RECYCLING OF NUTRIENTS WITH APPLICATION OF ORGANIC WASTE IN DEGRADED PASTURE

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ABSTRACT: The utilization of organic wastes represents an alternative to recover degraded pasture. The experiment aimed to assess the changes caused by the provision of different organic waste (poultry litter, turkey litter and pig manure) in a medium-textured Oxisol in Brazilian Savanna under degraded pasture. It was applied different doses of waste compared to the use of mineral fertilizers and organic mineral and evaluated the effect on soil parameters (pH, organic matter, phosphorus and potassium) and leaf of *Brachiariadecumbens* (crude protein, phosphorus and dry mass production). It was observed that application of organic waste did not increase the level of soil organic matter and pH in the surface layer, and the application of turkey litter caused acidification at depths of 0.20-0.40 m and 0.40-0.60 m. There was an increase in P and K in the soil with the application of poultry litter and swine manure. All organic wastes increased the productivity of dry matter and crude protein and phosphorus. The recycling of nutrients via the application of organic waste allows efficiency of most parameters similar to those observed with the use of mineral sources, contributing to improving the nutritional status of soil-plantsystem.

KEYWORDS: Poultry litter, swine manure, soil chemistry, nutrient uptake.

RECICLAGEM DE NUTRIENTES COM APLICAÇÃO DE RESÍDUOS ORGÂNICOS EM PASTAGEM DEGRADADA

RESUMO: O aproveitamento de resíduos orgânicos representa alternativa para recuperação de pastagens degradadas. O experimento objetivou avaliar as alterações provocadas pela disposição de diferentes resíduos orgânicos (cama de frango,cama de peru e dejeto de suíno) em um Latossolo Vermelho de textura média, em área de Cerrado sob pastagem degradada. Aplicaram-se diferentes doses de resíduos em comparação ao uso de fertilizante mineral e organomineral, e avaliou-se o efeito nos parâmetros de solo, tais comopotencial hidrogiônico (pH), matéria orgânica (MO), teores de fósforo (P) e potássio (K), bem como os parâmetros foliares da *Brachiariadecumbens* (concentração de proteína bruta (PB), fósforo e produção de massa seca (MS). Observou-se que a aplicação dos resíduos orgânicos não incrementou o teor de matéria orgânica no solo e os valores do pH na camada superficial, sendo que, na aplicação de cama de peru, observou-se acidificação nas profundidades de 0,20 – 0,40 e 0,40 – 0,60 m. Houve incremento no teor de P e K no solo com aplicação de cama de frango e dejeto de suíno. Todos os resíduos orgânicos incrementaram a produtividade de massa seca da *Brachiaria*, os teores de proteína bruta e o fósforo. A reciclagem de nutrientes via aplicação de resíduos orgânicos permite eficiência da maioria dos parâmetros estudados, similares ao observado com o uso de fontes minerais, contribuindo para a melhoria nutricional do sistema solo-planta.

PALAVRAS CHAVE: cama de aviário, dejetos suínos, química do solo, absorção de nutrientes.

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INTRODUCTION

Every production process is characterized by the use of inputs (raw materials, water, energy, etc.) that when processed give rise to products, byproducts and waste. The disposal and treatment of waste should be regarded as one of the production phases, and the search for the correct disposal procedure can lead to reduction of environmental impacts and the burdens resulted from fines and/or mismanagement.

The current need of disposal of the organic waste produced by both, rural and urban-industrial, increases the research demand in this sector, as demonstrated with the increase in research about use of sewage sludge (Nascimento et al., 2004; Souza et al., 2005), pig slurry (CERETTA et al., 2005, BASSO et al., 2004) and poultry litter (ANDREOLA, 1996; KONZEN & ALVARENGA, 2004, MENEZES et al., 2004).

It is expected that the organic wastes can supply plant nutrients and organic matter for microbial activity while preserving the natural organic biomass of the soil. Thus, fertilization with the use of renewable wastes aims to increase crop yields and reduce the environmental impact of increasing waste generated by production systems. For this practice to become sustainable, the understanding of soil chemical changes and the evaluation of plant mineral nutrition are essential.

