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Chemical composition and *in vitro* ruminal digestibility of hand-plucked samples of Xaraes palisade grass fertilized with incremental levels of nitrogen

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ABSTRACT

Improvements in the nutritional quality of tropical grasses depend on the proper use of grazing management and nitrogen fertilization as well as climatic conditions. The aim of this study was to evaluate the effect of nitrogen (0, 125, 250, 375, 500 or 625 kg/ha, applied as urea), grazing cycles (GCs) and growing degree days (GDD) on the chemical composition and *in vitro* digestibility of dry matter (IVDMD), organic matter (IVOMD) and neutral detergent fibre (NDFD) of hand-plucked samples of Xaraes palisade grass (*Urochloa brizantha* cv. Xaraes). A total of 24 plots of 112 m^2 each were cultivated with Xaraes palisade grass was evaluated and carried with repeated measures (GCs) and one treatment factor (N rate) in completely randomized block design, with four replications. Grass samples were collected after 26 days of regrowth from plots that were managed under rotational stocking (26 days of rest and 2 days of occupation) in six GCs (1–6). To achieve the target height of post-grazing residues (24–27 cm), dry Holstein cows were used with a body weight (BW) of 527 kg (SD 36 kg), considering a consumption of 2.5% of BW and 40% estimated mass loss of pre-grazing forage. All of the nutrient concentrations were affected by N fertilization and GCs. The crude protein (CP) content increased linearly with the N rate in each grazing cycle ($P < 0.05$). NDF decreased linearly with the N rate in each grazing cycle ($P < 0.05$). N fertilization increased the IVDMD, IVOMD and NDFD with a linear or quadratic response depending on the GC ($P < 0.05$). The average maximum point that was obtained in GC4 in the regression equations for IVDMD, IVOMD and NDFD as a function of N fertilization was 533 kg N/ha/year. The GDD had a quadratic effect on the chemical composition and digestibility of Xaraes palisade grass with distinct N doses. N fertilization stimulated the formation of cell walls with better-quality fibre and resulted in a higher forage digestibility according to the climatic conditions and GDD. The greatest improvements in forage quality were obtained, with N rates greater than 382 kg/ha/year.

Abbreviations: DM, dry matter; OM, organic matter; NDF, neutral detergent fibre assayed without a heat-stable amylase and expressed inclusive of residual ash; ADF, acid detergent fibre expressed inclusive of residual ash; EE, ether extract; CP, crude protein; NFC, non-fibrous carbohydrate; HEM, hemicellulose; CEL, cellulose; FY, forage yield; GDD, growing degree days; DD, degree days; IVDMD, *in vitro* digestibility of dry matter; IVOMD, *in vitro* digestibility organic matter; NDFD, neutral detergent fibre *in vitro* digestibility.

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1. Introduction

The state that livestock production in a pasture is a major contributor to the formation of greenhouse gases (GHG) Peters et al. (2013). Nevertheless, Pessarakli (2014) reports that sustainable intensification provides significant potential to generate environmental and social benefits. For Peters et al. (2013), the preferred method of sustainability is the mitigation of GHG by increasing carbon storage in the soil, which is achieved by well-managed and fertilized pastures, which, in addition to maintaining the productivity of pasture and animal, retain water in the soil and reduce flow and erosion.

Brazil has a significant ability to reduce the emission of GHG because of its large geographic extension, areas with favourable climatic conditions and adoption of an appropriate management system (Berndt and Tomkins, 2013). This country is a major worldwide supplier of meat and milk; has the second largest herd, with 213.1 million heads; and exports of 1.9 million tons of beef (FAOSTAT, 2015). The production of Brazil is based, for the most part, on different tropical pastures. Alone, the genus *Brachiaria* (syn. *Urochloa*) occupies approximately 80 million hectares (Pessarakli, 2014), and *Urochloa brizantha* cv. Xaraes is among the most productive, with potential use in many tropical and subtropical countries (Nave et al., 2010). However, major constraints to cattle production in the tropics include the quantity and quality of grasses, upper grazing, use of non-adapted grasses, depletion of soil nutrients that lead to the degradation of pastures, and consequently, low animal productivity (Pessarakli, 2014).

