



Cattle manure on soil nutrient availability and recovery

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INFO

Keywords

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plant nutrition
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ABSTRACT

Studies developed with organic fertilization show a potential for availability of nutrients from organic residues, in the improvement of soil attributes. Thus, the objective of this study was to evaluate the effect of the addition of cattle manure on soil chemical attributes. The experiment was conducted in the experimental field of the Federal University of Tocantins, Gurupi campus. The experimental design was in randomized blocks with three replications. The treatments were eight doses of cattle manure (2,5; 5; 10; 12,5; 20; 25; 50 and 100 t ha⁻¹), 27 plastic bags of 5 dm³. There was an increase in the levels of M.O, K, P, Ca, CTC, Sum of bases and decrease in PH, H⁺Al from the increase in manure doses when compared to the control, it was found that the addition of cattle manure at the highest doses resulted in increased soil fertility.

RESUMO

Esterco bovino na disponibilidade e recuperação de nutrientes em solo

Estudos desenvolvidos com adubação orgânica demonstram uma potencialidade para disponibilidade de nutrientes proveniente de resíduos orgânicos, na melhoria dos atributos dos solos. Assim, objetivou-se avaliar neste trabalho, o efeito da adição do esterco bovino nos atributos químicos do solo. O experimento foi conduzido no campo experimental da Universidade Federal do Tocantins, campus de Gurupi. O delineamento experimental foi em blocos casualizados com três repetições. Os tratamentos foram oito doses de esterco bovino (2,5; 5; 10; 12,5; 20; 25; 50 e 100 t ha⁻¹), constituindo-se de 27 sacos plásticos de 5 dm³. Constatou-se aumento dos teores de M.O, K, P, Ca, CTC, Soma de bases e diminuição do PH, H⁺Al a partir da elevação das doses do esterco quando comparado com a testemunha, verificou-se que a adição de esterco bovino nas doses mais elevadas resultou no aumento da fertilidade do solo.

Palavras-chaves

adubo orgânico
nutrição de plantas
cerrado

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INTRODUCTION

The Cerrado is considered as the Savana brasileira, known to have a natural gradient of physiognomies, open fields and forests, besides being located on the most different types of soil. Research-based on the improvement of agricultural and livestock activities in the Cerrado region is of great importance for Brazil to become one of the world leaders in agribusiness, mainly taking into account its area of more than 2 million m² (Bolfe et al., 2016).

Thus, given this large territorial extension, the chemical and physical attributes of the soil present variations, being mostly characterized as acidic soils, high aluminium concentration, poor in fertility, in addition to presenting some nutritional deficiencies, a limiting factor for the cultivation of commercial specifications (Bottega et al., 2011).

Also, soils found in the cerrado regions have deficiency of calcium, magnesium, phosphorus and also low organic matter content, this occurs naturally, due to the composition of the source material of its formation, as well as the weathering and leaching processes that occur in these types de soils (Siqueira Neto et al., 2009).

It is important to highlight that there are several farming techniques, such as sources of organic fertilization, derived from cattle manure that can improve soil fertility, pH, base saturation and cation exchange capacity, besides being one of the most viable fertilization methods for the producer, presents benefits for production, improvement of soil physical, chemical and biological characteristics (Steiner et al., 2012).

Manure as a fertilizer in food production and fodder has been increasing with the intensification of animal production so much in confined systems as in pasture systems, constituting how a source of nutrients for plants, which can reduce production costs, being a widely adopted alternative for the

supply of nutrients, mainly nitrogen and phosphorus, in family farming areas in the semi-arid and harsh region of northeastern Brazil (Silva, 2008).

The combined use of manure with mineral fertilization has also been shown to be an interesting management strategy to improve soil quality, as it promotes nutrient elevation in the soil over time, more it is necessary to see the effect of nutrient availability separately so that there are better results in the definition in the organic fertilization dose.

Due to the growth of agriculture implanted in the Brazilian savannah region in recent decades, the objective of this study was to evaluate the developmental effect of organic fertilization of cattle manure, demonstrating the potentiality, availability, and recovery of nutrients in soil.

