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Pig manure in the production of banana seedlings

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Abstract

Pig breeding generates waste that, if not handled correctly, can cause serious environmental problems. The application of these residues in the soil appears as a sustainable alternative, since the manure, being rich in organic matter and mineral nutrients, promotes the improvement of the physical, chemical and biological quality of the soil avoiding the contamination of natural resources if it is released in the water or directly on the ground without proper treatment. The objective of this study was to evaluate the development of banana seedlings fertigated with pig slurry (PS) analyzing its efficiency compared to conventional treatment (chemical). The experiment was carried out in a completely randomized design with six treatments and six replications (3 seedlings per repetition), the doses being defined based on the fertilizer recommendation for the production of banana seedlings and the nutrient in greater concentration in the manure, which, in this case, was nitrogen, considered as the dose limiter. The results showed that PS was efficient in supplying nutrients to the banana seedlings and it can be used as a substitute for chemical fertilizer. The treatment with manure corresponding to 25.0% of the nitrogen recommended to produce banana seedlings provided the greatest development.
Keywords: Fertigation. *Musa* ssp. Pig waste. Sustainability.

Introduction

The demand for meat in the world is increasing and it is expected to double by 2050 (FAO, 2006). Choi (2007) reports that 40.0% of the meat consumed in the world is pork. According to the Brazilian Animal Protein Association (ABPA, acronym in Portuguese, 2017), Brazil occupies the fourth position in the world ranking of pork production, lagging behind China, the European Union and the United States, which in 2016 produced approximately 53, 23 and 11 million tons of meat, respectively. In the same year, Brazilian production was approximately 3.7 million tons.

This high demand for pork production is directly responsible for the generation of pig slurry (PS), which are characterized by the mixture of faeces, urine, feed waste and washing

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residues, which can cause serious problems of contamination in water, air and soil if thrown into the environment without proper treatment (CERUTTI et al., 2011). Thus, in recent years, due to the pressure exerted by sectors of civil society to contain the contamination of the environment by PS, the main forms of treatment and destination of this waste have been the subject of studies by several researchers (KUNZ et al., 2009).

Because it is a waste that has high levels of organic matter and various nutrients, especially nitrogen, potassium and phosphorus, the PS has the capacity to improve the physical properties and the chemical and biological characteristics of the soil, enabling its use in agriculture as a supplier of nutrients and elements favorable to the development and production of plants (AMIRI; FALLARI, 2009; SCHERER et al., 2007).

Thus, the use of fertigation with PS as a final disposal of this waste is a good alternative, as this effluent has nutrients that can be used in agricultural crops, replacing or reducing the use of chemical fertilizers and, consequently, expenses with fertilizers. In addition, it can prevent contamination of natural resources.

The banana tree is one of the most cultivated crops, being one of the most consumed and produced fruits in the world, also a demanding crop for soils rich in nutrients and organic matter. The main nutrients demanded by the crop are nitrogen and potassium (TUNER; BARKUS, 1980), besides that, it needs a high amount of water and good physical soil conditions. Thus, banana fertigation with PS is a viable alternative for the disposal of this manure as fertilizer.

Given the above, the objective of this study was to evaluate the development of banana seedlings during the acclimatization period, fertigated with different doses of PS, comparing this development with conventional (chemical) treatment and thus verifying the possibility of using PS in the production of banana tree seedlings.

Material and methods

The experiment was conducted in a greenhouse located at the Federal Institute of Triângulo Mineiro (IFTM, in Portuguese) – Uberlandia campus, located in the city of Uberlandia, state of Minas Gerais, Brazil, whose geographic coordinates are: 18°45'54.17" south latitude and 48°17'19.28" west longitude, with an average altitude of 660 meters.

The climate of the municipality of Uberlandia, according to Köppen (1948), is of the Cwa type (Tropical climate), with two well-defined seasons: rainy season, from October to April; and the dry period, from May to September. The average atmospheric precipitation is around 1,540 mm and has an average annual temperature of 22.9 °C.