However, the low quality of tropical forages occurs not only during periods of drought by decreased production but also during wet periods. According to Wilson and 't Mannetje (1978), N fertilization increases the grass yield, but over the summer (rainy season), when it is usually difficult to maintain sufficient grazing pressure to control pasture growth. The benefits of this increased yield can be partially offset by nitrogen, promoting rapid leaf senescence and decreased leaf digestibility, thereby reducing the overall pasture quality. Poppi and McLennan (1995) report that to minimize the variation of live weight gain between the rainy and dry seasons, the strategy would be to improve the length and forage quality in the rainy season.

Increasing the production and maintaining the quality of grasses are essential to ensure the robustness of livestock grazing in pastures, for which soil fertility is a prerequisite. Weather is a key factor affecting the quality of pastures (Baumont et al., 2014).

However, with the advent of global warming, the great adaptive plasticity of tropical grasses makes them suitable for sustainable intensification in new regions. Thus, the present study aimed to assess samples that were derived from Xaraes palisade grass, hand-plucked, and managed within the concepts of soil-plant-animal interaction. In this context, we aimed to gather the N fertilization rate and real-time weather and animal grazing data, which would lead to an increase of the nutritional value and digestibility of Xaraes palisade grass and enable the indirect optimization of consumption, performance and animal productivity.

2. Materials and methods

2.1. Location, treatments and sampling

The experiment was carried out at the State farm at Americana, São Paulo, Brazil, at coordinates 47° 16′ 80″ west longitude and 22° 45′ 09″ south latitude and an altitude 545 m. The climate according to the Köppen classification is Cwa, hot and humid tropical, with the rainy season in summer and the dry season in winter. Climatological data were obtained from the Integrated Centre for Agro-meteorological Information (CIIAGRO) (Fig. 1). The monthly water balance was calculated according to the method of Rolim et al. (1998) considering a soil water storage capacity (WSC) of 175 mm, as estimated according to the soil classification using values that were tabulated by Thornthwaite and Mather (1957).

The soil in the experimental area was classified as Melanic Gleissoil with a sandy loam texture. The composition was 669 g/kg sand, 188 g/kg silt, and 143 g/kg clay, with 350 g/kg base saturation and 13 mg/dm^3 phosphorus.

A total of 24 plots measuring 112 m^2 each (14 m × 8 m), cultivated with Xaraes palisade grass, *U. brizantha* cv. Xaraes (Hochst. ex A. Rich.) R. D. Webster cv. Xaraes (Syn. *Brachiaria brizantha* cv. Xaraes) were evaluated by repeated measures (grazing cycles—CGs) with one treatment factor (N rate) in a completely randomized block design, with four replications. Each block received one of the following N fertilization treatments: 0, 125, 250, 375, 500 or 625 kg N/ha/year as urea (six plots per blocks) and six grazing cycles (September 22, 2009; October 20, 2009; November 17, 2009; December 16, 2009; January 13, 2010; and February 13, 2010).

After decreasing the plant height through grazing in August 2010, a total of 1.7 t/ha lime (PRNT 75%), with a Mg content between 12 and 15%, was applied to the pasture to increase the base saturation to 60%. Along with the first fertilizer application, 40 kg/ha P_2O_5 in the form of superphosphate, corresponding to 26 kg/ha of sulphur, was applied by broadcasting to fix the phosphorus and the sulphur. Potassium fertilization was based on the extraction of nutrients from 20 t/ha/year of herbage mass (Valle et al., 2001) and 20 kg K in newly expanded leaf blades (Silveira et al., 2005). These values were chosen to result in a 400 kg/ha/year potassium extraction from the aerial portion of the plant, which was restored to the soil in the form of potassium chloride and was redistributed in September and November 2009 because the soil texture was sandy loam.

Soon after the removal of the grazing cows, N fertilization, which was distributed throughout the year, occurred in five equal applications that were alternated with grazing during the rainy season (September 22, 2009; October 19, 2009; November 16, 2009; December 14, 2009; and January 11, 2010) and always occurred after the removal of grazing animals.