MATERIAL AND METHODS

The experiment was conducted in 2018, in a greenhouse in the experimental area of the Gurupi University Campus of the Federal University of Tocantins (UFT), located in the southern region of the state of Tocantins at 11° 43' S and 49° 04' W, 280 m altitude. The regional climate is humid type B1wA'a' with moderate water deficit (Seplan, 2012). It has an average annual rainfall between 1300 and 1500 mm, concentrated in the months from November to May, with an average annual temperature of 27 °C (Seplan, 2012). Soil samples collected from the 0 to 20 cm depth layer of a Red-Yellow Latosol according to the Brazilian Soil Classification System (Embrapa, 2018), collected in the UFT area. The samples were at room temperature in the open air, passed through a 2 mm sieve and homogenized, for later chemical and textural characterization according to table 1 in the soil laboratory on the campus.

Table 1 - Chemical and structural characterization of the Red-Yellow Latosol. Gurupi - TO.

Ca ²⁺	Mg ²⁺	Al ³⁺	H+Al	CTC(T)	SB	CTC(t)	K	P
.....cmolc dm ⁻³mg dm ⁻³
0.66	0.43	0.12	2.78	3.92	1.14	1.28	19.93	0.59
V	M	Org. Mat	pH H ₂ O	Sand	Silt	Clay		
.....(%).....		...%...	 Texture (%)				
29.10	9.52	2.57	5.01	49.01	13.60	37.39		

The beef manure was at outdoor room temperature, homogenized and sent a sample to the Laboratory and Agricultural Analysis of Tocantins Ltda (Sellar - Agricultural analyses), in Gurupi for

chemical characterization, as can be seen in the table 2.

Table 2 - Chemical characterization of cattle manure Gurupi - TO.

N	P	K	Ca ²⁺	Mg ²⁺	S	Org. Mat	pH CaCl
.....(%).....							
0,42	0,87	1,37	1,28	0,30	0,33	7,39	8,6
Cu	Fe	Zn		Mn			
.....mg dm ⁻³							
19	4763	131		51			

The incubation soil was previously sieved and placed in 5 dm³ plastic bags. After weighing, the liming of the soil was carried out based on the calculation of the liming requirement (NC) by the aluminum neutralization method and elevation of calcium and magnesium contents (Ribeiro et al., 1999) using an amount of 3 t ha⁻¹, which corresponds to 15 g per bag and 7 days after mixing 1.8 t ha⁻¹ of agricultural gypsum (9 g bag⁻¹). Liming was performed to correct the pH and raise the Ca and Mg levels of the soil. After 20 days 120 kg/ha of P₂O₅ (0,6 g bag⁻¹)(Simple Super Phosphate) was added to the soil, 100kg/ha K₂O (0,5 g bag⁻¹) (Potassium chloride), 150 Kg/ha of FTE (0,75 g bag⁻¹) (Chemical fertilizer based on essential micronutrients) and doses of cattle manure. However, as in its composition, the manure presented about 80% of mineral residues (sand among others), the doses were adjusted so that they represented exactly that amount of manure to be added to the soil, "full dose", which represents 100% manure, at any dose.

The experimental design used was completely randomized (DIC), with three replications. The treatments were eight doses of cattle manure (2.5; 5; 10; 12.5; 20; 25; 50 and 100 t ha⁻¹), plus the control - without addition of cattle manure (0 t ha⁻¹). The experiment lasted 50 days, where the samples were incubated in plastic bags, partially closed by wire rod, in order to leave a small opening for gas exchange to occur. Irrigation to maintain the moisture of the samples was done with distilled water, the amount of water was determined based on the field capacity of the soil used, aiming to maintain it at 60%.

The homogenization of the samples in the plastic bags was done daily.

After 50 days, the samples were taken for analysis and chemical characterization at the Soil

Laboratory - Soil × plant × animal relationship, Araguaína campus - UFT. The data obtained were submitted to regression analysis and the graphs were plotted in sigmaplot 10.0 software.

RESULTS AND DISCUSSION

Changes were recorded after 50 days of soil incubation management, in the chemical attributes: pH, M.O, P, K, Ca²⁺, Mg²⁺, H⁺, AL³⁺, CTC and SB, the response obtained in the equation was quadratic polynomial.

