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RESEARCH ARTICLE

PASTURES RECOVERY SYSTEMS IN THE BRAZILIAN CERRADO

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ABSTRACT

Improper management of added grazing the low soil fertility are each responsible for reducing pasture productivity increasing degradation. The objective was to evaluate three pasture management systems for the recovery of the productive characteristics of grass Marandu (*Brachiaria brizantha*) and the physical properties of the soil, in the third year of management in a pasture degradation in the Brazilian Cerrado. The experimental design was a randomized block with three treatments (recovery with chemical fertilizer; recovery with chemical fertilization associated with direct seeding corn, and chemical recovery associated with light rail use) with eight replications. The pasture was evaluated in its third year of this recovery management (2011/2012). The evaluations were performed at 35, 70 and 105 days after the start of treatment. It was found indirect index of leaf chlorophyll, shoot dry mass, index cover vegetation, bulk density, field capacity and soil penetration resistance. For dry weight of shoot and indirect chlorophyll content, the chemical recovery system with light rail use had the highest production (4.18 t ha^{-1}) and indirect chlorophyll content in the leaf (50.85). The highest soil coverage (98.56%) was obtained in the recovery system for chemical fertilization. The recovery system with light grid was the one who showed improvement in mechanical resistance to soil penetration in the layers of 0-0.20 m.

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INTRODUCTION

Pastures are one of the main production systems in the world, occupying about 70% of agricultural areas (Dubeux Jr. *et al*., 2011), and are of considerable importance in many regions of temperate and tropical (Braga, 2010). In Brazil, approximately 200 million hectares under different conditions of climate and soil, are covered by native and cultivated pastures (Silva *et al*, 2010; Kaschuk *et al*, 2010), mainly grasses Brachiaria (Costa *et al*., 2010). However, in the Midwest region, it is estimated that over 50% of pasture areas, around 28 million hectares, is in degradation process (Imea, 2011). This is caused by the Oxisol of the Midwest region, that presents good physical soil structure, resulting generally in good drainage and low fertility. In addition to this low fertility, these soils also have high acidity (Ipea, 2014). Managed grazing provides greater ground cover and favors the storage of water and its use by plants (Bonfim-Silva *et al*., 2011). In this context, the objective was to evaluate three grazing management systems in the Brazilian Cerrado, in the third year of implementation, which aimed at the recovery of the productive characteristics of *Brachiaria brizantha* and physical properties of the soil.

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MATERIAL AND METHODS

The experiment was conducted the field at the Federal University of Mato Grosso, State of Mato Grosso, the city of Rondonópolis, Brazil, located at 16 ° 27'45 "S, 54 ° 34'45"O in pasture with grass Marandu (*Brachiaria brizantha*) in moderate stage of degradation, from November 2011 to July 2012 (Figure 1). The temperature varies between 20 and 35 ° C and the precipitation reached 1,064 mm driving period of the experiment. The soil of the experimental area is classified as Oxisol (Embrapa, 2006), which is characterized by its low fertility. The experimental delineation was a randomized block, evaluating three pasture recovery systems (recovery with chemical fertilizer, chemical fertilizer with recovery associated with no-till corn and chemical recovery associated with the use of light grid) with eight replications. The experimental plot had 90 m^2 (4.5 x 20 m), totaling 2160 m^2 of experimental area.