The PS was obtained from the pig farm of the IFTM - campus Uberlândia, being collected in the settling pond. In order to obtain a representative sample, the PS was collected in an integrated manner with samples in different positions in relation to the width, length and depth of the pond, to determine its average composition or total load. The collection was carried out with a bucket and other safety equipment.

The PS dosages used in each treatment were based on the nutritional (chemical) recommendation for conducting banana seedlings and the nutrient with the highest concentration in the PS, which in this case was nitrogen, was a limiting element in the dosage. Thus, at the beginning of the experiment, its chemical characterization was carried out, with the following parameters being determined: pH, density, organic matter, organic carbon, total nitrogen, C/N ratio, total phosphorus, water-soluble potassium, calcium, magnesium, sulfur, sodium, boron, copper, iron, manganese and

zinc. The characterization of swine manure was carried out at FERLAB® Agricultural Laboratory, located in the municipality of Araguari/MG, following the recommendations of the Standard Methods for the Examination of Water and Wastewater from the American Public Health Association (2005). The average chemical composition of PS is shown in Table 1.

Table 1 – Chemical characterization of pig slurry (PS) from Sobradinho farm – Uberlândia –MG

Determination	Unity	Result
pH index	pH	7.00
Density	g/L	0.99
Organic Matter	%	0.09
Organic Carbon (C)	%	0.05
Total Nitrogen (N)	%	0.35
C/N Ratio	%	0.14
Total Phosphorus (P_2O_5)	%	0.07
Water-soluble Potassium (K_2O)	%	0.18
Calcium (Ca)	%	0.11
Magnesium (Mg)	%	0.03
Sulfur (S)	%	0.00
Sodium (Na)	mg/L	140.00
Boron (B)	mg/L	0.84
Copper (Cu)	mg/L	25.00
Iron (Fe)	mg/L	20.00
Manganese (Mn)	mg/L	9.00
Zinc (Zn)	mg/L	7.00

Source: Elaborated by the authors (2019).

The micropropagated banana seedlings (*Musa* spp.) used in this research were from the cultivar BRS Platina and they were acquired in the commercial nursery Multiplantas Tecnologia Vegetal Ltda®, in April 2017. They were stored in plastic containers with a capacity of three liters of substrate in the greenhouse. The substrate was composed of soil and sand in a 2:1 ratio. The initial chemical composition of the substrate is shown in Table 2.

Table 2 – Chemical composition of the substrate.

pH	P	K	Ca	Mg	Al	S.B	T	V	B	Cu	Fe	Mn	Zn
H_2O	mg dm^{-3}				$cmol_c$ dm^{-3}			%			mg dm^{-3}		
6.4	111	48	9.8	2.8	0	12.7	14.3	89	0.15	1.1	8	1.1	0.2

P = Mehlich Method 1, P. K. Na = [HCl 0.05 mol L^{-1} + H_2SO_4 0.0125 mol L^{-1}], S-SO_4 = [Monobasic Calcium Phosphate 0,01 mol L^{-1}], Ca, Mg, Al = [KCL 1 mol L^{-1}] / H + Al = [Buffer Solution SMP at pH 7,5], M.O. = Colorimetric Method, S.B= Base sum, V = Base saturation; T = CIC pH 7,0;

Source: Elaborated by the authors (2019).

The PS dose was determined in proportion to the chemical fertilizer dose recommended in the production of banana seedlings in Brazil, which is 5.0 kg m^{-3} of NPK substrate (NOMURA et al., 2009),

being that the treatments corresponded to 100.0%, 75.0%, 50.0%, 25.0% and 0% of the nitrogen dose recommended for banana cultivation (this being the nutrient in greater proportion in PS) and the sixth treatment consisted of 100.0% of the fertilizer dose applied in the chemical fertilizer formula NPK 14:14:14. The experiment was conducted in a completely randomized design with 6 treatments and 6 replications. Table 3 shows a summary of treatments.

Table 3 – Treatments and doses of PS and chemical fertilizer used in the experiment

Treatment	% of the recommended fertilizer dose[1]
PS -0	0.0
PS -25	25.0
PS -50	50.0
PS -75	75.0
PS -100	100.0
Chemical - Subject	Fertilizer 14-14-14

[1]Dose calculated based on the recommendation of 5.0kg of N m^{-3} and the chemical composition of PS.

