Comissão 3.4 - Poluição, remediação do solo e recuperação de áreas degradadas

INFLUENCE OF ORGANIC-MINERAL FERTILIZATION OF AN OXISOL ON SOIL CHEMICAL PROPERTIES AND *Bracharia brizantha* PRODUCTION[1]

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SUMMARY

The use of organic-mineral fertilizer produced by the manufacturing industry of lysine and threonine amino acids can improve the fertility of tropical soils. The objective of this study was to evaluate the influence of different doses of the organic-mineral fertilizer named Ajifer L-14 on chemical properties and on the response with increased production of a forage on a Red Latosol in the northwestern region of São Paulo State, Brazil. A randomized block design was used with seven treatments and four replications. The treatments consisted of: T_1- control (without application of Ajifer L-14); T_2- control (natural vegetation); T_3- mineral fertilization according to crop requirements and soil analysis (application of 1.35 kg plot^{-1} of urea, 2.20 single superphosphate, and 0.51 KCl, corresponding to 60 of N, 40 P_2O_5 and 30 kg ha^{-1} of K_2O); T_4- fertilization with Ajifer L-14 according to the recommendation resulting from the soil chemical analysis (40 L plot^{-1}, corresponding to 60 kg ha^{-1} N); T_5- fertilization with Ajifer L-14, at a rate of 150 % of the recommended values (60 L plot^{-1}, corresponding to 90 kg ha^{-1} N); T_6- fertilization with Ajifer L-14 at a rate of 50 % of the recommended values (20 L plot^{-1}, corresponding to 30 kg ha^{-1} N); T_7- fertilization with Ajifer L-14 at a rate of 125 % of the recommended values (50 L plot^{-1}, corresponding to 75 kg ha^{-1} N); T_8- fertilization with Ajifer L-14 at a rate of 75 % of the recommended values (30 L plot^{-1}, corresponding to 45 kg ha^{-1} N). The following soil chemical properties were evaluated (layers 0.0–0.1 and 0.1–0.2 m): P, organic matter, pH, K^+, Ca^{2+}, Mg^{2+}, cation exchange capacity, potential acidity, and base saturation. The application of this organic-mineral fertilizer does not influence the soil chemical properties. Regression analysis indicated a polynomial relationship between the application

[1] Part of the Master's Dissertation of the first author. Received for publication in January 8, 2011 and approved in September 1, 2011.

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rates of organic-mineral fertilizer and the production of dry matter and crude protein of *Bracharia Brizantha*.

Index terms: pasture, Ajifer, dry matter, crude protein.

RESUMO: *ATRIBUTOS QUÍMICOS DO SOLO E PRODUÇÃO DE Bracharia brizantha EM LATOSSOLO TRATADO COM FERTILIZANTE ORGANOMINERAL*

A utilização de fertilizante organomineral da indústria produtora dos aminoácidos lisina e treonina pode melhorar a fertilidade de solos tropicais. O presente trabalho teve como objetivo avaliar a influência de diferentes dosagens do fertilizante organomineral denominado Ajifer L-14 nos atributos químicos e no aumento de produção de forragem de um Latossolo Vermelho do noroeste paulista. O delineamento utilizado foi em blocos casualizados, com sete tratamentos e quatro repetições. Os tratamentos foram: T_1- testemunha (sem aplicação de Ajifer L-14); T_2- testemunha com vegetação natural; T_3- adubação mineral de acordo com a necessidade da cultura e a análise do solo (usando 1,35 kg de ureia, 2,20 kg de superfosfato simples e 0,51 kg de KCl por parcela, o que corresponde a 60 kg de N, 40 kg de P_2O_5 e 30 kg ha^{-1} de K_2O, respectivamente); T_4- adubação com Ajifer L-14 de acordo com a recomendação da análise química do solo (40 L $parcela^{-1}$, o que corresponde a 60 kg ha^{-1} N); T_5- adubação com Ajifer L-14 em dosagem 50 % acima da recomendação (60 L $parcela^{-1}$, o que corresponde a 90 kg ha^{-1} N; T_6- adubação com Ajifer L-14 em dosagem 50 % abaixo da recomendação (20 L $parcela^{-1}$, o que corresponde a 30 kg ha^{-1} N); T_7- adubação com Ajifer L-14 em dosagem 25 % acima da recomendação (50 L $parcela^{-1}$, o que corresponde a 75 kg ha^{-1} N); e T_8- adubação com Ajifer L-14 em dosagem 25 % abaixo da recomendação (30 L $parcela^{-1}$, o que corresponde a 45 kg ha^{-1} N). Nas profundidades de 0,0–0,1 e 0,1–0,2 m, avaliaram-se os seguintes atributos químicos do solo:, teor de matéria orgânica (MO), pH, K^+, Ca^{2+}, Mg^{2+}, capacidade de troca catiônica (CTC), acidez potencial e saturação por bases. A aplicação do fertilizante organomineral não influenciou os atributos químicos do solo. Na análise de regressão, houve relação polinomial entre as doses de aplicação do fertilizante organomineral e a produção de massa seca e proteína bruta de Bracharia brizantha.