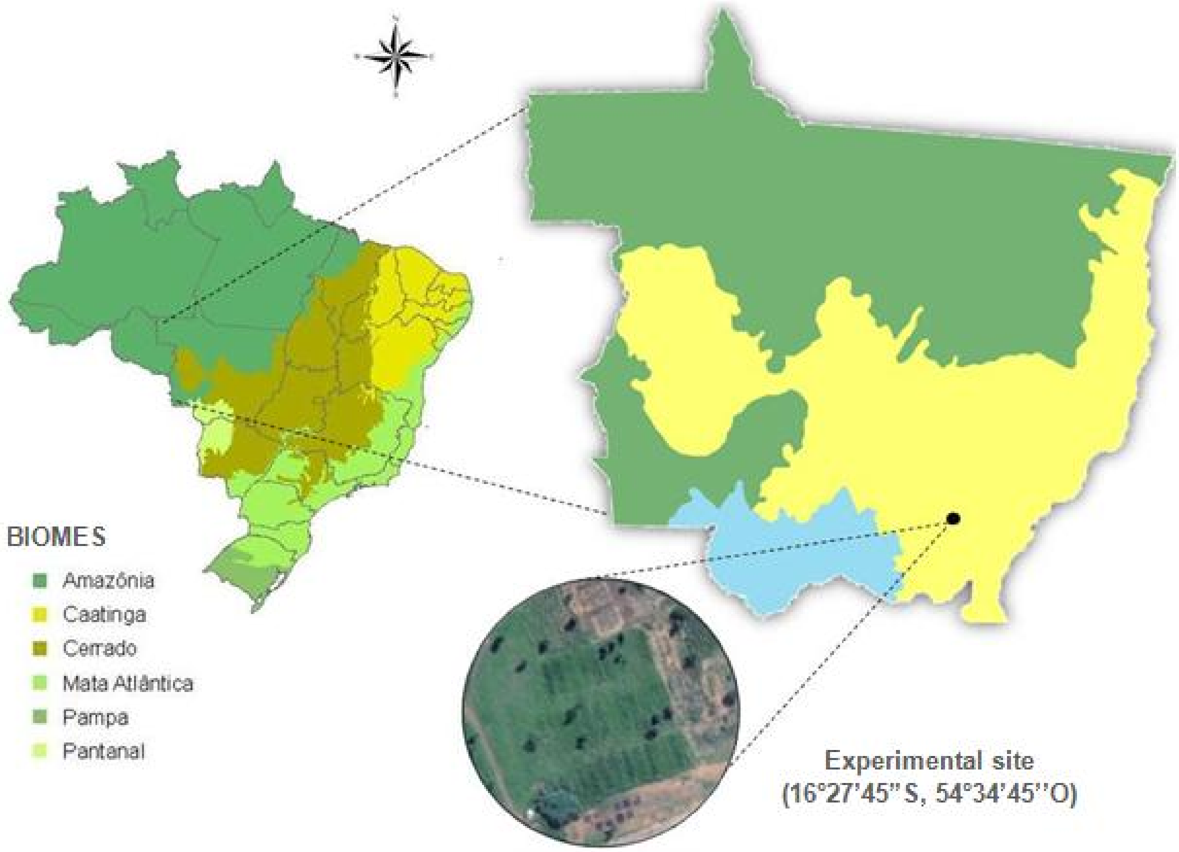

Figure 1. Representation of the location of the experimental area, State of Mato Grosso, Rondonópolis City, Brazil

Table 1. Chemical characterization Oxisol sample of the depth of 0-0.2 m from the experimental plots in the third year of the management system implementation evaluation

Treatment	pH	P	K	Ca	Mg	Al	H+Al	SB	CTC (T)	V	M
	$CaCl_2$	(mg dm^{-3})		.... (cmolc dm^{-3})...................................						........(%)......	
GR.	4.70	2.70	0.18	1.00	0.70	0.20	3.60	1.88	5.48	34.30	9.60
SD.	4.60	3.40	0.17	0.80	0.60	0.30	4.00	1.57	5.57	28.20	16.00
RQ.	4.30	1.60	0.17	0.60	0.30	0.50	4.20	1.07	5.27	20.30	31.80

GR. recovery system with chemical fertilization associated with light rail use; SD. recovery system with chemical fertilization associated with direct seeding corn; RQ. recovery system for chemical fertilizer.

This area is being recovered with these managements, two years ago, so the evaluation are described for the third consecutive year of recovery. Liming and fertilization was based on Cerrado Bulletin (Embrapa, 2006) after chemical analysis of soil (Table 1). Thus amounted to base saturation to 50%, and applied the fertilizer with 200, 50 and 40 kg ha^{-1} of nitrogen (urea), phosphorus (P_2O_5) and potassium (K_2O), respectively, was uniform, to haul in all experimental plots. Pasture recovery systems were: recovery with chemical fertilizer (RQ): Only application of chemical fertilizer (Figure 2A). Recovery with chemical fertilization associated with direct seeding corn (SD): Receives the same chemical fertilization that the RQ treatment, however, is applied to glyphosate desiccation of forage, and the straw, is sown corn (Zea mays L.) cultivar 2B655HX with seeder (Figure 2 B) and recovery with chemical fertilization associated with the light grid use (GR): Receives the same chemical fertilization of other treatments, however, the plots were barred with light grating (depth up to 0.18 cm), incorporating the fertilizer to the soil (Figure 2 C).