For pH values (Figure 1) there was an increase, ranging from 6.3 to 6.81, these values reflect the addition of cattle manure that has elements in its composition that increase the sum of bases (SB) and therefore reduce the negative charges of the soil, as verified by Galvão et. al. (2008), when studying and quantifying nutrient concentrations in cattle manure samples in a neosoil, found that the continuous application of manure provides a significant increase in pH and in the contents of all elements in the 0-20 cm layer, in relation to unfertilized areas. The tendency to add organic compounds to the soil is that the pH is increased, albeit momentarily, in particular, due to the exchangeable bases, such as Ca²⁺, Mg²⁺, K⁺ e Na⁺ (Kiehl, 1985). The removal of these bases by plants or leaching is what causes soil acidification (Raij, 2011).

The increase in pH values can also be attributed to the presence of organic matter in the manure composition, which influenced the reduction of the Al³⁺ content and increased the pH and P, Ca and Mg contents after the addition of residues (Silva et al., 2008; Lima et al., 2009). The increase in pH is provided by the adsorption of H⁺ ions by anions of organic compounds (Mantovani et al., 2005).

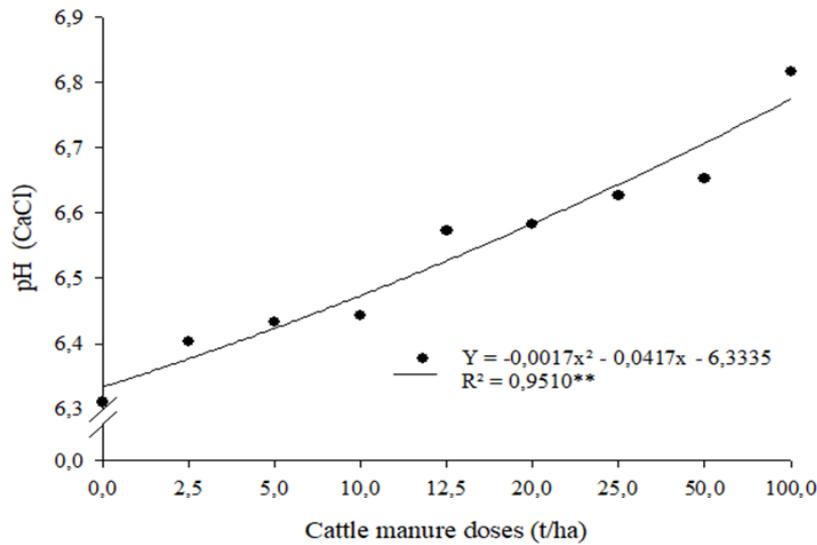


Figure 1 - Effect of incubation with cattle manure on the pH of a Red-Yellow Latosol on the pH, Gurupi - TO.

Soil organic matter contents show that cattle manure provided a significant increase in these attributes (Figure 2). The dose 100 t ha⁻¹ was the one that resulted in the highest higher organic materials values (M.O.) (13.84 g/kg). Artur et al. (2007) found that the addition of manure doses about the mean MO content in the treatment without manure (7.75 g dm⁻³) increased by 19 g dm⁻³ of MO in the treatment that received 101 kg m⁻³ of manure. Rodrigues et al. (2011) studied the addition of organic compounds in soils of different

textures, concluded that the total organic carbon (TOC) content in the soil (sandy texture) after cultivation, increased approximately 90% with fertilization of 80 g dm⁻³ of the organic compound, improving soil fertility, while the dose of 40 g dm⁻³ did not differ significantly from the control treatment. These results were similar to those found in this study using cattle manure as a source of organic materials and soil enrichment.