The objective of this study was to evaluate the changes caused by the provision of different organic waste in a medium-texture Oxisol, in an area of the Brazilian Savanna under degraded pasture.

MATERIALS AND METHODS

The experiment was carried out in a dystrophic Red Latosol (EMBRAPA, 1999), in the farm Caminho das Pedras, 18º 52' and 18º 51'south latitude and meridians 48º 33' and 48º 33' longitude west of Greenwich, with an altitude of 800 meters within the municipality of Uberlândia, State of Minas Gerais, Brazil.

The farm keeps activities of poultry production in feedlot, and beef production in extensive system, using pasture as the staple food, although this system was showing signs of deterioration, with presence of invasive plants and small patches with bare soil. The initial pH was in the range 5.5 to 6.2 (Table 1), close to the ideal for the development of most crops, with absence of aluminum toxicity and nutrient levels considered low to medium, according to CFSEMG (1999).

Prior to the experiment (December 2003), soil samples were collected from the experimental area for chemical characterization, at the layers 0-10, 10-20, 20-40 cm (Table 1), according to CFSEMG (1999) recommendation.

TABLE 1. Chemical characterization of soil at different depths.

Depth	pH[2]	P[3]	K[3]	Al[4]	Ca	Mg	H+Al	SB[5]	t[6]	T[7]	V[8]	m[9]	MO[10]
m	1:2,5	mg dm^{-3}		----------------------cmol$_c$dm^{-3}-----------------------							-----%-----		g kg^{-1}
0.0 - 0.10	6.5	2.9	32	0.0	1.1	0.4	1.7	1.6	1.56	3.22	48	0	20.0
0.10 - 0.20	5.5	1.3	29	0.3	0.4	0.1	2.9	0.6	0.89	3.49	17	34	12.0
0.20 - 0.40	5.5	0.9	27	0.3	0.3	0.1	2.6	0.5	0.77	3.06	15	39	8.0

[1]Depth; [2]pH in H_2O; [3] P and K = (HCl 0.05 mol l^{-1}+ H_2SO_4 0.025 mol l^{-1}); [4]Al, Ca, Mg = (KCl 1 mol l^{-1}); [5]SB = Sum of Bases; [6]t= Effective CTC; [7]T= CTC at pH 7.0; [8]V= Base Saturation; [9]m= Aluminum Saturation; [10]MO= Organic Matter.

The area has uniform relief, with gentle undulated topography and 2% slope. The area was chosen because it has the medium-textured to sandy soil (801.3, 33.7 and 165 g kg^{-1}, respectively ratios of sand, silt and clay), according to EMBRAPA (1999), since possible problems arising from leaching of nutrients through the soil profile can be seen more quickly than in clayey soils.

During the experimental period, from January to August 2004, there was a total rainfall of 1,074 mm, unevenly distributed and concentrated in the months of January, February, March and early April.

Organic wastes were applied in three independent experiments. The characterization of waste from poultry litter was performed according to the organic waste methodology described by SARRUGE & HAAG (1974) as adopted by the Laboratory of Soil Analysis (LABAs), Federal University of Uberlândia (Table 2). For the swine slurry, the average composition assigned was 4,000 mg l^{-1} of N, 2,860 mg l^{-1} of P, 2,900 mg l^{-1} of Ca, 390 mg l^{-1} of K, 370 mg l^{-1} of Mg, 170 mg L^{-1} of Na, 92 mg l^{-1} of Cu and 26 mg l^{-1} of Zn. It was used two poultry litters, since broilers and turkeys had different nutritional needs, causing the waste to present different composition characteristics, which can change the chemical properties of soil with different levels of phosphorus, calcium, copper, zinc and physical attributes.

TABLE 2. Chemical characteristics and properties of broiler and turkey litter.

