each treatment. Biomass yield, CP, NDF and ADF were determined. Variance analysis was carried out. The means were compared through Fisher's test, for a significance level of $p < 0,05$. The statistical package InfoStat 2012, free version, was used.

Results: There were highly significant differences for each of the studied variables in the different treatments. Regarding yield, the best ones were T5, T8, T9 and T10, which did not differ statistically from the others, except from T2. The CP values were low (lower than 8 %), and the best corresponded to T2 and T4. The NDF and ADF showed characteristic values of natural pastures (between 47,24-55,77 and 28,79-32,83 %, respectively).

Conclusions: Low yield of the farm pastures was shown, in spite of going through the rainy season. The nutritional quality was also low, typical of natural pastures of the region.

Keywords: natural pasture, yield, nutritional value

Introduction

Pastureland agroecosystems have relevant importance for the production of such items as milk and meat, among others, and it is estimated that they occupy more than the fourth of the Earth surface (Iermanó and Sarandón, 2016).

The feeding of livestock should be supported, mainly, on the utilization of pastures, because they constitute feedstuffs of more economical acquisition than the diets based on concentrate feeds. For such reason emphasis must be made on the search for ways, methods and alternatives to maintain and increase the livestock production with the more efficient use of pastures and forage plants.

Through the years, work has been done on the identification of species, grasses as well as legumes (herbaceous and trees), and of other families that show good agricultural and productive potential, capable of making acceptable contributions, even with minimum inputs. Nevertheless, the species vary depending on the geographic zone, edaphoclimatic conditions, among other factors (Rincón-Castillo and Villalobos, 2021).

In the southern zone of Brazil, the Santa Catarina State is considered the main animal husbandry zone of that region. In Florianópolis, the Ressacada farm, belonging to the Federal University of Santa Catarina (UFSC), shows a broad diversity of species of different families, some considered native, and other naturalized, which make up the feeding basis of grazing animals. In the pasturelands *Cyperaceae* plants, grasses and herbaceous legumes prevail. The presence and permanence of these species can be affected by several factors: management, climate (incidence of the seasons) and soil conditions. Mainly, immobile nutrients, such as P and K,

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constitute essential primary elements for plant growth (Martínez-Sáez *et al*., 2018).

The objective of this study was to characterize the productivity and nutritional quality of the herbaceous community in the cattle area of the Ressacada farm, after two years and a half of being treated with different doses of calcareous, phosphoric and potassium fertilizers.

Materials and Methods

Location. The studies were conducted in the experimental farm Ressacada-UFSC, in the Tapera zone, south of Florianópolis island, capital of the Santa Catarina State, geographically located at 27º 41' 06,28" S; 48º 32' 38.81" W, with predominance of flat land, at 3 m.a.s.l.

Soil and climate characteristics. The climate of the zone is humid subtropical (Andrade, 1996). The study was conducted during the summer (January-April) of 2019, with predominance of daily temperatures of 27 ºC and average minimum temperature of 23 ºC. This period comprises more than 60 % of the total annual rainfall (1 506 mm). The soil of the area is constituted by sandy sediments of alluvial-colluvial, wind and water origin, classified as typical hydromorphic neo-soil (IBGE and IPUF, 1991).

Experimental design and treatments. A randomized block design, with four repetitions, was applied. The research was conducted in paddocks that were under fertilization study, with 12 experimental treatments. The last fertilization was carried out 2,5 years before conducting this work.

The treatments were: T1) 0 calcareous, 0 P_2O_5 and 0 K_2O; T2) 0 calcareous, 0 P_2O_5 and 1 K_2O; T3) 0 calcareous, 1 P_2O_5 and 0 K_2O; T4) 0 calcareous, 1 P_2O_5 and 1 K_2O; T5) ½ calcareous, 0 P_2O_5 and 0 K_2O; T6) ½ calcareous, 0 P_2O_5 and 1 K_2O; T7) ½ calcareous, 1 P_2O_5 and 0 K_2O; T8) ½ calcareous, 1 P_2O_5 and 1 K_2O; T9) 1 calcareous, 0 P_2O_5 and 0 K_2O; T10) 1 calcareous, 0 P_2O_5 and 1 K_2O; T11) 1 calcareous, 1 P_2O_5 and 0 K_2O and T12) 1 calcareous, 1 P_2O_5 and 1 K_2O.

