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Organic Fertilization In Soy Farming In A Tropical Region

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ABSTRACT

Large volumes of poultry waste are generated by agribusiness activities, among them turkey manure, which has the potential to be used as organic fertilizer. The present work aims at assessing the effects of replacing conventional chemical fertilization with organic fertilization using turkey manure in the chemical attributes of the soil and in the productivity of soy beans. The treatments assessed had only potassium fertilization as control; 400 kg $ha^{-1}$of 2-20-10, recommended chemical fertilization; organic fertilization with 2,540 kg ha^{-1} of turkey manure; 5,080 kg ha^{-1} of turkey manure ha^{-1}; 50% of chemical fertilization (200 kg $ha^{-1}$of 2-20-10) + 50% of organic fertilization (1,270 kg ha^{-1}); 50% of chemical fertilization + 100% of organic fertilization (2,540 kg ha^{-1}). Organic fertilization promoted greater amounts of P and K in the soil. The highest productivity of soy beans was obtained using 50% of chemical fertilization and 100% of organic fertilization and the lowest was in the control treatment, only potassium fertilization. The waste deriving from poultry farming used as organic fertilizer implies a correct destination and reduction of environmental risks, also resulting in soil fertility improvements and, at the same time, enabling the reduction of dependency of chemical fertilizers for soy production.

INTRODUCTION

Production of turkey meat generates large volume of waste, and there is a need to find alternatives of usage of this organic waste. An alternative and its adoption in organic fertilization of plants (Conte *et al*., 2014; Pinto *et al*., 2012).

The use of organic fertilization has grown significantly in recent years due to the increased cost of processed fertilizers, as well as the greater offer of waste deriving from agribusiness (Espanhol *et al*., 2007; Marouni *et al*., 2016). The waste generated by poultry, pork and beef agribusiness should return to nature in a rational manner, i.e., not impacting the environment. Therefore, there is a need to provide technological resources to reuse this waste, meeting the sustainability principles and collaborating with the development of the country (Corrêa *et al*., 2011; Ribeiro *et al*., 2015).

In addition, the use of organic waste influences physical, chemical and biological attributes of the soil (Pinto *et al*., 2012). Poultry waste, which includes turkey manure, is rich in nutrients, and its application has been associated with improvements in chemical, physical and biological attributes of the soil (Costa *et al*., 2009), frequently raising the pH and increasing the fertility of the soil (Whalen *et al*., 2000; Scherer *et al*.,

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2010). Scherer *et al*. (2007) evidenced increased availability of nutrients to the plants; improvement of the physical quality of the soil, due to less erosion and increased water retention; and improvement in the biological quality of the soil, due to greater volumes of carbon and nitrogen (Bayer *et al*., 2004).

In tropical regions such as Cerrado, the agricultural farming systems present low addition of vegetable waste, which results in reduced volumes of organic carbon (Corrazza *et al*., 1999). In such regions the volume of organic carbon in the soil plays an important role in the cationic exchange capacity (CTC) (Oorts *et al*., 2003), contributing with up to 85% of the loads, therefore becoming essential the pursuit for alternatives to increase or keep its volumes. This may be achieved through great addition of organic waste, of vegetable and/or animal origin, such as turkey manure (Pinto *et al*., 2012).

However, there are few studies that have assessed the consequences of applying turkey manure in tropical soils. There is no evidence regarding the capacity of this material to replace chemical fertilization. Therefore, the aim is assessing the effect of total and partial substitution of chemical fertilization with organic fertilization with turkey manure on the chemical attributes of a Rhodic Hapludox and the productivity of soil farming, planted in a tropical region.

MATERIAL AND METHODS

The essay was conducted in an area with the coordinates of 17º 30' 081" S and 52º 44' 299" W, altitude of 898 m, located in Mineiros - Goiás, central region of Brazil, belonging to the Miner Grains Producers' Association. The soil was classified as Rhodic Hapludox, clayey in texture (Embrapa, 2013), which chemical and granulometric characteristics are presented in (Table 1).