Determinations	Natural Humidity of the Broiler Litter	Natural Humidity of the Turkey Litter
pH in $CaCl_2$ (0.01 mol l^{-1})	8.2	8.0
Total Organic Matter (g kg^{-1})	455.5	556.9
C/N Ratio (total C / total N)$^{(2)}$	19/1	16/1
Total Nitrogen (g kg^{-1})$^{(3)}$	13.3	19.9
Total Phosphorus (g kg^{-1})$^{(4)}$	6.8	12.9
Total Potassium (g kg^{-1}) $^{(5)}$	15.1	16.1
Calcium (g kg^{-1})$^{(6)}$	11.2	2.7
Magnesium (g kg^{-1}) $^{(6)}$	2.70	3.5
Total Sulfur (g kg^{-1})$^{(5)}$	25.3	31.5
Total Manganese (mg kg^{-1})$^{(6)}$	200.9	203.0
Total Copper (mg kg^{-1}) $^{(6)}$	24.3	52.0
Total Zinc (mg kg^{-1}) $^{(6)}$	86.5	183.0
Total Sodium (mg kg^{-1}) $^{(6)}$	1730	1979

^{2} C/N (Carbon/nitrogen ratio), total (Oxidation of organic matter with 0.17 mol l^{-1} potassium dichromate and reading in colorimeter; ^{3}N (micro-kjedhal method); ^{4}P (vanadate-molibdate method, reading in spectrophotometer); ^{5}K (flame spectrophotometry); ^{6}Ca; Mg; S; Mn; Cu; Zn; Fe; B; Na (atomic absorption spectrophotometry).

The application of waste was carried out using a limestone distributor for poultry litter, and slurry distributor in the case of swine slurry, in plots with an area of 250 m^2 (25 x 10 m), an runners spaced two meters between plots to allow machinery traffic.

For the experiment with poultry litter: T0 - zero fertilization; T1 - inorganic fertilizer with the equivalent of 60 kg ha^{-1} of N; 90 kg ha^{-1} of P_2O_5 and 100 kg ha^{-1} of K_2O; T2 –1,200 kg ha^{-1} of poultry litter, T3 – 2,400 kg ha^{-1} of poultry litter, T4 – 4,800 kg ha^{-1} of poultry litter, T5 – 2,400 kg ha^{-1} of poultry litter + mineral supplement of 30 kg of N, 30 kg of P_2O_5 and 30 kg of K_2O (organic-inorganic treatment).

For the experiment with the swine slurry, treatments were T0 - control, no fertilization, T1 - control with inorganic fertilization, T2 - 60 m^3 ha^{-1} of swine slurry, T3 - 120 m^3 ha^{-1} of swine slurry, T4- 180 m^3 ha^{-1} of swine slurry; T5 - organic-inorganic treatment with 120 m^3 ha^{-}1of swine slurry + ½ dose of inorganic fertilizer. The sources of mineral fertilizers used were urea (42% of N), superphosphate (18% of P_2O_5) and potassium chloride (57% of K_2O).

The experiments were independent. It was used a randomized block design with four replications, with treatments in a split-plot arrangement, with parcels being the fertilization levels and the subplots being the pasture cutting age and the period of soil sampling during the rainy and the dry seasons.

Soil sampling was carried out after the rainy season (April 2004), at the depths of 0.0 - 0.20; 0.20 - 0.40, and 0.40 - 0.60 m, determining the soil chemical properties according to the methodology proposed by EMBRAPA (1997). Leaf data were determined according the method described by Silva (1981), in which the CP was determined by semi-micro Kjedahl method, P content was obtained by nitropercloric digesting solution and read incolorimeter, while MS determination was performed by weighing the sample after drying in a forced air oven at 65°C for 72 hours or until constant weight.