Termos de indexação: pastagem, Ajifer, matéria seca, proteína bruta.

INTRODUCTION

Adequate topsoil management with crop residues can prevent soil erosion, maintain the organic matter content and contribute to the sustainability of crop productivity. Thus, the use of organic mineral fertilizers is an alternative that improves soil structure and fertility, mainly by increasing the organic matter (OM) content, because of the low relative cost and the possibility of reducing the water pollution load, provided that the depth of the ground water, the distance from water springs, and mainly non-polluting doses are respected.

Solid products resulting from a number of human activities, including industry, are generated in quantities and characteristics that require a proper final disposal (Flohr et al., 2005). Several sources of OM and fertilizer have been used to minimize the costs for agriculture and stock raising; the organic by-product Ajifer L-14 from the fabrication of the essential amino acid lysine has proved interesting as an alternative low-cost source for crops and pastures, providing OM enrichment and fertilization, especially in the case of crops that are not directly consumed by humans.

Ajifer L14 is a liquid product resulting from fermentation. This process occurs when sugarcane syrup is fermented in the production of L-lysine and L-Threonine, which are amino acids used as feed supplement for poultry and swine. This fertilizer has been widely used as a rich source of N, S and OM (Costa et al., 2003).

The solution serves as a substrate for specific aerobic microorganisms that promote fermentation. The sugar solution is heat-sterilized and no antibiotics are used in the process. Optimum substrate pH is achieved by the addition of NH_3, to buffer (control pH) the system for fermentation efficiency. The NH_3 also serves as N source. After the removal of lysine or threonine, the resulting solution, containing 1 % of total N, is subjected to evaporation, producing an organic material to which 16 kg m^{-3} of soybean bagasse is added. The resulting product, containing 1.5 % of N, is called Ajifer L-14.

Livestock farming is one of the most important economic activities in the Cerrado (savannah-like vegetation) region. More than half of an estimated total of 48 million hectares in the region are *Brachiaria decumbens* pastures (Soares et al., 2000). However, approximately 80 % of the pastures in the Cerrado are partially degraded, as indicated by the low productivity and low support capacity (Lima et al., 2000). The low productivity can be explained by the lack of fertilization and liming at recommended quantities and the degradation of the physical soil quality. The recovery of these areas is fundamental for environmental, technical, and economical reasons. To recover these areas, it is essential to improve soil fertility and manage forage plants properly (Oliveira et al., 2005).

Studies on changes in properties of soil fertilized with Ajifer L-14 are still incipient. It is known that during the dry season (April-August) the pasture quality decreases considerably, consequently reducing the productivity in the exploited area. Aimed at higher OM contributions as well as longer pasture utilization, the study of this residue and the investigation of its feasibility are very important.

In the search for solutions to improve soil conditions and the disposal of industrial products, this study was developed to evaluate the influence of different rates of the product called Ajifer L-14 on chemical properties of a Red Latosol and the response in forage production, in the northwestern region of São Paulo State, Brazil.

MATERIAL AND METHODS

The study area is located on the sedimentary plateau of Paraná, in the city of Rubiácea, São Paulo, Brazil (latitude 21°18'56" S, longitude 50° 42'12" W, average 414 m asl). The climate according to Köppen is Aw, humid tropical, with a rainy season in the summer and dry season in the winter. The relative humidity in the rainy months lies between 60 and 80 %. The terrain is slightly sloped, with a flat to gently undulating relief. The soil was classified as a dystrophic A moderate deep and very weathered Red Latosol soil with medium texture.

The study was initiated in September 2005, in a randomized block design with seven treatments and four replications. Each plot covered an area of 100 m^2 (10 x 10 m). The spacing between the blocks was 7.0 m and the plot border was 5.0 m. The quantities of nutrients applied to the soil were defined by the results of chemical soil analysis and the nutritional requirements of brachiaria (Raij et al., 2001). Urea was used as N source, with 45 % N, and the P and K sources were single superphosphate and potassium chloride, respectively.