Three evaluations were performed from November 2011 to July 2012, and at 35, 70 and 105 days (first, second and third evaluation, respectively) after application of treatments. After each evaluation was performed lowering of the grass to 0.10 m, with the help of costal weeder, simulating the animal grazing, and removal of the cut grass. In the plant, the variables analyzed were: indirect index of leaf chlorophyll, shoot dry weight, índex cover vegetation. In the soil there was, density, field capacity and penetration resistance in the layers 0-0.10 m and 0.10-0.20 m deep. In determining the indirect index of leaf chlorophyll, used the portable meter, ClorofiLOG CFL 1030 Falker. The chlorophyll content was determined by performing up to 10 readings in diagnostic leaves (leaves +1 and +2) newly expanded as Bonfim-Silva & Monteiro (2010). Quantification of shoot dry mass was performed after 0.5 m² of green shoots of bulk sampling, randomly throwing two samplers frames of 0.25 m² each, the floor area of each plot. Subsequently, the green mass of the total aerial part of each portion was dried in a forced air circulation oven with temperature ± 65 °C to constant mass.

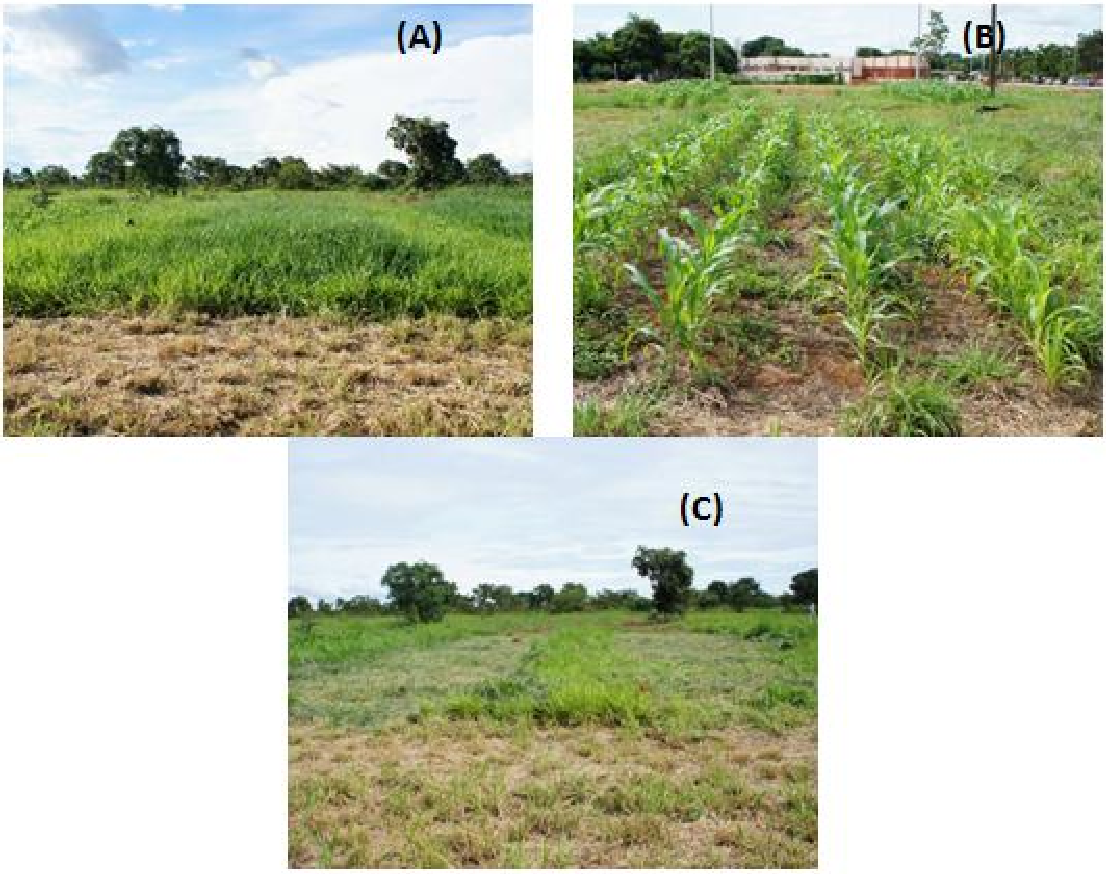

Figure 2. Experimental grassland plots in recovery (*Brachiaria brizantha* cv. Marandu) submitted to the recovery systems for chemical fertilizer (A), recovery with chemical fertilization associated with direct seeding corn (B), and recovery with chemical fertilization associated with the use light grid (C)