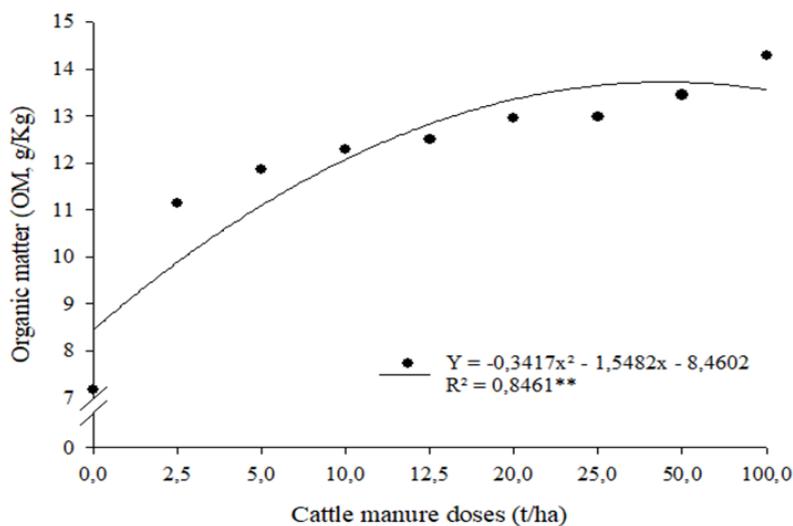


Figure 2 - Effect of incubation with cattle manure on organic matter, Gurupi - TO.

According to Nascimento et al. (2017), the supply of cattle manure increases CTC and influence on potassium dynamics. Leonardo et al. (2014) demonstrated that fertilization as cattle manure is a viable alternative for use, especially for places where manure is available at low cost, and sweet potato yield with cattle manure fertilization increased the average mass of commercial roots linearly in the order of 250 kg ha⁻¹ of nitrogen in the presence of manure, while in its absence an average mass of 192.1 g was obtained, referring to nitrogen doses, and with the use of cattle manure increased plant roots⁻¹ was higher in 108.3 g, compared to without manure use. K contents had a positive

influence on the elevation of the and the ideal dose range considered is between 71 and 120 mg dm⁻³ in cerrado soils (Ribeiro et al., 1999), and the point of greatest efficiency at the dose of 100 t ha⁻¹ manure with 100.66 mg dm⁻³ value this superior about 674.31% in relation to the controls 0 t ha⁻¹ of manure. The same authors portray that organic fertilizers such as cattle manure contribute not only primary macronutrients (N, P, and K), but also secondary macronutrients (Ca, Mg and S) and micronutrients. Possibilities evidenced in this work, which show positive gains and increases with the use of cattle manure in the soil.

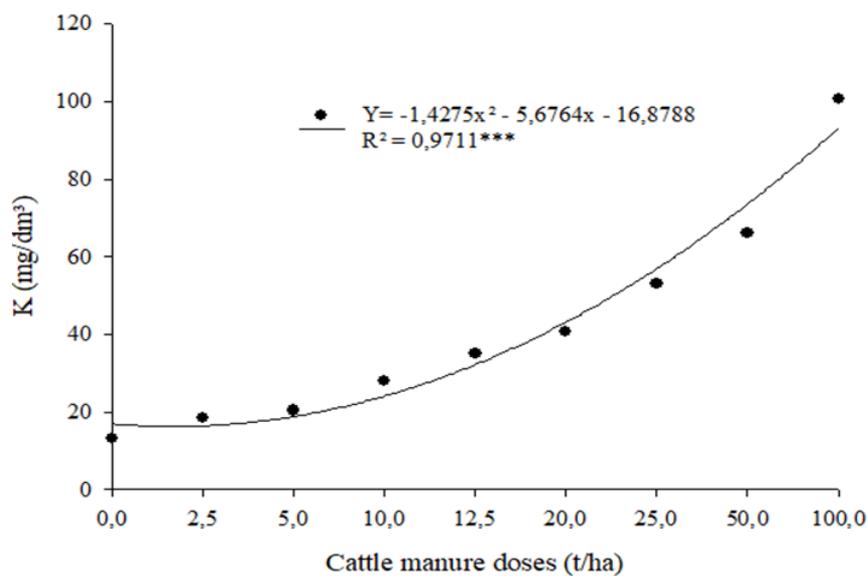


Figure 3 - Effect of the application of doses of cattle manure on potassium (K), Gurupi – TO.

As for phosphorus, it was verified that the manure positively influenced the elevation of the content since the first treatment, however, in the second dose of 2.5 t ha⁻¹ was not enough to differentiate the doses of P, with a higher numerical increase in activity from the third dosage, with an increase of 102% about the control. A fact that P content remained constant between dosages, with an increase of 1338% in the last dosage with the control.