Source: Elaborated by the authors (2019).

After determining the dosages, PS was applied in installments every 15 days for better use of manure by the plants, in the total period of 60 days. The seedlings were kept in the field capacity during the time they remained in the greenhouse.

Throughout the experiment, the following variables were evaluated: the height of the seedlings with the aid of a graduated ruler; the number of leaves; and the diameter of the pseudostem using a digital caliper. For the data of these evaluations, the general averages of each treatment and the average increments of development were calculated, which refer to the average of the results at the end of the experiment, less the average data found at the beginning of the experiment.

At the end of the experimental period, the fresh and dry mass of the banana seedlings were evaluated, and chemical analyzes of the substrates of the treatments were performed to verify if there were changes in their chemical attributes.

The results obtained related to the development of the plants were submitted to the analysis of variance test at 5.0% probability and, when they presented statistical difference, they were submitted to the Dunnett test at 5.0% significance, comparing the doses of PS to the standard chemical fertilizer, using the Assistat® program (SILVA; AZEVEDO, 2016). The results of increment of dry and fresh matter within the treatments only with PS and the treatments of PS with the best result were subjected to analysis of variance with a probability of 5% and, when they presented statistical difference, they were submitted to regression analysis, through the SISVAR® program (FERREIRA, 2014).

Results e discussion

There was a significant difference between the use of PS and the standard chemical fertilizer. The treatment that stood out in relation to the chemical treatment (subject) was 25.0% of the chemical fertilizer dose, which, at the end of the experiment, provided higher averages of height, diameter and number of leaves and, consequently, a greater increase of these attributes over the studied period, as can be seen in Table 4.

Table 4 – Morphological development of banana seedlings (*Musa* spp.) fertigated with PS compared to chemical fertilization

Treatment	Morphological Development					
	Height (cm)		Diameter (mm)		Nº of Leaves	
	Average	Increase	Average	Increase	Average	Increase
PS – 0	14.44	7.21	14.16	5.91	4.42	0.80
PS – 25.0%	18.56*	11.64*	18.93*	11.39**	7.27**	3.00*
PS – 50.0%	15.94	9.61	14.90	7.18	5.53	1.52
PS – 75.0%	15.48	8.84	16.44	8.02	6.55**	2.38*
PS – 100.0%	15.09	8.92	14.92	7.22	6.33**	2.22*
Chemical (subject)	15.44	8.83	14.58	6.92	4.44	0.33
CV[1]	18.66	39.48	15.07	33.08	21.13	35.98

** significant at the 1% probability level and * significant at the 5% level of significance by the Dunnett Test (bilateral) in relation to the chemical subject. 1- coefficient of variation.

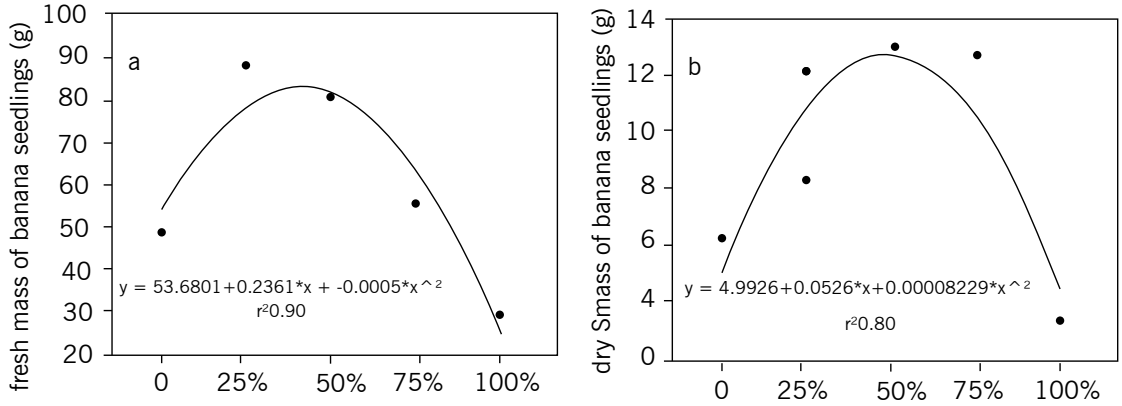
Source: Elaborated by the authors (2019).