RESULTS AND DISCUSSION

Values of pH (Table 3) at a depth of 0.0 - 0.20 m showed the lowest values in the treatment with inorganic fertilizers. This pH reduction caused by use of inorganic fertilizer was reported by ANDREOLA (1996) due to urea hydrolysis and subsequent ammonia nitrification, potassium uptake and release of H^+ by the roots. In the experiment with broiler litter, it was observed that the lowest pH values were found in the T1 treatment, as well as for the treatment with turkey litter. There were no significant differences between treatments with swine slurry.

Even though, pH values differed from one another, they were within the same interpretation class, according to CFSEMG (1999). This variable may have been affected by the use of waste, since the waste pH (Table 2) was approximately 8.0, which suggests that the soil was not acidified. However, the amphoteric character of organic materials does justify this behavior.

At the depth of 0.20 - 0:40 and 0.40 - 0.60 m, there were no significant differences ($p<0.05$) for pH values for the treatments with broiler litter and swine manure. On the other hand, the treatment with turkey litter showed effect of both mineral and organic fertilizers, characterizing the importance of monitoring continuously during residue applications. OLIVEIRA et al. (2002) also reported a decrease in pH after application of the garbage residue due to a higher rate of decrease of organic C content associated with the natural process of acidification. Changes in the subsurface layers were observed, even though the residue was applied on top of the soil. This fact should be assessed, because the acidity amendment in these layers is difficult to manage in areas of perennial pastures. This is in agreement with RHEINHEIMER et al. (2000), who found that superficial liming changed chemical properties in the layer between 0.05 and 0.23 m depth.

The organic matter content (Table 3) was not altered for the three residues at a depth of 0.0 - 0.20 m, although the application has been performed on top soil. At a soil depth from 0.20 to 0.40 and 0.40 to 0.60 m, there were no changes observed in the treatments of broiler litter and swine slurry. For the treatment with turkey litter, however, organic fertilization promoted an increase of organic matter content in the depth of 20-40 cm and 40-60 cm in all levels applied. This phenomenon is inconsistent with what is described by MUZILLI (1983) and DE MARIA & CASTRO (1993), who said that the greatest accumulation occurs in smaller fractions sampling as 0-2.5 cm and 0-5cm, the fact that sampling was performed in this experiment in 20-cm layers may have contributed to the effect of organic matter inclusion via organic waste have been diluted, thus resulting in lower significance of the accumulation.

TABLE 3. Values the pH and organic matter (g kg-1) in the soil after application of fertilizer with broiler and turkey litter, swine slurry and mineral fertilizer at three depths collection.

				0.0 - 0.20 m Depth				
Broiler[1]	pH	MO	Turkey[2]	pH	MO	Swine[3]	pH	MO
T0	5.9 ab	21.23 a	T0	6.00 a	22.00 a	T0	6.00 a	22.00 a
T1	5.1 c	21.46 a	T1	5.00 d	22.00 a	T1	5.00 a	22.00 a
T2	6.0 a	21.19 a	T2	5.25 cd	22.25 a	T2	5.75 a	21.75 a
T3	5.7 ab	22.10 a	T3	5.41 bcd	22.50 a	T3	5.50 a	22.00 a
T4	5.6 b	22.21 a	T4	5.49 bc	22.25 a	T4	5.75 a	22.00 a
T5	5.7 ab	21.46 a	T5	5.86 ab	22.00 a	T5	6.00 a	21.75 a
C.V. (%)	3.08	3.73		3.75	1.89		8.11	1.36
DMS	0.39	18.50		0.48	0.97		1.05	0.68
				0.20- 0.40 m Depth				
Broiler[1]	pH	MO	Turkey[2]	pH	MO	Swine[3]	pH	MO
T0	5.6 a	21.83 a	T0	5.75 a	21.82 b	T0	5.75 a	21.00 a
T1	5.3 a	22.08 a	T1	5.25 ab	22.07 ab	T1	5.25 a	22.00 a
T2	5.5 a	21.88 a	T2	5.00 b	22.23 a	T2	5.50 a	19.50 a
T3	5.3 a	22.10 a	T3	5.33 ab	22.25 a	T3	5.25 a	22.00 a
T4	5.5 a	21.95 a	T4	5.38 ab	22.20 a	T4	6.00 a	19.50 a
T5	5.4 a	21.93 a	T5	5.38 ab	22.18 a	T5	5.50 a	21.25 a
C.V. (%)	4.0	1.20		5.81	0.59		5.54	14.32
DMS	0.50	0.60		0.72	0.30		1.15	6.87
				0.40 – 0.60 m Depth				
Broiler[1]	pH	MO	Turkey[2]	pH	MO	Swine[3]	pH	MO
T0	5.6 a	21.20 b	T0	5.75 a	21.00 c	T0	5.75 a	22.00 a
T1	5.2 a	21.80 a	T1	5.00 b	22.00 a	T1	5.00 a	22.00 a
T2	5.3 a	21.20 b	T2	5.00 b	22.00 a	T2	5.75 a	21.50 a
T3	5.3 a	21.63 ab	T3	5.32 ab	22.00 a	T3	5.25 a	21.75 a
T4	5.5 a	21.28 b	T4	5.24 b	22.00 a	T4	5.50 a	22.00 a
T5	5.4 a	21.48 ab	T5	5.36 ab	21.50 b	T5	5.75 a	22.00 a
C.V. (%)	2.91	0.94		4.04	0.67		5.50	1.34
DMS	0.36	0.46		0.49	0.34		1.08	0.67