The treatments consisted of the following mineral and organic mineral fertilizers: T_1- control (without application of Ajifer L-14); T_2- control (natural vegetation); T_3- mineral fertilization according to crop requirements and soil analysis (application of 1.35 kg urea, 2.20 kg single superphosphate, and 0.51 kg $plot^{-1}$ KCl, corresponding to 60 kg N, 40 kg P_2O_5, 30 kg ha^{-1} K_2O); T_4- fertilization with Ajifer L-14, according to the recommendation based on the soil chemical analysis (40 L $plot^{-1}$, corresponding to 60 kg ha^{-1} N); T_5- fertilization with Ajifer L-14, at a rate of 150 % of the recommended values (60 L $plot^{-1}$, corresponding to 90 kg ha^{-1} N); T_6- fertilization with Ajifer L-14 at a rate of 50 % of the recommended values (20 L $plot^{-1}$, corresponding to 30 kg ha^{-1} N); T_7- fertilization with Ajifer L-14 at a rate of 125 % of the recommended values (50 L $plot^{-1}$, corresponding to 75 kg ha^{-1} N); T_8- fertilization with Ajifer L-14 at a rate of 75 % of the recommended values (30 L $plot^{-1}$, corresponding to 45 kg ha^{-1} N).

In September 2005, the soil was limed to reach 50 % of the base saturation. This occurred after lowering of the pasture height, due to intensive grazing. Ajifer L-14 was applied to the soil, on *Brachiaria brizantha*, on April 28, 2006, with manual garden sprinklers, at the rates determined for each plot.

Ajifer was obtained from the company AJINOMOTO, in Valparaiso, SP, during the production of the essential amino acids lysine and threonine used as animal feed component, mainly for swine and poultry. A sterile sugar solution, to which nutrients such as P, K, Mg, Mn and Fe are added, is used to produce lysine. The chemical characterization showed that Ajifer L-14 contained 8.0 % OM, 0.92 kg kg^{-1} moisture, 1.5 % N, 0.08 % P, 0.03 % K, 0.003 % Ca, 0.004 % Mg, and 0.89 % S. No B, Cu, Fe, Mn, and Zn were detected in the fertilizer.

The soil was sampled in April 2006. In the soil chemical analysis, the active acidity (pH in $CaCl_2$) was potentiometrically determined. The available values of exchangeable Ca, Mg and K, and P were determined by the ion-exchange resin method, as proposed by Raij et al. (2001). Based on the results, the sum of bases (SB), cation exchange capacity (CEC) and base saturation (V %) were calculated. The OM content was calculated according to Embrapa (1997).

Brachiaria dry matter production was assessed in June and September 2006, using a ground area of 1.0 m^2, at three points per plot, approximately 45 days after cutting, to a height of 0.5 m. The dry matter weight was determined after drying in a forced air oven at an average temperature of 60–70 °C, matter to constant weight, expressed in kg ha^{-1}. The production of dry matter and crude protein was evaluated, according to the methodology described by Silva (1990).

To test the influence of organic-fertilizer rates, the data were subjected to polynomial regression analysis, at 5 % by the SAS program (Schlotzhaver & Littell, 1997).

RESULTS AND DISCUSSION

In relation to the levels established for soil fertility in São Paulo State by Raij et al. (1997) the contents found in the soil under study had a very low P content, average values of OM, Mg^{2+}, and K^+, high acidity, high values for Ca^{2+}, and low V % values (Table 1). Except for K^+ and CEC, all chemical properties studied were near the natural vegetation conditions, which can be attributed to the OM quality, since the contents were similar in both conditions of soil utilization.

In a comparison after 58 days of by-product application, the treatments did not differ much from the soil with natural vegetation (Table 2). However this small difference cannot be attributed to the addition of Ajifer L-14, but to the spatial variability of the soil. The same performance was observed in the layer 0.1–0.2 m.

Although Ajifer L-14 contains some P, its application had no effect on the "available" P concentration in the soil (Table 2). According to Cantarella et al. (1992), the release of P from organic materials is relatively slower, which indicates a possible lack of time for effective P mineralization during the study period. However, there are no reports in the literature on the decomposition rate of this by-product. When applying sewage sludge, opposite results are observed. Trannin et al. (2005) reported that 10 Mg ha^{-1} of dry sewage sludge increased P availability in the soil, resulting in equivalent corn yields to the complete mineral fertilization.

Regarding N, even when its quantity is not determined in the soil, it was found that its content in the essential amino acid lysine is very high, characterizing it as having a great potential for N supply to the soil, besides presenting a relatively low C/N ratio. As for differences between treatments 58 days after application, no differences were found between the chemical properties when the mineral fertilization effects were compared to the effect of Ajifer L-14 application (Table 2). This was probably due to the fast decomposition of organic material in the substance.