The fertilization was carried out according to the indications described in the Handbook of Fertilization Recommendations for the Rio Grande do Sul and Santa Catarina State (FS-RS/SC, 2004), based on the soil analyses. A dose of 50 kg of the calcareous fertilizer/ha and 40 kg for P and K/ha was applied.

Animals and management. The experimental area, with predominance of natural pastures, was managed with Voisin rational grazing (VRG) since 2016. In the paddocks 22 animals of the Brahman breed grazed, with average weight of 300 kg, aimed at replacement for milk production.

Used inputs. The applied fertilizers were Arad phosphate (natural phosphate), triple superphosphate (46 % of P_2O_5) and potassium chloride (60 % of K_2O_5) and a source of calcareous fertilizer.

Measurements. Before carrying out the measurements, deep grazing was done of all the experimental paddocks, for their homogenization regarding pasture height and availability. Then, rotation was adjusted, and after the recovery of the pastureland, approximately between 40 and 45 days, the yield measurements were performed. For such purpose a 0,25-m^2 frame was used in each experimental plot and the pasture was cut at a height of 20 cm. In each plot the frame was thrown four times, for a total of 48 samples cut in the selected area.

The collected samples were weighed in their fresh form to determine the weight of the total green matter. They were later taken to stove, during three days, at 105 ºC, to determine DM and estimate the yield.

The dried samples were ground in a Wiley mill, at 1 mm of thickness. They were transferred, duly packed, to the Forage Plant Laboratory of the CCA-UFSC for the determination of some indicators of nutritional quality (CP, NDF, ADF), using the MPA FT-NIR spectrometer.

Processing. For the statistical analysis of the yield and bromatology results, variance analysis was carried out. Before this analysis, the normal distribution and variance homogeneity were tested. The means were compared through Fisher's test, for a significance level of $p < 0,05$. For such purpose the statistical package InfoStat® 2012, free version, was used.

Results and Discussion

Pastures and forages are characterized by their high fiber content (approximately 30 % of DM is made up by this fraction) and constitute a very important part in the rations for ruminants, because they stimulate rumination and salivation and maintain adequate pH of the rumen (Domínguez *et al*., 2019).

The bromatological analysis of pastures allows to have an approximate idea of the degree of their nutritional quality, for which it is recommended to conduct, as minimum, the analyses of DM, CP,

ADF, NDF and ash (Cortes-Jojoa and Ramos-Obando, 2018).

Regarding yield (fig. 1), it was proven that this indicator was low for all the treatments, with values that did not exceed 2,5 t DM/ha/rotation. This is characteristic of natural pastures, which, barely, achieve yields of 4,0-8,0 t DM/ha/year (Domínguez-Escudero, 2020). It was observed that T5, T8, T9 and T10 were the ones with the best performance. However, they did not differ statistically from the others, with the exception of T2, which had the lowest value. This last one showed significant differences with regards to the above-mentioned treatments.