Different lowercase letters in the column differ by Tukey test 5% probability for each variable. 1- Treatments corresponding to the application of poultry litter T0 = control, T1 = recommended inorganic fertilization, T2 = 1,200 kg ha^{-1},T3 = 2,400 kg ha^{-1}, T4 = 4,800 kg ha^{-1}, T5 = organic-inorganic treatment;2- Treatments with turkey litter corresponding to T0 = control, T1 = recommended inorganic fertilization, T2 = 1,200 kg ha^{-1},T3 = 2,400 kg ha^{-1}, T4 = 4,800 kg ha^{-1}, T5 = organic-inorganic treatment;3- T0 = control, T1 = recommended inorganic fertilization, T2 = 60 m^3ha^{-1},T3= 120 m^3 ha^{-1},T4 = 180 m^3 ha^{-1}; T5= organic-inorganic fertilization.

At a depth of 0-20 cm, it appears that there were no significant differences ($p<0.05$) between treatments P values for the application of turkey litter (Table 4). For broiler litter, only the organic-inorganic treatment differed statistically from the control, while the other treatments with broiler litter presented exclusively equivalence with the organic-inorganic treatment.

One way of evaluating the interpretation of available phosphorus in the soil is by means of class interpretation according to the soil clay content (CFSEMG, 1999). That is, according to the clay content (Table 3) up to 6.6 mg dm^{-3} is considered too low, and ideal values lie between 12.1 and 20.0 mg dm^{-3}. The values observed in the soil for the treatments were very low, even when using inorganic source.

TABLE 4. Values the phosphorus and potassium (mg dm$^{-3)}$ in the soil after application of fertilizer with broiler and turkey litter and swine slurry and mineral fertilizer at three depths collection.