The application of Ajifer L-14 did not increase the OM content, but it was observed that for Ajifer L-14 treatments, values were very similar to the control and mineral fertilization and superior to the control treatment with natural vegetation (Table 2). The maintenance of the OM content is important for tropical soils with naturally low OM levels, indicating Ajifer L-14 as an additional alternative to maintain and raise soil OM levels. De Maria et al. (2007) observed that sewage sludge application increased the OM content, but only in the surface layer of the soil under study, 0.00–0.10 m. Opposite results were reported by Andrade et al. (2005), when evaluating the quality and quantity of OM and organic C and N in Latosol growing eucalyptus, treated with biosolids; they found that the total soil levels of C and N were not affected by the treatments after five years of applying alkaline biosolid or mineral fertilizers.

Statistical differences were observed regarding Al saturation in the layer 0.0–0.1 m between the assessment periods (beginning of the study and after applying the treatments), considering that the soil was slightly more acid 58 days after treatment applications (Table 3). In the nitrification process, soil acidification occurs due to the release of H^+ ions (Melgar et al., 1999). Similar results were obtained by Abd El-Moez (1996), with the application of 5–60 t ha^{-1} waste from guava processing (dry) to alkaline soils in Egypt, who attributed the acidification to the

Table 1. Average values for the properties: OM, pH, P, K, Ca, Mg, Al, CEC, and BS (V), in the layers 0.0–0.1 and 0.1–0.2 m, prior to the study (September/2005)

Treatment	OM	pH_{CaCl_2}	P	K^+	Ca^{2+}	Mg^{2+}	H + Al	CTC	V
	g dm^{-3}		mg dm^{-3}	mmol$_c$ dm^{-3}					%
				Layer 0.0–0.1 m					
Control	26.2	4.9	5.5	2.4	9.5	7.0	18.5	37.1	49.5
Natural vegetation	31.0	4.9	7.5	3.6	15.0	7.8	27.0	55.8	52.5
Mineral fertilization	21.2	4.8	3.2	1.6	8.8	5.9	18.8	34.2	45.8
Recommended Ajifer rate	26.5	4.9	3.2	3.1	9.8	5.8	18.3	36.9	50.5
150 % of the rec. Ajifer rate	24.0	4.8	3.5	1.9	9.0	6.5	18.5	35.9	48.0
50 % of the rec. Ajifer rate	23.2	4.9	3.2	1.5	9.0	6.5	17.5	34.3	48.8
125 % of the rec. Ajifer rate	25.8	5.0	4.5	2.4	10.5	7.3	17.5	37.7	53.5
75 % of the rec. Ajifer rate	21.2	4.8	4.0	2.1	8.8	5.3	18.8	34.9	46.0
				Layer 0.1–0.2 m					
Control	20.7	4.8	3.2	1.9	8.8	5.0	20.8	36.5	42.7
Natural vegetation	19.7	4.6	4.5	4.1	9.5	7.5	23.0	44.2	48.2
Mineral fertilization	15.7	4.8	3.0	0.9	10.3	5.3	18.5	34.5	46.2
Recommended Ajifer rate	19.2	4.9	2.8	1.9	10.5	5.4	19.3	36.8	47.5
150% of the rec. Ajifer rate	18.2	4.8	3.8	1.5	10.3	5.5	18.3	35.2	47.8
50 % of the rec. Ajifer rate	18.5	4.9	3.0	1.2	10.8	5.5	18.8	35.9	47.7
125 % of the rec. Ajifer rate	20.5	4.9	3.2	2.1	11.5	5.5	18.0	37.2	51.7
75 % of the rec. Ajifer rate	18.0	4.8	3.5	1.7	11.0	4.5	19.8	36.8	46.2

Table 2. Average values for the properties: OM, pH, P, K, Ca, Mg, Al, CEC and BS (V), in the layers 0.0–0.1 and 0.1–0.2 m; values for F and coefficient of variation (CV) 58 days after application (June/2006)