Table 1: Chemical and granulometric analysis of the soil, in the depth of 0-20 cm, before the deployment of treatments and soy planting, in Mineiros - GO, in 2012.

MOS	pH	P Resin	K	Ca	Mg	Al	H+Al	SB	CTC[3]	V	clay	silt	sand
g dm^{-3}	$CaCl_2$	mg dm^{-3}	----------	----------	mmol$_c$ dm^{-3}	----------				%	----------	g dm^{-3}	--------
36.0	4.8	12.0	2.1	36.0	14.0	1.0	38.0	52.0	90.0	57.0	500.0	200.0	300.0

MOS: organic material of the soil; Pres: phosphorus resin; SB: sum of bases; CTC: cationic exchange capacity; V: saturation per bases.

The experimental area was planted, more than 20 years ago, with annual crops such as soy, corn, millet and sorghum. It was farmed with soy in the previous summer and with corn in the winter.

The experiment consisted of 6 treatments with 5 repetitions, adopting the random blocks trial design (DBC), with portions of 36 m².

The treatments consisted of different proportions of replacement of chemical fertilization with organic fertilization with turkey manure. The dosage of phosphorus and potassium were based on recommended doses for the central region of Brazil. In this regard, the treatments were control with absence of phosphate fertilizer; chemical fertilization with 400 kg $ha^{-1}$of 2-20-10, 8 kg ha^{-1} of N, 80 kg ha^{-1} of P_2O_5 and 40 kg ha^{-1} of K_2O; use of 2,540 kg ha^{-1} of turkey manure; 5,080 kg ha^{-1} of turkey manure; 50% of chemical fertilization (200 kg ha^{-1}) + 50% of organic fertilization (1,270 kg ha^{-1} of turkey manure); 50% of chemical fertilization + 100% of organic fertilization (2,540 kg ha^{-1} of turkey manure). The implementation of the treatments, applied with broadcast seeding and soy sowing were performed on November 5th, 2012. The entire trial area received top dressing using 60 kg ha-^{1} of K_2O in the form of potassium chloride, 30 days after planting.

The composition of the turkey manure used was 4 % of N, 5% of P and 3.5% de K, with 70% of dry matter, the amounts of nutrients available in the soil are presented in Table 2. The type of soy used in the trial was SYN1080RR, with a space of 0.45 m between lines and stand of 350,552 plants ha^{-1}.

Table 2: Amounts of nutrients (N, P and K) available in the soil due to doses of turkey manure and chemical fertilizer applied.

Treatments	Fertilization kg ha^{-1}	N	P_2O_5	K_2O
		---------- kg ha^{-1} ----------		
Control	--	00	00	60
AQ400	400 (02-20-10)	8	80	40.+60
CP2,540	2540 of Turkey Manure (TM)	71.12	88.9	62.23 +60
CP5,080	5080 of Turkey Manure (TM)	142.24	177.8	124.4.+60
AQ200+CP1,270	200(02-20-10) + 1,270 CP	39.56	84.45	51.11.+60
AQ200+CP2,540	200(02-20-10) + 2,540 CP	75.12	128.9	113.34.+60

Determination of the productivity of soy was carried out 124 days after planting, 4 central rows with 4 meters of length were harvested. Subsequently, humidity was determined and the estimated productivity considered 13% of grain humidity.

The assessment of chemical attributes of the soil was carried out after the harvest of the soy crop, for this purpose 0-0.1 m depth samples were collected with a Dutch auger, 4 simple samples were collected in the inter-row and one in the planting row. Granulometric and chemical analysis of the soil were carried out according to Embrapa (2009), and the anionic resin exchange method was used for phosphorus extraction.

The data was subject to analysis of variance and, when significant, the Tukey test at 5% was applied to compare averages with the support of Sisvar statistic program (Ferreira, 2008).

RESULTS AND DISCUSSION

The large volume of waste generated annually in poultry farming causes a series of impacts on the environment. The use of this waste as fertilizers is a feasible and sustainable alternative in agriculture.