				0.0 - 0.20 m Depth				
Broiler[1]	P	K	Turkey[2]	P	K	Swine[3]	P	K
T0	0.35 b	30.50 b	T0	0.35 a	27.50 ab	T0	0.54 b	3.75 b
T1	1.13 ab	37.50 ab	T1	1.13 a	27.50 ab	T1	1.63 a	28.50 ab
T2	2.58 ab	33.00 ab	T2	1.48 a	15.75 b	T2	1.64 a	41.75 a
T3	1.27 ab	38.00 ab	T3	0.70 a	19.75 b	T3	1.29 ab	49.25 a
T4	1.50 ab	43.00 ab	T4	1.15 a	28.50 ab	T4	1.30 ab	33.25 a
T5	3.70 a	58.00 a	T5	1.83 a	37.75 a	T5	1.45 a	42.75 a
C.V. (%)	64.59	29.71		86.99	25.22		1.31	45.45
DMS	2.60	26.17		2.21	15.58		1.09	34.69
				0.20- 0.40 m Depth				
Broiler[1]	P	K	Turkey[2]	P	K	Swine[3]	P	K
T0	0.10 a	28.00 a	T0	0.10 b	25.00 a	T0	0.59 b	3.50 b
T1	0.23 a	15.80 a	T1	0.23 b	15.50 a	T1	0.65 b	16.50 ab
T2	0.10 a	25.50 a	T2	0.90 a	12.00 ab	T2	1.79 a	38.75 a
T3	0.10 a	20.50 a	T3	0.60 ab	12.00 ab	T3	1.25 ab	34.75 ab
T4	0.10 a	25.50 a	T4	0.48 ab	19.25 a	T4	1.26 b	32.00 ab
T5	0.18 a	28.00 a	T5	0.85 a	16.50 a	T5	1.17 ab	40.50 a
C.V. (%)	81.01	30.61		43.71	34.13		1.12	50.24
DMS	0.25	16.80		0.53	13.62		0.89	31.94
				0.40 – 0.60 m Depth				
Broiler[1]	P	K	Turkey[2]	P	K	Swine[3]	P	K
T0	0.23 ab	15.50 a	T0	0.23 a	15.50 ab	T0	0.25 b	2.25 b
T1	0.70 a	21.30 a	T1	0.70 a	21.30 a	T1	1.10 ab	22.00 a
T2	0.10 b	18.00 a	T2	0.55 a	10.05 b	T2	1.58 a	26.00 a
T3	0.15 b	18.25 a	T3	1.75 a	11.05 b	T3	2.11 a	24.25 a
T4	0.10 b	23.00 a	T4	1.60 a	13.05 ab	T4	1.78 a	24.75 a
T5	0.25 ab	18.00 a	T5	2.05 a	12.62 ab	T5	1.66 a	36.75 a
C.V. (%)	89.89	37.89		74.98	30.69		1.41	37.57
DMS	0.53	16.55		1.97	9.82		1.41	19.57

Different lowercase letters in the column differ by Tukey test 5% probability for each variable. 1- Treatments corresponding to the application of poultry litter T0 = control, T1 = recommended inorganic fertilization, T2 = 1,200 kg ha^{-1},T3 = 2,400 kg ha^{-1}, T4 = 4,800 kg ha^{-1}, T5 = organic-inorganic treatment;2- Treatments with turkey litter corresponding to T0 = control, T1 = recommended inorganic fertilization, T2 = 1,200 kg ha^{-1},T3 = 2,400 kg ha^{-1}, T4 = 4,800 kg ha^{-1}, T5 = organic-inorganic treatment;3- T0 = control, T1 = recommended inorganic fertilization, T2 = 60 m^{3}ha^{-1},T3= 120 m^3 ha^{-1},T4 = 180 m^3 ha^{-1}; T5= organic-inorganic fertilization.

Phosphorus is the most needed macronutrient for pastures and an element that is found at low levels in most soils of the Brazilian Savanna region (SOUSA & LOBATO, 2004). It is the basic element for the calculation of organic fertilization, and the application of 100 kg per hectare of P_2O_5 according to the recommendation by CFSEMG (1999), both organic and inorganic forms were not sufficient to promote substantial increases in soil content for the three organic sources applied. At a depth of 0.20 - 0.40 m and 0.40 - 0.60 m, both the turkey litter and the swine slurry provided increase of phosphorus greater than the high-solubility inorganic source. Nutrient leaching found in these tests demonstrates a need for closer monitoring of the phosphorus element regarding waste disposal in the soil, as in many soils the highest ground water level may receive the phosphorus load, causing water eutrophication, which corroborates with information by YLI-HALLA et al. (1995), which states that losses of soluble phosphorus can be even higher and cause eutrophication of conservation systems, which soil erosion is significantly reduced. From the environmental point of view, concentrations of inorganic phosphorus in the surface water between 0.1 and 0.2 mg L^{-1} are considered critical (SHARPLEY et al., 1996).