As for the number of leaves, there was a similar behavior between treatments PS (25.0%), PS (75.0%) and PS (100.0%), with increments higher than the subject, and the final average of the number of leaves was also higher in these treatments. Again, there was an emphasis on seedlings belonging to the PS 25.0% treatment, which at the end of the study reached an average of 7.27 leaves per seedling, with an increase of 3 leaves in relation to the initial evaluation. In contrast, in seedlings that received chemical treatment, there was an average increase of less than half a leaf per seedling (033 leaves), reinforcing the greatest advantage of the PS treatment (25.0%) in the development of the seedlings.

The initial development of seedlings also leads to greater photosynthetic activity and, consequently, a more vigorous seedling and a greater possibility of adaptation to the field, leading to greater initial productivity. Zenatti et al. (2012) concluded that the application of PS in the culture of Tifton 85 enabled greater production when compared to the use of other fertilizers, among them, the chemical fertilizer.

The application of increasing doses of PS in the fertigation of banana seedlings caused a peak in the accumulation of fresh and dry matter. However, as the PS dose increased, there was a severe drop in this accumulation (FIGURE 1). As the substrate used in the experiment was rich in nutrients (TABLE 2), the excess of some of these nutrients may have caused an imbalance in the absorption of the others (NOVAIS et al., 2007). However, the substrates of the different treatments with application of PS, at the end of the study, did not show significant difference in their chemical attributes in relation to the initial substrate. Thus, there was no significant change in the conditions of the substrate at the time the experiment was conducted.

Figure 1 – Accumulation of fresh (a) and dry matter (b) due to the increase in the applied dose of PS.

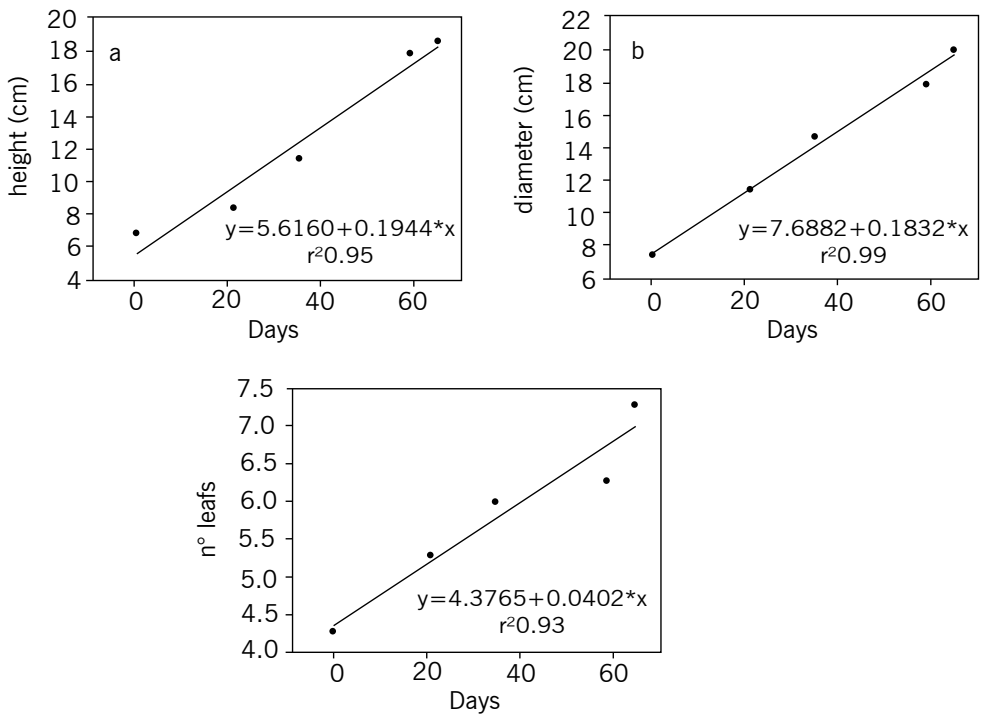


Source: Elaborated by the authors (2019).