For the variable phosphorus (P), as the doses of manure used increased, there was a progressive increase. These values corroborate with some authors that when working with the addition of organic compounds to the soil, to name the work of (Galvão et al., 2008) and Barcelos et al. (2015) Checked the accumulation of nutrients in the soil, working with the chance to there was an ancestry in

the P contents in the surface layers.

Brito et al. (2005) evaluating changes in the chemical properties of a soil subjected to treatments with organic residues, Found the increase in the levels of extractable phosphorus with the increase in doses of said manure. Applications of tanned corral manure resulted in higher phosphorus values extracted by Mehlich⁻¹, resin, and Bray⁻¹, about non-fertilized areas (Galvão et al., 2008).

The additions of organic matter to the soil as cattle manure increased from P, neutralizing acidity and promoting the elevation of soil organic matter content to optimize the use of P by crops. This can be attributed to the power of the soil in adsorbing organic acids, which will occupy the p adsorption sites, mainly on the surfaces of Fe and Al oxides Sousa et al. (2006).

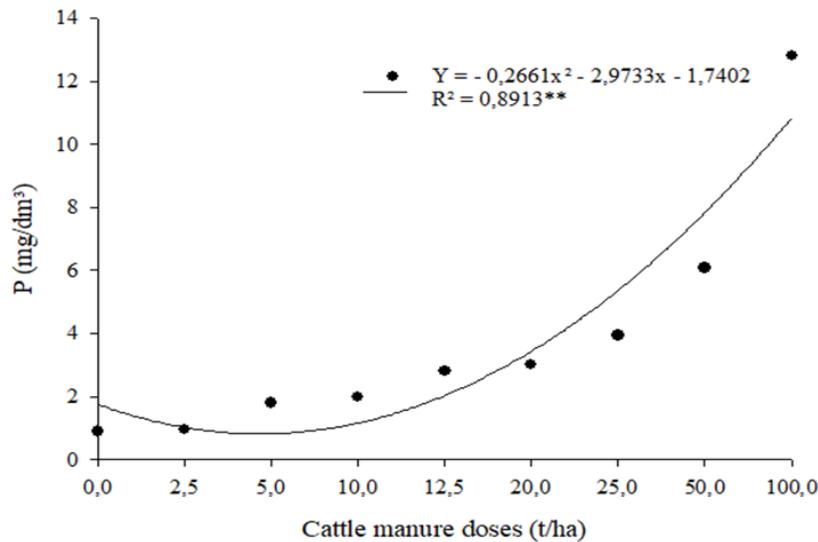


Figure 4 - Effect of the application of doses of cattle manure on phosphorus (P), Gurupi – TO.

The data that refer to calcium (Figure 5) reveals soil behavior in different amounts of manure dosages, this demonstrates the quadratic effect for the doses used. From the control (without application of cattle manure) to the highest dose of 100 t ha⁻¹, there was an increase of 20.7% of the nutrient calcium.

This shows that the application of cattle manure positively influences the Ca increase. Cattle manure is rich in fiber and a cow produces about 15 t of fresh manure per year, which corresponds to approximately 78 kg of N (nitrogen), 20 kg of P (phosphorus), 93 kg of K (potassium) and 35 kg of Ca (calcium) plus Mg (magnesium) (Weinärtner et

al., 2006). Thus, manure may be able to supply the needs of plants in macronutrients, showing organic fertilization as a potential for the use tanto em of perennial crops, as well as in annual or short-cycle crops. Silva et al. (2011) it was found that the higher the proportion of cattle manure used, the higher the calcium values to the soil at both soil depths, being (0-0.10 and 0.10-0.20m). Dim et al. (2010); Galvão et al. (2008) show that increasing doses of cattle manure showed positive gains of Ca²⁺, Mg²⁺, and K contributing to the chemical quality of the soil of nutrients.