Treatment	OM	pH	P	K^+	Ca^{2+}	Mg^{2+}	H + Al	CTC	V
	g dm^{-3}		mg dm^{-3}	mmol$_c$ dm^{-3}					%
Layer 0.0–0.1 m									
Control	23.5	4.9	3.0	1.8	9.0	7.2	20.5	38.5	45.7
Natural vegetation	20.0	4.8	2.0	3.1	9.5	8.5	21.7	42.5	48.5
Mineral fertilization	22.0	4.9	2.0	1.4	8.5	6.2	18.5	35.1	47.5
Recommended Ajifer rate	21.5	4.9	3.0	2.2	9.0	7.2	19.2	37.7	48.7
150 % of the rec. Ajifer rate	22.1	4.9	2.0	1.5	8.7	6.8	19.2	36.5	47.2
50 % of the rec. Ajifer rate	22.2	4.8	2.0	1.3	8.2	7.7	19.0	36.1	47.2
125 % of the rec. Ajifer rate	24.8	4.7	2.5	1.5	8.3	6.7	20.0	36.4	44.7
75 % of the rec. Ajifer rate	22.0	4.7	3.0	1.7	9.0	6.8	20.5	37.8	45.5
Regression (5 %)	0.3^{ns}	1.0^{ns}	0.8^{ns}	1.4^{ns}	0.2^{ns}	0.3^{ns}	0.4^{ns}	0. 2^{ns}	0.3^{ns}
Coefficient of variation (%)	19.2	3.2	43.0	33.0	19.2	21.4	11.1	10.4	11.4
Layer 0.1–0.2 m									
Control	18.0	4.8	2.5	1.2	9.0	4.7	21.7	35.7	42.0
Natural vegetation	16.0	4.6	2.0	3.1	7.7	7.0	23.8	42.5	43.5
Mineral fertilization	16.5	4.8	2.0	1.1	10.5	5.0	19.5	35.9	45.5
Recommended Ajifer rate	18.8	4.9	2.0	1.9	10.2	5.0	19.2	36.8	47.2
150 % of the rec. Ajifer rate	16.0	4.9	2.0	1.3	10.0	5.2	19.5	36.1	46.5
50 % of the rec. Ajifer rate	15.8	4.8	2.5	0.8	8.7	5.3	19.7	35.1	43.7
125 % of the rec. Ajifer rate	16.5	4.8	2.0	1.1	10.0	5.7	19.5	36.4	46.2
75 % of the rec. Ajifer rate	16.5	4.8	2.0	1.0	9.7	5.0	20.2	35.9	43.2
Regression (5 %)	1.4^{ns}	0.5^{ns}	0.8^{ns}	1.2^{ns}	0.6^{ns}	0.4^{ns}	1.0^{ns}	0.4^{ns}	1.0^{ns}
Coefficient of variation (%)	11.8	2.5	27.0	57.8	16.0	21.0	5.7	5.4	9.3

Average values followed by the same letters in the column do not differ statistically by the Tukey test at 5 %. ns: not significant, *: significant at the 5 % level.

release of organic acids and consequently of H^+ ions by the decomposition of organic material. Trannin et al. (2008) found an acidification in soil as a result of treatments of biosolid application.

At the depth of 0.1–0.2 m, there were differences between the periods in the P and OM contents (Table 3). In the treatment with mineral fertilizer, the OM content was lower than in the control, but did not differ from the others. As the mineral elements were promptly available in this treatment, microbial activity was probably more intense, increasing OM mineralization. The OM content was similar to that observed by Oliveira et al. (2005), who reported a decrease of OM content over time.

Calcium and Mg concentrations and the CEC and V % values were not significantly affected by Ajifer L-14 applications (Table 3). This may be related to the short period of residue application and the decomposition rate of the organic waste achieved by the end of the study. Similar results were observed by Côrrea et al. (2005) for the chemical contents in soil treated with organic wastes from the guava processing industry. Oliveira et al. (1995) found no K increase in the area treated with 20 Mg ha^{-1} sewage sludge and reported that the increase of Ca and Mg in the soil was not sufficient to change the soil CEC.

Regarding dry matter production and quality of Brachiaria, different interactions between assessment periods and treatments were observed, i.e., after the application of Ajifer L-14 (Table 4 and Figure 1). Although the chemical soil properties were not good indicators of the changes caused by the Ajifer L-14 application in the evaluation period, the same was not true for Brachiaria. The treatment that received the recommended Ajifer L-14 dose differed from the area that received 50 % less and from the area treated with mineral fertilizer in dry matter production. For crude protein, the treatment that received 125 % of the recommended dose of Ajifer L-14 had a better performance than the control treatments, as well as the treatments with mineral fertilizer and with a 50 % lower Ajifer L-14 rate. Forage production response must be related to N addition, because Ajifer L-14 represents a good N source. In regression analysis there was a polynomial relationship between the N level in the treatments (rates of organic-mineral fertilizer) and dry matter (Figure 1), indicating an increasing N content, as the rates of Ajifer L-14 applied to the soil increase. Araujo et al. (2009), studied the influence of sewage sludge on soil fertility and nutrition of brachiaria grass, observed that the sludge dose of 80 mg dm^{-3} N soil, equivalent to four times the N requirement, increased the dry biomatter production and leaf N content of *Brachiaria decumbens*.