The dose of PS that provides the greatest benefits to cultures is very uncertain. In a study conducted in southern Brazil by Lourenzi (2014) with several cultures (corn, beans, oats, millet, sunnhemp and vetch), there was an oscillation of more than 400% in the dose that provided the best development between cultures. The authors also emphasize that the best dose also depends on the stage of development of the cultures.

In the initial conduction of micropropagated banana seedlings (*Musa* spp.) of the BRS Platina variety, the best treatment was the PS (25.0%) which provided a very linear growth during the 60 days of acclimatization in a greenhouse (Figure 2).

Figure 2 – Equations and regression model throughout the experiment considering the PS treatment – 25.0% for the evaluated characteristics: A - height (cm); B - diameter (mm); C - number of leaves.



Source: Elaborated by the authors (2019).

During the 60-day period, with only 25.0% of the recommended dose of N for conducting seedlings, when produced with chemical fertilizer, it was possible to obtain banana seedlings with better morphological characteristics (TABLE 4). This way, the use of PS as a fertilizer certainly contributes to the correct disposal of manure and to the production of quality banana seedlings.

In addition to this benefit, fertigation with PS can anticipate the production of seedlings, since in the treatment of PS (25.0%) they have developed in a much more pronounced way. Similar results have also been observed in a study conducted with Eucalyptus seedlings, in which the seedlings were anticipated by approximately 30 days using PS (PELISSARI et al., 2009). This anticipation is yet another benefit of using PS in the production of banana seedlings, as these, growing faster, can be transported earlier to the field and, consequently, optimize the use of greenhouses.

The results obtained show the importance of intensifying studies with the use of PS in order to know its behavior in the soil-plant system. In this study, in which a substrate with good fertility was used, it was observed that the lowest dose was the one that provided the greatest development. Further studies in different substrate, climate and management conditions are necessary for a better understanding of the benefits of using PS in acclimatizing banana seedlings.

Conclusion

The PS was efficient in supplying nutrients to the banana seedlings and can be used instead of chemical fertilizers.

The dose of PS that represents 25.0% of the nitrogen dose of the chemical fertilizer was the one that provided the best development conditions for the banana seedlings during the acclimatization period.

Dejeto de suínos na produção de mudas de bananeiras

Resumo

A criação de suínos gera resíduos que, se não manejados corretamente, podem causar sérios problemas ambientais. A aplicação destes resíduos no solo surge como uma alternativa sustentável, uma vez que o dejeto, por ser rico em matéria orgânica e em nutrientes minerais, promove a melhoria da qualidade física, química e biológica do solo, evitando a contaminação dos recursos naturais, caso seja lançado na água ou no solo diretamente sem tratamento adequado. Assim, o objetivo deste trabalho foi avaliar o desenvolvimento de mudas de bananeiras fertirrigadas com dejeto líquido de suínos (DLS), analisando sua eficiência em comparação com o tratamento convencional (químico). O experimento foi realizado em delineamento inteiramente casualizado com seis tratamentos e seis repetições (3 mudas por repetição), sendo as doses definidas com base na recomendação de fertilizante para a produção de mudas de bananeiras e o nutriente em maior concentração no dejeto, que, neste caso, foi o nitrogênio, considerado como o limitante da dose. Os resultados mostraram que o DLS foi eficiente no fornecimento de nutrientes para as mudas de bananeira, podendo ser utilizado como substituto do fertilizante químico. O tratamento com dejeto correspondente a 25,0% do nitrogênio recomendado para a produção de mudas de bananeira foi o tratamento que proporcionou o maior desenvolvimento das mudas de bananeira.

Palavras-chave: *Musa* ssp. Resíduos de suíno. Fertirrigação. Sustentabilidade.

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