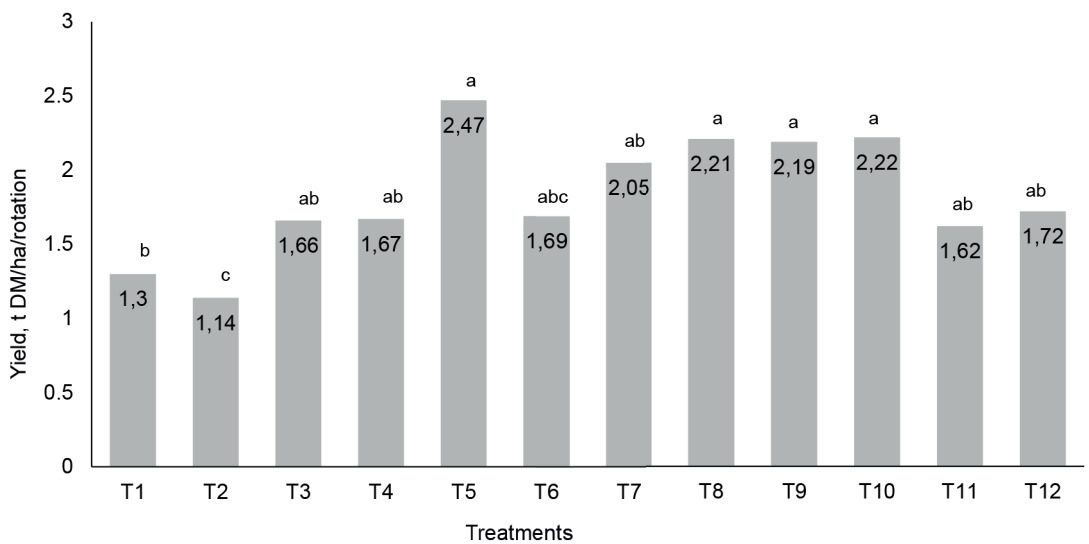
This differentiation could have been influenced by the presence of the fertilizers, and also the floristic composition (Olivera-Castro *et al*., 2020), which was different in each treatment. Nineteen families prevailed, with representation of 64 species, and among these families those of higher representativeness were *Cyperaceae* (21,9 %), *Poaceae* (14,7 %) and *Fabaceae* (5,8 %). The other identified species, with a representation percentage below 1,33 %, belong to the families *Apiaceae*, *Asteraceae*, *Commelinaceae*, *Euphorbiaceae*, *Hypoxidaceae*, *Juncaceae*, *Lamiaceae*, *Lythraceae*, *Melastomataceae*, *Ochnaceae*, *Onagraceae*, *Polygalaceae*, *Rubiaceae*, *Scrophulariaceae* and *Xyridaceae*. They are all naturalized species, which respond differently to rational management, and express different yield and quality potentials.

It is known that yield is one of the most important variables and one of the most influential on the agroproductive performance of plants (Boschini *et al*., 2002). This variable is linked, among other factors, with the genetic potentiality of the species, the climate and management conditions, as well as with the physical and chemical properties of the soil, the last ones with marked influence (Debelis *et al*., 2005). This indicates that the variations that appear in this sense can sensibly modified DM production during the exploitation cycle.

Table 1 shows the results of the analysis of some bromatological variables, regarding the nutritional quality of the pastureland per each treatment.

In general, there were highly significant differences for each one of the studied variables in the different treatments. In this differentiation, as mentioned above, the presence of fertilizers could have influenced, although the floristic component could have had repercussions too (Olivera-Castro *et al*., 2020) in each paddock.

The CP showed the best value in T2 and T4, which differed statistically from the others. The lowest



T1) 0 calcareous, 0 P_2O_5, 0 K_2O; T2) 0 calcareous, 0 P_2O_5, 1 K_2O; T3) 0 calcareous, 1 P_2O_5, 0 K_2O; T4) 0 calcareous, 1 P_2O_5, 1 K_2O; T5) ½ calcareous, 0 P_2O_5, 0 K_2O; T6) ½ calcareous, 0 P_2O_5, 1 K_2O; T7) ½ calcareous, 1 P_2O_5, 0 K_2O; T8) ½ calcareous, 1 P_2O_5, 1 K_2O; T9) 1 calcareous, 0 P_2O_5, 0 K_2O; T10) 1 calcareous, 0 P_2O_5, 1 P_2O_5, T11) 1 calcareous, 1 P_2O_5, 0 K_2O and T12) 1 calcareous, 1 P_2O_5, 1 K_2O.

Figure 1. Performance of yield in each one of the treatments.

Table 1. Quality analysis of the pastureland in the different treatments, %.