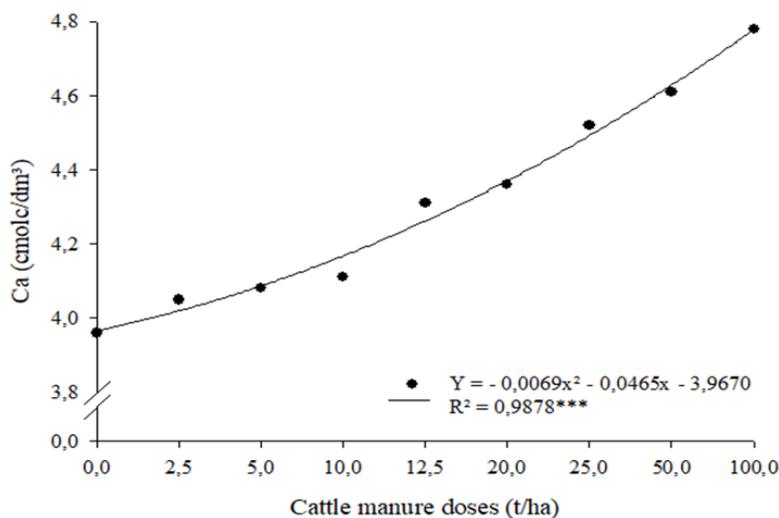


Figure 5 - Effect of the application of doses of cattle manure on calcium (Ca), Gurupi - TO.

Taking into account only the Magnesium data present in the figure 6, it was observed that in the first dosages of cattle manure did not significantly contribute to the increase in Mg. The efficiency effect was satisfactory at the dose of 100 t ha⁻¹ of manure, with a gain of 42% compared to the (control). In general, the dosages allowed a quadratic increase in the amount of efficiency of Mg content.

Castro et al. (2016) shows that organic fertilization can positively and significantly influence the development of forage grasses, as of the *Urocloa brizantha* weeds (Syn. *Uroclhoa*

brizantha) cv. Marandu and *Panicum maximum* cv. Mombasa, using doses of cattle manure, equations occurred in the doses, providing Mg growth, causing increasing linear adjustment of plant height as a function of the application of doses of cattle manure.

According to Freitas et al. (2012); Souza et al. (2015), the use of organic material in fertilization as cattle manure or other sources has contributed significantly to soil fertility, providing an increase in the absorption of various nutrients, such as P, K, Ca, Mg.

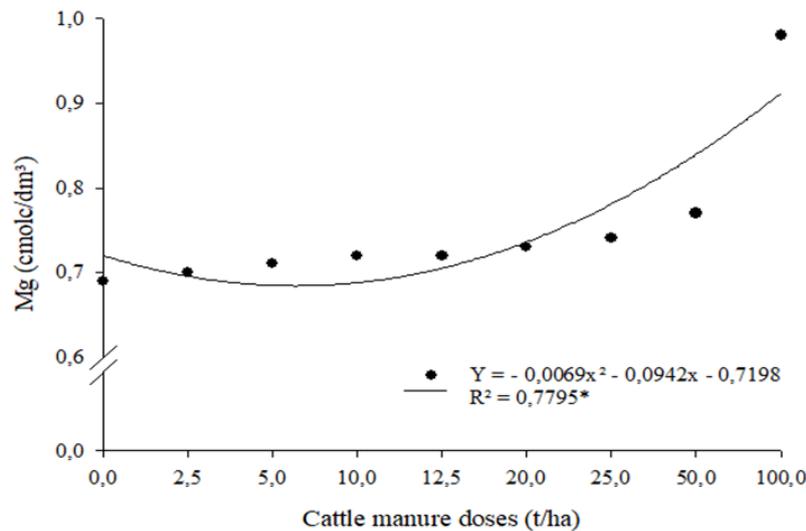


Figure 6 - Effect of the application of doses of cattle manure on the values of magnesium (Mg), Gurupi - TO.

The values of potential acidity (H+Al) (Figure 7) were decreasing as the doses of cattle manure increased, ranging from 1.44 to 0.47 cmolc kg⁻¹, which provided a quadratic polynomial response in the curve, which was inversely proportional to the pH behavior. This is due to the acidity being the exchange of basic cations of the cationic exchange complex for exchangeable Al³⁺ and non-dissociated H⁺ (Raij, 2011) and the stable complexes with

organic matter. Strojaki et al. (2013) referring the fertilizer potential of an urban waste compound in sunflower and corn crops and its effect on the properties of a red latosol with very clayey texture, obtained a linear decrease in potential acidity as a function of the increase in doses of urban waste compound, responses similar to that of the work performed