The increase in dry matter production of Brachiaria by applying by-products was also observed by Oliveira et al. (2003). The authors found higher

Table 3. Average values for the properties: OM, pH, P, K, Ca, Mg, Al, CEC and BS (V) for the treatments and periods (September/05 and June/06) in the layers 0.0–0.1 and 0.1–0.2 m

Treatment	OM	pH	P	K^+	Ca^{2+}	Mg^{2+}	H + Al	CTC	V
	g dm^{-3}		mg dm^{-3}	mmol$_c$ dm^{-3}					%
				Layer 0.0–0.1 m					
Control	25.0	4.9	4.25	2.1 ab	9.2	7.1	19.5	37.8	47 .6
Mineral fertilization	21.6	4.8	2.62	1.5 ab	8.6	6.1	18.6	34.8	46 .6
Recommended Ajifer rate	22.5	4.9	3.12	2.7 a	9.4	6.5	18.8	37.3	49 .6
150 % of the rec. Ajifer rate	23.4	4.9	2.75	1.7 ab	8.9	6.6	18.9	36.2	47 .6
50 % of the rec. Ajifer rate	22.8	4.8	3.12	1.4 b	8.6	7.1	18.2	35.2	48 .0
125 % of the rec. Ajifer rate	25.2	4.9	3.50	1.9 ab	9.4	7.0	18.7	37.0	49 .1
75 % of the rec. Ajifer rate	21.6	4.9	3.50	1.9 ab	8.9	6.0	18.6	36.3	45 .7
Period	0.8^{ns}	0.4^{ns}	15.6^{ns}	6.56^{ns}	2.6^{ns}	5.1^{ns}	5.98*	1.5^{ns}	2.2^{ns}
Treatment	1.1^{ns}	0.6^{ns}	1.1^{ns}	2.56*	0.4^{ns}	1.2^{ns}	0.5^{ns}	1.1^{ns}	0.5^{ns}
Period x treatment	0.2^{ns}	1.3^{ns}	0.6^{ns}	0.31^{ns}	0.5^{ns}	0.8^{ns}	0.4^{ns}	0.4^{ns}	0.8^{ns}
Coefficient of variation (%)	17.1	3.5	44.5	40.2	16.7	17.8	10.7	8.2	11 .4
Period 1 (09/2005)	23.6	4.9	4.0	2.1	9.3	6.3	18.2 b	35.9	48 .9
Period 2 (06/2006)	22.7	4.8	2.5	1.6	8.7	7.0	19.6 a	36.9	46 .7
				Layer 0.1–0.2 m					
Control	19.4 a	4.8	2.9	1.5	8.9	4.9	20.7	36.1	42 .4
Mineral fertilization	16.1 b	4.8	2.5	1.0	10.4	5.1	19.0	35.3	45 .9
Recommended Ajifer rate	19.0 ab	4.9	2.4	1.9	10.4	5.1	19.2	36.8	27 .4
150 % of the rec. Ajifer rate	17.1 ab	4.9	2.9	1.4	10.1	5.4	18.9	35.6	26 .9
50 % of the rec. Ajifer rate	17.1 ab	4.9	2.7	0.9	9.7	5.4	19.2	35.5	45 .7
125 % of the rec. Ajifer rate	18.5 ab	4.9	2.6	1.6	10.7	5.6	18.7	36.8	49 .0
75 % of the rec. Ajifer rate	17.2 ab	4.8	2.7	1.3	10.4	4.7	20.0	36.3	44 .7
Period	12.3^{ns}	0.2^{ns}	25.2*	3.1^{ns}	2.9^{ns}	0.08^{ns}	4.3^{ns}	0.1^{ns}	3.0^{ns}
Treatment	2.9*	0.7^{ns}	0.4^{ns}	1.4^{ns}	1.3^{ns}	0.8^{ns}	2.2^{ns}	0.8^{ns}	1.5^{ns}
Period x treatment	1.3^{ns}	0.3^{ns}	0.6^{ns}	0.5^{ns}	0.7^{ns}	0.2^{ns}	0.4^{ns}	0.5^{ns}	0.3^{ns}
Coefficient of variation (%)	11.15	3.0	29.8	55.9	14.9	18.4	0.67	5.4	10 .6
Period 1 (09/2005)	18.7	4.8	3.2 a	1.6	10.4	5.2	19.1	36.1	47 .1
Period 2 (06/2006)	16.9	4.8	2.1 b	1.2	9.7	5.1	19.8	35.9	44 .9

Averages followed by same letters in the column do not differ by the Tukey test at 5 %.

Table 4. Average values of *Brachiaria brizantha* dry matter and crude protein for different treatments, assessed in two periods (September/05 and June/06)

Treatment	First Cut		Second Cut	
	Dry Matter	Crude Protein	Dry Matter	Crude Protein
	kg ha^{-1}	%	kg ha^{-1}	%
Control	3.27	6.24	3.70	5.21
Mineral fertilization	3.30	5.08	3.36	4.69
Recommended Ajifer rate	3.30	5.51	4.59	6.74
150 % of the rec. Ajifer rate	3.35	5.64	4.42	8.05
50 % of the rec. Ajifer rate	3.34	6.02	3.36	6.11
125 % of the rec. Ajifer rate	2.64	6.37	4.21	8.96
75 % of the rec. Ajifer rate	3.04	5.38	3.60	7.37
Regression	2.852^{ns}	2.388^{ns}	3.979*	3.977*
Linear regression	-	-	10.382*	15.542*
Coefficient of variation (%)	13. 46	9.01	12.47	19.71

Averages followed by the same lower case letters in the row and capital letters in the column do not differ by the Tukey test at 5 %.

yields in fertilized treatments than in the control, and the addition of N is essential. In the first year of *Brachiaria brizantha* forage recovery, Oliveira et al. (2005) found a dry matter production of 2,200 and 7,000 kg ha^{-1} after N fertilization.