Table 2. Indirect index of leaf chlorophyll, dry mass of shoot and index cover vegetation of *Brachiaria brizantha* cv. Marandu subjected to pasture recovery systems, the first evaluation (35 days), second evaluation (70 days) and third evaluation (105 days), the third year of evaluation of implementation of pasture recovery systems

	Evaluation	Recovery with chemical fertilizer	Chemical fertilizer with recovery associated with no-till corn	Chemical recovery associated with the use of light grid
Indirect index of leaf chlorophyll	1ª	51.68 A	50.30 AB	49.98 B
	2ª	47.81 B	49.40 AB	50.85 A
	3ª	43.00 A	44.64 A	47.43 A
Dry mass of shoot (t ha^{-1})	1ª	3.05 B	1.81 C	4.18 A
	2ª	2.02 B	3.15 AB	3.56 A
	3ª	1.70 A	2.18 A	2.50 A
Index cover vegetation (%)	1ª	98.56 A	92.66 B	91.50 B
	2ª	89.83 A	90.04 A	90.94 A
	3ª	94.28 A	91.70 AB	85.50 B

Means followed by the same letter, the lines of each evaluation, do not differ by Tukey test up to 5% probability

Table 3. Soil density, field capacity , resistance to penetration in depth from 0 to 0.10 m, the first assessment (35 days), second evaluation (70 days) and third evaluation (105 days), the third year of evaluation of implementation of pasture recovery systems

	Evaluation	Recovery with chemical fertilizer	Chemical fertilizer with recovery associated with no-till corn	Chemical recovery associated with the use of light grid
Soil density (Mg m^{-3})	1ª	1.42 A	1.39 A	1.45 A
	2ª	1.40 A	1.35 A	1.43 A
	3ª	1.39 A	1.34 A	1.43 A
Field capacity (%)	1ª	22.51 A	22.50 A	23.41 A
	2ª	22.63 A	22.90 A	22.13 A
	3ª	23.42 A	23.17 A	22.58 A
Penetration resistance (MPa)	1ª	2.68 A	2.11 A	2.59 A
	2ª	2.82 B	1.53 A	2.56 AB
	3ª	2.97 B	1.98 AB	1.72 A

Means followed by the same letter, the lines of each evaluation, do not differ by Tukey test up to 5% probability

The index cover vegetation was determined by visual inspection method in the field (line-transect method), described and compared by Laflen *et al*. (1981). To determine the physical properties of soil were collected four soil subsamples randomly in the useful area of the experimental plot, using volumetric ring at 0-0.10 m and 0.10-0.20 m. Determination of bulk density and field capacity followed the methodology described by Embrapa (1997). For penetration resistance was used penetrometer table MA 933, with a penetrometer data acquisition system version 1010/03. The results were submitted to analysis of variance, F test ($p \leq 0.05$) and Tukey test ($p \leq 0.05$), the statistical program Sisvar (Ferreira, 2011).

RESULTS AND DISCUSSION

The indirect index of leaf chlorophyll in Marandu grass were influenced by pasture recovery systems, with a significant difference at 35 and 70 days, first and second evaluation respectively. The largest indirect indices of chlorophyll were obtained in the recovery of pasture with chemical fertilizer (51.68) first evaluation and recovery with chemical fertilizers associated with the light grid use (50.85), but did not differ from fertilization system with direct seeding maize (Table 2). there was the incorporation of urea (recovery system for chemical fertilizers and direct seeding corn), it is likely to have been higher nitrogen losses by volatilization. Leaching and volatilization can occur when applying nitrate nitrogen (Costa *et al*., 2013). The ground cover was influenced by pasture recovery systems at 35 and 105 days of fertilization, getting the best results in the recovery system with chemical fertilization, with 98.56 and 94.28% of soil covered, respectively (Table 2). It is found that the recovery grid system with use, the ground structure changes, and is the destruction of part of the implement grass roots. Moreover, the recovery system with direct seeding, grazing in the first 30 days of fertilization, was in one of his shoots reconstruction process due to their desiccation corn seeding. These factors may have favored the highlight recovery system with chemical fertilizer for soil cover. Assess physical, chemical and biological soil properties are essential to verify the quality of the soil and the environment (Stefanoski *et al*., 2013). The physical properties of the soil, such as soil density and field capacity, were not affected in terms of management systems used. However for penetration resistance, there was influence 70 and 105 days of fertilization in the surface layer (0- 0.10 m), in recovery systems with corn seeding and the system with light grid,