The productivity of soy beans was influenced by different forms of fertilization (Figure 1). The highest productivity was obtained when organic fertilization was adopted, with no dosage reduction. However, this fertilization was not different from the other combinations of chemical and organic fertilization.

The highest productivity was obtained with treatment 6 (200 kg chemical ha^{-1} + 2,540 kg CP ha^{-1}), when compared to the witness, they are possibly due to the larger amount of nutrients in the chemical and organic fertilizers used (Table 2). The similarity of soy productivity in relation to the treatments that used either chemical or organic fertilizers or the mix of both is due to the increased level of nutrients in the area where the trial was installed, except for the element phosphorus, which presented average level (Souza and Lobato, 2004). The same nutrient may have limited the productivity of the witness, as in addition to presenting an average level, the Rhodic Hapludox (Latosoil) of the Center-West region of Brazil tend to adsorb large amounts of phosphorus, even reaching a maximum adsorption capacity of 2,635.7 mg kg^{-1} (Pinto *et al*., 2013).

The largest amounts of organic waste 5,080 kg ha^{-1} were not capable of enhancing soy productivity in comparison with the other treatments that applied chemical, organic or a mix of both fertilizers, however, they did not damaged the soy crop.Availability of nutrients in poultry waste is slower than that of chemical fertilizers, as in these organic fertilizers there are still non-released nutrients even 270 days after their application (Silva *et al*., 2014).

Similar findings were noted by Conte *et al*. (2014) in corn crop, where no differences were noted in corn productivity, fertilized with turkey manure, as well as with the use of chemical fertilizers in direct planting, even applying increasing doses of organic waste.

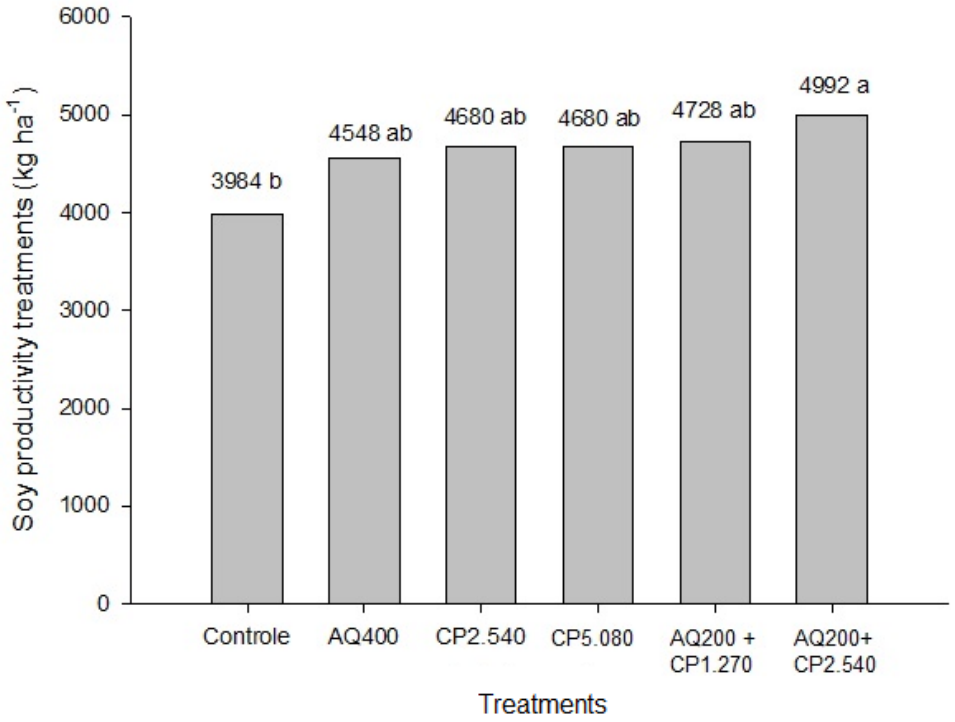

Fig. 1: Productivity of the soy crop in Rhodic Hapludox subject to total and partial replacement of chemical fertilization with organic fertilization with turkey manure.