The crude protein contents in Brachiaria dry matter were, in general, within the average range (5 to 10 %) (Gomide 1982). For Fernandes et al. (2002), crude protein below 6 % is low. It was found that the control and the treatment with mineral fertilization

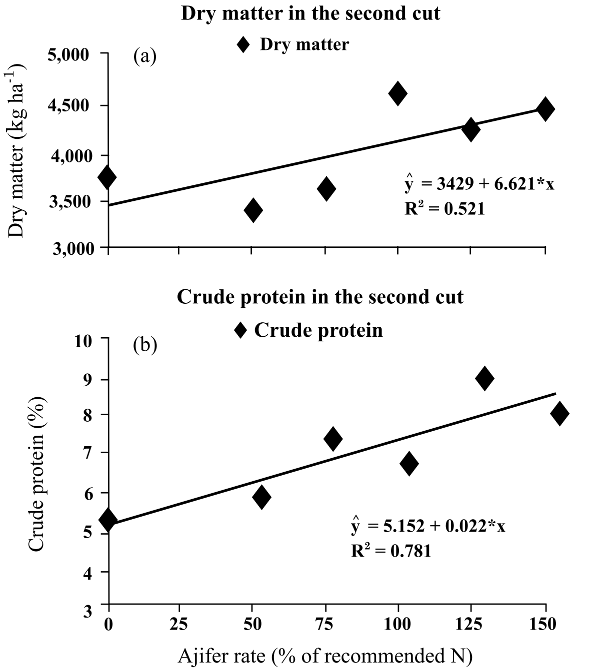

Figure 1. *Brachiaria decumbens* dry matter (a) and plant crude protein (b) in the in the second cut, depending on the Ajifer rate (% of recommended N).

were different from the Ajifer L-14 treatments with 125 and 150 % of the recommended rate (Table 4 and Figure 1). It must be highlighted that the treatment with mineral fertilization, which received 50 % of the recommended Ajifer L-14 amount as well as the control, were the least promising treatments in dry matter and crude protein production of Brachiaria. With a similar behavior as in the case of dry matter, crude protein production increased with increasing Ajifer L-14 rates (Figure 1).

Apparently, only a small part of the organic content of the byproduct was decomposed within the short study period. However, the results suggest potential benefits in the application of waste from the lysine-producing industry (Ajifer L-14) for soil fertility, indicating its use in agricultural systems.

CONCLUSIONS

1. There was no effect of organic mineral fertilizer on the soil chemical properties.

2. Regression analysis indicated a polynomial relationship between the application rates of organic-mineral fertilizer and the dry matter and crude protein production of *Bracharia Brizantha*.

3. The short study period of nine months was not long enough for the degradation of the applied organic waste.

LITERATURE CITED

ABD EL-MOEZ, M.R. Response of *Vicia faba* followed by *Zea mays* to application of mineral fertilizers and organic industrial waste. An. Agric. Sci., 34:1331-1343, 1996.

ANDRADE, C.A.; OLIVEIRA, C. & CERRI, C.C.C. Qualidade da matéria orgânica e estoques de carbono e nitrogênio em latossolo tratado com biossólido e cultivado com eucalipto. R. Bras. Ci. Solo, 29:803-816, 2005.

ARAUJO, F.F.; GIL, F.C. & TIRITAN, C.S. Lodo de esgoto na fertilidade do solo, na nutrição de *Brachiaria decumbens* e na atividade da desidrogenase. Pesq. Agropec. Trop., 39:1-6, 2009.

CANTARELLA, H.; ABREU, C.A.A. & BERTON, R.S. Fornecimento de nutrientes pela matéria orgânica do solo. In: ENCONTRO SOBRE MATÉRIA ORGÂNICA DO SOLO: PROBLEMAS E SOLUÇÕES, 1992, Botucatu. Anais... Botucatu, Faculdade de Ciências Agronômicas, 1992. p.63-122.

CÔRREA, M.C.M.; FERNANDES, G.C.; PRADO, R.M. & NATALE, W. Propriedades químicas do solo tratado com resíduo orgânico da indústria processadora de goiabas. R. Bras. Agroci., 11:241-243, 2005.