Table 4. Soil density, field capacity, resistance to penetration in depth from 0.10 to 0.20 m, the first assessment (35 days), second evaluation (70 days) third evaluation (105 days), the third year of evaluation of implementation of pasture recovery systems

	Evaluation	Recovery with chemical fertilizer	Chemical fertilizer with recovery associated with no-till corn	Chemical recovery associated with the use of light grid
Soil density	1ª	1.46 A	1.45 A	1.47 A
($Mg\ m^{-3}$)	2ª	1.42 A	1.41 A	1.44 A
	3ª	1.44 A	1.40 A	1.45 A
Field capacity (%)	1ª	22.58 A	22.39 A	23.08 A
	2ª	21.91 A	22.40 A	21.38 A
	3ª	20.79 A	22.73 A	20.74 A
Penetration resistance (MPa)	1ª	2.19 A	2.37 A	3.52 A
	2ª	2.52 A	1.94 A	2.59 A
	3ª	2.05 AB	1.40 A	2.79 B

Means followed by the same letter, the lines of each evaluation, do not differ by Tukey test up to 5% probability

Chlorophyll index is directly related to evaluation of nitrogen nutrition, since there is a positive correlation between the index with the concentration of nitrogen in the leaves of grasses (Schlichting *et al*., 2015). It can be observed at the first evaluation of the third year of Marandu grass recovery, the pasture recovery system only chemical fertilizer may have provided favorable conditions for immediate availability of nitrogen to plants, however in the second evaluation, the chlorophyll content was higher in the treatment with chemical fertilization associated with use of light grid, it shall be associated with possibly the mineralization of organic matter after soil disturbance and also the root system has recovered from damage mechanics during the implementation of this treatment. To shoot dry mass, the greatest results 4.18 t ha^{-1} and 3.56 t ha^{-1} were observed in the chemical recovery system with the use of light grid, the first and third evaluation, respectively (Table 2). The pasture production capacity is intrinsically related to environmental conditions prevailing in the area and management practices. Thus, possibly associated with fertilizer grad use, favored best soil conditions in preparation for nutrient absorption. In this study, nitrogen availability is one of the factors that may have influenced the limitation of the dry mass of shoots. Thus, in systems where respectively (Table 3) and also at 105 days in the top layer (0.10 to 0.20 m), the recovery system with corn seeding (Table 4). Bonfim-Silva *et al*. (2010) noting the density and field capacity in the same experimental area of this study in the first year of driving (2009/2010), found that the variables studied were not influenced by pasture recovery systems, confirming the results observed in this study, which corresponds to the third year review. With the physical characterization of the soil in two layers, higher densities were observed at a depth 0.10 to 0.20 m in the three management systems.

Oliveira *et al*. (2015) evaluating physical soil quality under different management systems and application of liquid manure pig in native forest, pasture, conventional tillage, no-till, they found that the soil managed under pasture had the highest penetration resistance values. In the first and second evaluation showed that treatment with direct sowing of maize, that the 0 - 0.10m presented penetration resistance values of 1.53 and 1.98 MPa, respectively below the threshold considered critical to the development of grass roots, which according to Taylor *et al*. (1996) is around 2 MPa. The soil penetration resistance is an important indicator of compaction of soils cultivated (Santos *et al*., 2015). Increased compression can increase the density and reduce the volume of pores in the soil, which increases the likelihood of erosion, loss of hydraulic conductivity and reduced soil exploitation by roots (Shi *et al*., 2012). For extended period, may form compacted layers (Lima *et al*., 2013).

Conclusions

The pasture recovery system with the light grid use increases the chlorophyll and dry matter content of the aerial part of Marandu grass, but the ground cover was more pronounced in the recovery system with chemical fertilizer. The pasture recovery management systems studied did not influence the soil density and soil field capacity in the third year of management. The recovery system with grid use decreases the penetration resistance of the soil in the surface layer (0 - 0.10m), but increases in the top layer (0.10 to 0.20 m).

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