Treatment/variable	CP	NDF	ADF
T1: 0 calcareous, 0 P_2O_5, 0 K_2O	5,97^{bc}	51,27^{ab}	28,79^{a}
T2: 0 calcareous, 0 P_2O_5, 1 K_2O	7,59^{a}	51,88^{ab}	28,83^{a}
T3: 0 calcareous, 1 P_2O_5, 0 K_2O	6,44^{ab}	52,54^{ab}	31,00 ^{ab}
T4: 0 calcareous, 1 P_2O_5, 1 K_2O	7,32^{a}	51,96^{ab}	30,42^{ab}
T5: ½ calcareous, 0 P_2O_5, 0 K_2O	5,35^{cd}	51,17^{ab}	30,95^{ab}
T6: ½ calcareous, 0 P_2O_5, 1 K_2O	5,11^{cd}	51,11^{ab}	30,62^{ab}
T7: ½ calcareous, 1 P_2O_5, 0 K_2O	4,80^{d}	55,77^{a}	32,83^{b}
T8: ½ calcareous, 1 P_2O_5, 1 K_2O	5,96^{bc}	51,96^{ab}	31,16^{ab}
T9: 1 calcareous, 0 P_2O_5, 0 K_2O	5,13^{cd}	53,20^{a}	31,30^{ab}
T10: 1 calcareous, 0 P_2O_5, 1 K_2O	5,19^{cd}	52,35^{ab}	31,14^{ab}
T11: 1 calcareous, 1 P_2O_5, 0 K_2O	5,59^{c}	49,00^{b}	30,02^{a}
T12: 1 calcareous, 1 P_2O_5, 1 K_2O	6,06^{bc}	47,24^{c}	29,24^{a}
SE ±	1,12**	1,41**	3,63**

Means with different letters significantly differ at $p < 0,05$

T1) 0 calcareous, 0 P_2O_5, 0 K_2O; T2) 0 calcareous, 0 P_2O_5, 1 K_2O; T3) 0 calcareous, 1 P_2O_5, 0 K_2O; T4) 0 calcareous, 1 P_2O_5, 1 K_2O; T5) ½ calcareous, 0 P_2O_5, 0 K_2O; T6) ½ calcareous, 0 P_2O_5, 1 K_2O; T7) ½ calcareous, 1 P_2O_5, 0 K_2O; T8) ½ calcareous, 1 P_2O_5, 1 K_2O; T9) 1 calcareous, 0 P_2O_5, 0 K_2O; T10) 1 calcareous, 0 P_2O_5, 1 K_2O, T11) 1 calcareous, 1 P_2O_5, 0 K_2O and T12) 1 calcareous, 1 P_2O_5, 1 K_2O.

percentage was for T7. It is relevant to emphasize that the CP percentage of the pastureland was low for all the cases (between 4,8 and 7,6 %), which was influenced by the presence of species of low nutritional contribution, like the ones of the genus *Cyperaceae*, *Melastomataceae*, *Apiaceae*, *Euphorbiaceae*, among others. In a study conducted by Ojo *et al*. (2017) CP contents lower than 6,0 % were reported in natural pastures of southeast Nigeria, very similar (5,3-6,1 %) to the ones found by Triana-González *et al*. (2017) in the savannas of Camagüey, Cuba and by da Oliveira *et al.* (2015) in tropical forage plants of Brazil. No influence of the legumes present in the paddocks was observed, regarding the pastureland quality, in spite of their increase compared with the beginning of the experiment.

For an effect of legumes on the nutritional value of the pastureland in general to occur, they should be in a proportion that is not lower than 30,0 % (Terra *et al*., 2019). In this study, the presence of the legumes was below this value (Olivera-Castro *et al*., 2020), and T12 was the one that showed the best result (25,9 %). That is why the improvement actions of the pastureland should be continued, like species rehabilitations or sowing, even both, because they contribute protein, to offer thus to the animals a more balanced and higher-quality pastureland. Olivera-Castro (2016), in a study of several accessions of *Urochloa brizantha* (Hochst. ex A. Rich.) R.D. Webster, associated to the legume *Stylosanthes guianensis* (Aubl.) Sw., found that the protein contribution of the associations varied between 9,4 and 11,2 %.