Many authors consider phosphorus an element of low mobility in the soil, which contradicts the observations in this experiment, mainly related to the application of swine slurry. One possibility was raised by EGHBALL et al. (1996) and MOZZAFFARI & SIMS (1994), who compared the movement of phosphorus from manure and fertilizers, and observed a greater movement of phosphorus in the soil profile. The authors discussed that this could be due to the movement of phosphorus in the organic form.

As for potassium, changes were observed for contents in all depth levels in the experiment with broiler litter. For the experiment with turkey litter, the contents were generally reduced with application, since the turkey and poultry litters have similar levels of potassium. On the other hand, for swine slurry, an increase was observed in all depths, and since potassium is recognized as an element of great mobility, corroborating with FAGERIA et al. (1990), who found movement of potassium to the lower layers of the soil, especially at higher dosages of the nutrient. The swine slurry is a liquid residue, which increases the possibility of leaching of this element. Although MATOS et al. (1997) stated that there is little movement of potassium in the soil below 45 cm, with application of up to 200 m^3 ha^{-1} of swine slurry, attributing this phenomenon to the elevated removal of vegetation, which immobilizes part of this nutrient in the biomass.

It is observed that the MS productivity (Table 5) in the treatments that received broiler litter showed no significant increase compared to the control at 35 days, despite the fact that all treatments that received poultry litter presented similarity to the inorganic fertilizer treatment. At 60 days, only the highest dosage (4,800 kg ha^{-1}) and organic-inorganic treatment was equivalent to inorganic fertilizer, while the other treatments did not differ from the control.

In the experiment with turkey litter, since the first cut at 35 days, it was observed that all treatments were equivalent to the inorganic fertilization, i.e., they responded to the fertilization levels applied. At 60 days, only the treatment with application of 2,400 kg ha^{-1} differed from the treatment with inorganic fertilization.

TABLE 5. Productivity of dry matter in Brachiariadecumbens at 35 and 60 days after application of different levels of poultry and turkey litter and swine manure.

Productivity of Dry Mass								
Broiler[1]	35 days	60 days	Turkey[2]	35 days	60 days	Swine[3]	35 days	60 days
T0	996 b	1.450 c	T0	996 c	1450 b	T0	996 cb	1451 c
T1	1.416 a	2.489 a	T1	1416 ab	2489 a	T1	1417 a	2490 b
T2	1.296 ab	1.587 bc	T2	1126 bc	1771 ab	T2	825 c	3020 ba
T3	1.226 ab	1.448 c	T3	1151 abc	1538 b	T3	798 c	3579 a
T4	1.347 ab	1.952 abc	T4	1455 a	1724 ab	T4	991 cb	3826 a
T5	1.209 ab	2.295 a	T5	1188 abc	1734 ab	T5	1118 b	3998 a
C.V. (%)	13,95	16,97		11,14	20,34		11,95	13,95
Mean	1.248	1.870		1222	1784,8		1024	3075

Different lowercase letters in the column differ by Tukey test 5% probability for each variable. 1- Treatments corresponding to the application of poultry litter T0 = control, T1 = recommended inorganic fertilization, T2 = 1,200 kg ha^{-1},T3 = 2,400 kg ha^{-1}, T4 = 4,800 kg ha^{-1}, T5 = organic-inorganic treatment;2- Treatments with turkey litter corresponding to T0 = control, T1 = recommended inorganic fertilization, T2 = 1,200 kg ha^{-1},T3 = 2,400 kg ha^{-1}, T4 = 4,800 kg ha^{-1}, T5 = organic-inorganic treatment;3- T0 = control, T1 = recommended inorganic fertilization, T2 = 60 m^3ha^{-1},T3= 120 m^3 ha^{-1},T4 = 180 m^3 ha^{-1}; T5= organic-inorganic fertilization.