The levels of phosphorus and potassium in the soil were changed with the adopted treatments (Table 3). The levels of exchangeable P being higher when organic fertilization of 5080 kg ha^{-1} is adopted, with no difference in the levels obtained with fertilization with 80 kg ha^{-1} of P_2O_5 and 2540 kg ha^{-1} of organic waste. Therefore, turkey manure has chemical conditions suitable to be adopted in phosphate fertilization of the soy crop, providing grain productivity and enhanced soil fertility. Similar behavior was obtained for potassium, a

nutrient that presented similar levels also when chemical fertilization was reduced by 50% and organic fertilization was already carried out.

Table 3: Chemical attributes of the soil due to different organic and chemical fertilization systems.

Treatments	pH	P	K	MOS	CTC	V%
		mg dm^{-3}	---------mmolc dm^{-3}--------			
--	5 ^{ns}	10.7 c	1.6 b	40.8 ^{ns}	66 ^{ns}	48.5 ^{ns}
400 (02-20-10)	5.1	23.7 a	2.0 ab	42	70	56
2540 of Turkey Manure (TM)	5.1	19 ab	1.8 b	45	72	52.6
5080 of Turkey Manure (TM)	4.9	26 a	2.8 a	44.8	70.3	53
200(02-20-10) + 1,270 CP	5	13.8 bc	1.9 ab	41.8	67	53.4
200(02-20-10) + 2,540 CP	4.9	15.7 bc	2.1 ab	43	71	49.9

^{NS} Non-significant. *Treatments followed by the same letter are not statistically different by the Tukey test at the level of 5% of probability.

Confirming the present finding, other studies found that using large doses of organic waste deriving from animal production provide increased levels of P. An example of this are the results obtained by Pinto *et al*. (2012) using turkey manure in a pasture area and Scherer *et al*. (2010) with the adoption of pig manure in Rhodic Hapludox and Cambisol, which had their phosphorus level increased in the layer of 0-0.5 m. Therefore, in line with the findings of the present study, it is possible to use an organic source as the source of this important nutrient. This handling is an alternative to fertilize soils with low or even medium level of P in the soil. It may even enable greater availability of this element for soy plantations in tropical soils that present great capacity of retention and availability of phosphorus.

Replacement of chemical fertilization with organic fertilization does not interfere in the levels of P, and also presents similar behavior for potassium (K), and the higher the applied doses of organic waste, the higher levels of these elements may be made available to the soil.

As potassium levels changed significantly when applying 5,080 kg ha^{-1} of turkey manure (2.82 $mmol_c\ dm^{-3}$) in relation to the witness treatment (1.64 $mmol_c\ dm^{-3}$), with a 72% increase in the level of potassium, turkey manure is an alternative agricultural-industrial waste to fertilize soy crops, as it is an efficient organic source of potassium and phosphorus supply. They may partially replace the chemical fertilization adopted in this plantation.

The values of base saturation, pH and levels of organic matter, as well as CTC were not significantly influenced by the treatments (Table 3), probably due to the short time lapse between the application of organic waste to the soil and the assessment. However, contrasting results were found by Costa *et al*. (2008) in similar weather conditions, verifying an increase in the level of MOS with the use of turkey manure, even a short time after the application of the organic waste to the soil. According to Pinto *et al*. (2012) non-plowing the soil and, consequently, non-incorporation of organic waste, promotes a slower mineralization of MOS due to lower exposure of it to microorganisms in the soil, which favors the increase of MOS levels with time.

Conclusions:

The use of organic fertilization with turkey manure was capable of partially replacing the adoption of the chemical fertilizer as source of nutrients for soy crops, providing enhancements in the levels of exchangeable phosphorus and potassium in the soil.

The waste deriving from poultry farming used as organic fertilizer implies a correct destination and reduction of environmental risks, also resulting in soil fertility improvements and, at the same time, enabling the reduction of dependency of chemical fertilizers for soy production.

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