The NDF content, total cell wall, composed by the ADF fraction (cellulose and lignin) plus hemicellulose, is one of the most utilized criteria to determine the forage quality, because it indicates the intake capacity of the animal and the energy density of the diet (Bassi, 2008). According to the report by Van Soest *et al.* (1991), the forages with NDF content < 40,0 % can be considered of good quality; while those with NDF > 60,0 %, can interfere the DM digestion and intake.

Regarding this variable, no treatment was below 40,0 %. This was influenced, to a large extent, by the floristic component (Olivera-Castro *et al*., 2020) present in the paddocks, dominated by natural pastures, which increase the production of stem biomass and dead material (Villareal-González *et al.,* 2014). T12 showed lower NDF content, and differed statistically from the others.

With regards to the performance of ADF, T7 showed the highest concentration of this element and differed statistically from T1, T2, T11 and T12, which were the ones with lower percentage and,

thus, lower digestibility values, because according to Osorio-Espinoza and Tapara-Jurado (2020), as the ADF increases, the capacity of the animals to digest the forages within their reach is reduced.

Nevertheless, the used rational rotation system (VRG), based on the entrance of the animals to the paddock, when the pastures are in their optimum grazing point, allowed the values obtained in this research to be lower than those reported by López *et al*. (2019) in *Megathyrsus maximus* (Jacq.) B.K. Simon & S.W.L. Jacobs cv. Likoni (35,2-34,4 % and 68,7-68,0 %), for ADF and NDF, respectively, and the ones recorded by Rodríguez and Lara (2018) in *cv.* Tanzania (42,9-57,6 % and 74,9-80,7 %) for the rainy and dry season, respectively, both in silvopastoral systems in association with *Leucaena leucocephala* (Lam.) de Wit. They were also lower than those referred by Ortega *et al*. (2015) in the rainy season, for Guinea grass Tanzania and *Brachiaria* mulato and toledo (66,32-70,0-78,0 %, respectively).

In general, it can be inferred that low yields, as well as the low nutritional quality of the pastureland, were closely related to the high presence of species from families that do not make a good nutritional contribution, among which the ones belonging to the family *Cyperaceae* stand out. They are considered undesirable, adapt to different edaphoclimatic conditions (Bozal *et al*., 2011) and their presence affects the development and growth of other species within the pastureland. Many *Cyperaceae* species are dominant in ecosystems of humid soils.

Although the species of this family are not recommended for feeding cattle, due to their low quality, studies are known in which they have been part of the diet of other animal species, mainly of birds (Echaccaya *et al*., 2017).

It is concluded that the pastureland of the farm, cataloged as natural or naturalized, showed low productive yield, in spite of undergoing the rainy season. The nutritional quality was also low, typical of the natural pastures of the region.

Rehabilitation is recommended in the paddocks that merit it, as well as planting cultivated species (grasses and legumes), which contribute nutritional quality to the pastureland and to the diet of the animals; besides allowing the decrease of less important species, like those of the family *Cyperaceae*.

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Conflicts of interests

The authors declare that there is no conflict of interests among them.

Authors' contribution

- Yuseika Olivera-Castro. Elaborated the project, as part of a postdoctoral research, carried out the studies, data taking and processing, manuscript writing and correction.
- Maiara Mendes de Azevedo. Contributed to measurement taking in the field and to manuscript elaboration.
- Laura Livia Arias-Avilés. Participated in the measurement taking in the field and in the manuscript elaboration.
- Luiz Carlos Pinheiro-Machado Filho. Participated in the design and setting up of the experiments, as well as in the advisory of the research.
- Pedro Pablo del Pozo-Rodríguez. Contributed to the advisory of the research and to the manuscript writing.

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