In the treatment with swine slurry, T1 showed higher dry matter yields of forage at 35 days treatment, being statistically different from the other treatments ($p<0.05$). At 60 days, it was found that only the application of the lowest dose of swine slurry (60 m^3) was comparable to the inorganic fertilizer, these being 108% and 71% respectively higher than the control. The other treatments with swine slurry application promoted higher dry matter yield than the inorganic fertilizer, reaching values up to 175% higher than the control. Fauvel and Morvan (1998) observed that for corn crop, dry matter production with application of swine manure was higher 12.5 and 33% for doses of 60 and 124 kg ha^{-1} of N via mineral fertilizer, respectively.

At 35 days after application of broiler litter, it is observed that the residue did not cause significant increase in CP content (Table 6) in all treatments. Opposite behavior was observed in treatment with turkey litter and swine slurry, in which both treatments in all doses showed similar levels of inorganic fertilizer. Regarding phosphorus, there is no difference between the absorbed contents among all treatments. In the treatments with swine slurry and turkey litter, there were differences in the levels present in leaf samples between the control and treatments that received fertilizer, either organic or inorganic. Dealing with broiler litter, it was observed that the highest levels were for mineral and organic-inorganic fertilization. The treatments with doses exclusively with broiler litter were equivalent to control and inorganic fertilizer.

TABLE 6. Content of crude protein and Phosphorus (g kg^{-1}) in Brachiariadecumbens at 35 and 60 days after application of different levels of poultry and turkey litter and swine manure.

Broiler[1]	PB	P	Turkey[2]	PB	P	Swine[3]	PB	P
	---------------	---------------	---------------	g kg^{-1}	---------------	---------------	---------------	---------------
T0	6.25 b	1.25 c	T0	6.25 b	1.25 b	T0	6.25 b	1.42 a
T1	14.50 a	3.00 ab	T1	14.50 a	3.00 a	T1	16.00 a	2.25 a
T2	10.75 ab	1.75 bc	T2	10.75 ab	3.50 a	T2	9.75 ba	2.40 a
T3	7.00 b	2.25 bc	T3	11.25 ab	3.25 a	T3	12.50 ba	3.02 a
T4	7.50 b	2.25 bc	T4	14.00 a	4.00 a	T4	15.75 a	2.53 a
T5	8.00 b	4.00 a	T5	13.75 a	3.25 a	T5	15.00 a	2.85 a
C.V. (%)	35.42	29.26		20.08	18.08		25.67	47.75
Mean	9.25	2.42		11.75	3.08		12.54	2.43

Different lowercase letters in the column differ by Tukey test 5% probability for each variable. 1- Treatments corresponding to the application of poultry litter T0 = control, T1 = recommended inorganic fertilization, T2 = 1,200 kg ha^{-1},T3 = 2,400 kg ha^{-1}, T4 = 4,800 kg ha^{-1}, T5 = organic-inorganic treatment;2- Treatments with turkey litter corresponding to T0 = control, T1 = recommended inorganic fertilization, T2 = 1,200 kg ha^{-1},T3 = 2,400 kg ha^{-1}, T4 = 4,800 kg ha^{-1}, T5 = organic-inorganic treatment; 3- T0 = control, T1 = recommended inorganic fertilization, T2 = 60 m^{3}ha^{-1},T3= 120 m^{3} ha^{-1},T4 = 180 m^{3} ha^{-1}; T5= organic-inorganic fertilization.

CONCLUSIONS

The recycling of nutrients via application of organic waste can be an efficient alternative for most of the parameters studied.

Since little variation was observed among the application of different doses, this fact underscores the importance of constant monitoring of organic waste application in order to reduce potential environmental impacts.

All waste residues applied broiler litter, turkey litter and swine slurry, promoted changes in soil properties and nutrient uptake in *Brachiariadecumbens*, contributing to improve the nutritional status of the soil-plant-system.

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