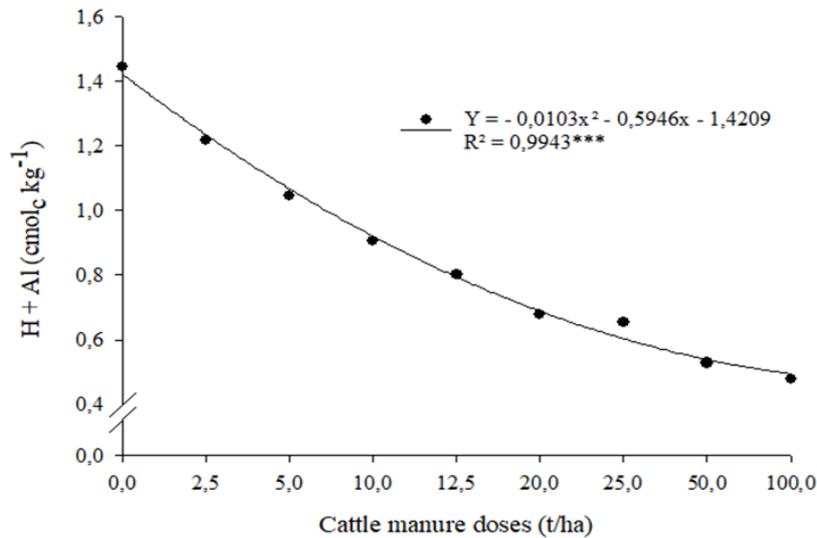


Figure 7 - Effect of the application of doses of cattle manure on the values of H+Al, Gurupi - TO

Regarding cation exchange capacity (CTC), the application of cattle manure had a quadratic effect, as can be seen in figure 8. The amount of organic matter increases in the doses contributed directly reaction of CTC, succeeding in increasing increase in soil pH through M.O, with an increase in potassium, calcium and magnesium contents.

According to Matins et al. (2016), organic fertilizing may come to supplement or even replace chemical fertilizers in the longterm, where in the study in the cultivation of common bean it was observed that the cattle manure provided a significant increase in pod length, in the number of

Pods per plant, and may replace mineral fertilization in bean cultivation.

Costa et al. (2011) in his work on evaluating the effects of fertilization with cattle manure on the attribute cation exchange capacity (CTC), increased its value from 47.70 to 59.40 cmolc dm⁻³, which is associated with an increase in organic matter content from 16.54 to 21.18 g dm⁻³. In this sense, cattle manure reveals its importance for crops with a fragile root system that requires soils with good physical and fertility properties, justifying the use of cattle manure in soils of low natural fertility.

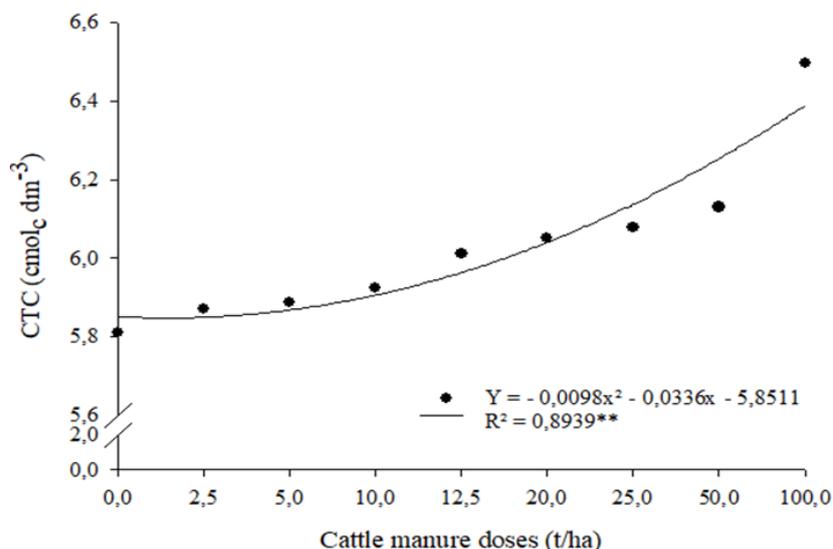


Figure 8 - Effect of the application of doses of cattle manure on the values of CTC, Gurupi – TO.