COSTA, M.C.G.; VITTI, G.C. & CANTARELLA, H. Volatilização de N-NH_3 de fontes nitrogenadas em cana-de-açúcar colhida sem despalha a fogo. R. Bras. Ci. Solo, 27:631-637, 2003.

DE MARIA, I.C.; KOCSSIS, M.A. & DECHEN, S.C.F. Agregação do solo em área que recebeu lodo de esgoto. Brag., 66:291-298, 2007.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA – EMBRAPA. Centro Nacional de Pesquisa de Solos. Manual de métodos de análise de solo. 2.ed. Rio de Janeiro, 1997. 212p.

FERNANDES, L.O.; REIS, R.A.; RODRIGUES, L.R.A.; LEDIC, I.L. & MANZAN, R.J. Qualidade do feno de *Brachiaria decumbens* Stapf. submetido ao tratamento com amônia anidra ou uréia. R. Bras. Zootec., 31:1325-1332, 2002.

FLOHR, L.; BRENTANO, D.M.; CARVALHO-PINTO, C.R.S.; MACHADO, V.G. & MATIAS, W.G. Classificação de resíduos sólidos industriais com base em testes ecotoxicológicos utilizando *Daphnia magna*: Uma alternativa. Biotemas, 18:7-18, 2005.

GOMIDE, J.A. Valor nutritivo e produtividade do capim colonião submetido a diferentes intervalos entre cortes com ou sem adubação de reposição. R. Bras. Zootec., 11:508-592, 1982.

LIMA, D.V.; FAQUIN, V.; FURTINI NETO, A.E.; MORAIS, A.R.; CURI, N. & HIGA, N.T. Macro e micronutrientes no crescimento do braquiarão e da soja em Latossolos sob Cerrado da região de Cuiabá-MT. Ci. Agrotec., 24:96-104, 2000.

MELGAR, R.; CAMOZZI, M.E. & FIGUEROA, M.M. Guía de fertilizantes, enmiendas y productos nutricionales. Buenos Aires, Instituto Nacional de Tecnologia Agropecuária, 1999. p.13-25.

OLIVEIRA, F.C.; MARQUES, M.O.; BELLINGIERI, P.A. & PERECIN, D. Lodo de esgoto como fonte de macronutrientes para a cultura do sorgo granífero. Sci. Agric., 52:360-367, 1995.

OLIVEIRA, P.P.A.; TRIVELIN, P.C.O. & OLIVEIRA, W.S. Eficiência da fertilização nitrogenada com uréia (^{15}N) em *Brachiaria brizantha* cv. Marandu associada ao parcelamento de superfosfato simples e cloreto de potássio. R. Bras. Ci. Solo, 27:613-620, 2003.

OLIVEIRA, P.P.A.; TRIVELIN, P.C.O.; OLIVEIRA, W.S. & CORSI, M. Fertilização com N e S na recuperação de pastagem de *Brachiaria brizantha* cv. Marandu em Neossolo Quartzarênico. R. Bras. Zootec., 34:1121-1129, 2005.

RAIJ, B.van.; CANTARELLA, H.; QUAGGIO, J.A. & FURLANI, A.M.C. Recomendações de adubação e calagem para o Estado de São Paulo. 2.ed. Campinas, Instituto Agronômico/Fundação IAC, 1997. 285p. (Boletim Técnico, 100)

RAIJ, B.van; ANDRADE, J.C.; CANTARELLA, H. & QUAGGIO, J.A. Análise química para avaliação da fertilidade de solos tropicais. Campinas, Instituto Agronômico de Campinas, 2001. 285p.

SILVA, D.J. Análise de alimentos: Métodos químicos e biológicos. Viçosa, MG, Universidade Federal de Viçosa, 1990. 166p.

SCHLOTZHAVER, S.D. & LITTELL, R.C. SAS: System for elementary statistical analysis. 2.ed. Cary, 1997. 905p.

SOARES, W.V.; LOBATO, E.; SOUSA, D.M.G. & REIN, T.A. Avaliação do fosfato natural de Gafsa para recuperação de pastagem degradada em Latossolo Vermelho-Escuro. Pesq. Agropec. Bras., 35:819-825, 2000.

TRANNIN, I.C.B.; SIQUEIRA, J.O. & MOREIRA, F.M.S. Avaliação agronômica de um biossólido industrial para a cultura do milho. Pesq. Agropec. Bras., 40:261-169, 2005.

TRANNIN, I.C.B.; SIQUEIRA, J.O. & MOREIRA, F.M.S. Atributos químicos e físicos de um solo tratado com biossólido industrial e cultivado com milho. R. Bras. Eng. Agríc. Amb., 12:223-230, 2008.