Figure 9 shows that the values of the sum of bases (SB) presented a curve with quadratic tendency, according to the increasing doses of cattle manure. The value of the sum of bases increased from 8.55 $\text{cmol}_c \text{dm}^{-3}$ in the treatment with 2.5 t ha^{-1} of the cattle manure applied, to 10.60 $\text{cmol}_c \text{dm}^{-3}$, with 100 t ha^{-1} of cattle manure in the soil, which represents 3.68% and 30.06% increment, respectively, about the control. It is worth mentioning that at a dose of 50 t ha^{-1} there was an increase of 19.63% about the control, with

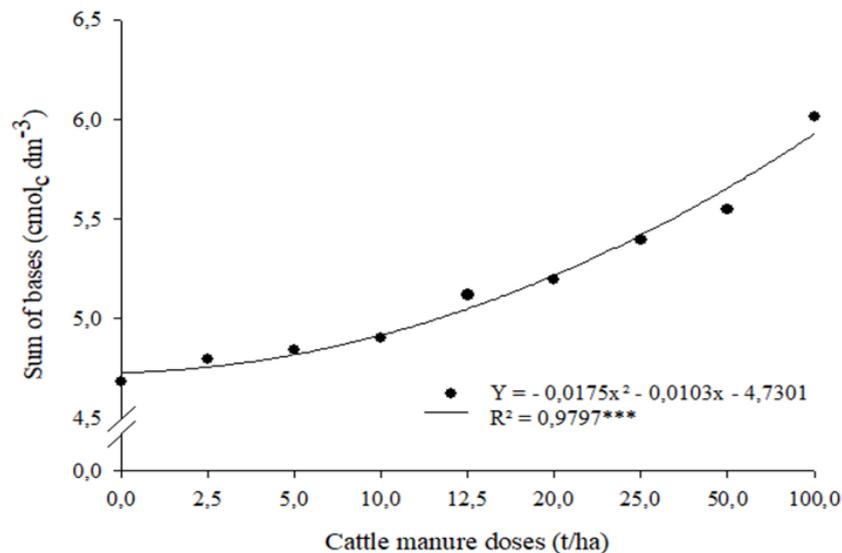


Figure 9 - Effect of the application of doses of cattle manure on the values of the sum of bases, Gurupi - TO.

The elevation of the sum and bases reflects the increase of the basic cations in the soils, Ca^{2+} , Mg^{2+} , and K^+ , provided through liming and organic fertilization. Oliveira et al. (2014) studying the changes in soil chemical characteristics and the productive response of lettuce fertilized with organic compounds found that it hears a linear increase in the sum of bases in soils fertilized with the compounds. The sum of bases corresponding to the sum of Ca^{2+} , Mg^{2+} and K^+ showed positive gains when increasing doses of cattle manure were used, increased soil chemical quality and contributed to higher offerings of these nutrients for forage (Dim et al., 2010; Araújo et al., 2011).

In general, it is noted that the use of cattle manure increases the nutritional potential of the soil in practically all the nutrients evaluated, although studies with cattle manure have been conducted since years, it is seen that there are few studies focused on the cerrado region, and even less related to the state of tocanins. Studies such as this are important to have more efficient base parameters for each region, considering that most of the

a reduction of 0.85 $\text{cmol}_c \text{dm}^{-3}$ compared to the highest dose of cattle manure (100 t ha^{-1}) used in the study.

Cardoso et al. (2011) also found an increase in both the sum of bases and the saturation of bases, applying organic compounds in soil cultivated with lettuce. This is because the sum of interchangeable cation contents ($\text{Ca}^{2+} + \text{Mg}^{2+} + \text{K}$) were also increasing with increases in doses of cattle manure.

literature is based on more than twenty years and almost all addressing a general structure, not specific, and when it comes to soils, it is more than evidenced that in a single farm there are numerous different types and situations, which demonstrates the importance of the results obtained here.

CONCLUSION

It can be concluded that the addition of cattle manure to the soil, although in smaller doses, generates a positive effect on soil chemical conditions, and therefore provides improvements to soil quality. The effect of manure fertilization served to evaluate the availability and recovery of nutrients by increasing fertility significantly, promoting changes in soil chemical and physical attributes.

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