ISSN 0798 1015

REVISTA ESPACIOS

Vol. 38 (Nº 41) Año 2017. Pág. 23

Swine biosolids in initial growth of eucalyptus

Biosólidos suínos no crescimento inicial do eucalipto

Lígia Gabriela de Sá VANIN [1]; Joiran Luiz MAGALHÃES [2]; Arthur Almeida RODRIGUES [3]; June Faria Scherrer MENEZES [4]; Gustavo Andre SIMON [5]; Melissa Selaysim DI CAMPOS [6]; Daniela Borges do Couto MAGALHÃES [7]

Recibido: 06/04/2017 • Aprobado: 28/04/2017

Contents

ABSTRACT:
The large amount of waste generated by swine production in Brazil has become a problem in relation to its adequate destination. The aim of this study was to compare the use of swine biosolids with inorganic fertilizers in the initial growth of Urograndis 3241 (GG100), an eucalyptus clone, as alternative source of the final destination of this residue. The experiment was conducted in a completely randomized design, with 5 treatments and 3 replicates, at concentrations of 0; 3.8; 7.6; 15.2% and inorganic fertilizer. The irrigation was performed with water from artesian well, and the volume of water was added according to plants needs. After 120 days of transplanting, plant height, leaf diameter, leaf area, shoot and root dry mass, total dry mass, root and total dry mass ratio were evaluated. The increase in swine biosolids doses promoted a reduction in root and total dry mass ratio and increased plant height, stem diameter, shoot fresh mass, shoot, root and total dry mass. The application of inorganic fertilizer did not differ from the treatments with swine biosolids. Eucalyptus initial growth was not affected by swine biosolids. Eucalyptus fertilization with swine sludge is a viable alternative for the final destination of this residue, providing an increase in the agronomic traits of plants.
Keywords: organic fertilization, mineral fertilization, swine sludge, waste.

RESUMO:
A grande quantidade de resíduos gerados pela produção suína no Brasil tornou-se um problema em relação ao seu destino adequado. O objetivo deste estudo foi comparar o uso de biosólidos suínos com fertilizantes inorgânicos no crescimento inicial do urograndis 3241 (GG100), um clone de eucalipto, como fonte alternativa do destino final deste resíduo. O experimento foi conduzido em um projeto completamente randomizado, com 5 tratamentos e 3 replicações, em concentrações de 0; 3,8; 7,6; 15,2% e fertilizante inorgânico. A irrigação foi realizada com água do poço de artes, e o volume de água foi adicionado de acordo com as necessidades das plantas. Após 120 dias de transplante, altura da planta, diâmetro da folha, área da folha, tiro e massa seca da raiz, massa seca total, raiz e relação de massa seca total foram avaliados. O aumento das doses de biosólidos suínos promoveu uma redução da proporção de massa seca e total da raiz e aumento da altura da planta, diâmetro da haste, tiro de massa fresca, tiro, raiz e massa seca total. A aplicação do fertilizante inorgânico não diferiu dos tratamentos com biosólidos suínos. O crescimento inicial do eucalipto não foi afetado por biosólidos suínos. A fertilização do eucalipto com lama suína é uma alternativa viável para o destino final deste resíduo, proporcionando um aumento nas características agrárias das plantas.
Palavras-chave: fertilização orgânica, fertilização mineral, lodo suíno, resíduos.

1. Introduction

Brazil is one of the largest pig producers in the world. In 2015, approximately 3.6 million tons of pork were produced (ABPA, 2016). In this context, Goiás is the fourth greatest pork producer in the country and represents 9.5% of pork exports (ABPA, 2016).

The increase in pork production is directly related to waste generation, so it is necessary to properly allocate this waste (Andreazzi et al., 2015). Swine production is known as an agricultural activity of high impact on the environment (Rizzoni et al., 2012), since pig manure has pollution potential. Swine manure consists of feces, urine, water wasted by drinkers, sanitation water, food waste, animal dander, dust, etc. (Rizzoni et al., 2012). A strategy to minimize environmental impacts is the reuse through stabilization of organic matter and reutilization as organic fertilizer (Amorim et al., 2005; Sediyama et al., 2008).

The use of swine biosolids represents the possibility of associating gains to forester and producer, increasing crop yield and reducing the application of inorganic fertilizers (Pelissari et al., 2009). Besides providing nutrients for crops, organic fertilizers also provide organic matter to improve physical, chemical and biological properties of soil (Souza et al., 2006).

Organic fertilization is an efficient alternative that can be associated in forest species, mainly species of the genus *Eucalyptus*, allowing its cultivation in different climates and types of soils. Eucalyptus present rapid growth, which favors yield (Poggiani, 2004; Lima, 2005; Silveira, 2008). *Urograndis* is the most used hybrid of eucalyptus species, which allows the union of the characteristics for segregating generation of *E.Urophylla* and *E. Grandis* (Muro_Abad, 2000).

Considering the importance of eucalyptus hybrid and the fertilizer potential of swine biosolids, this work aimed at analyzing the use of swine biosolids in concentrations of: 0; 3.8; 7.6; 15.2% and inorganic fertilizer in the initial growth of *Urograndis* 3241 (GG100), an eucalyptus clone.

2. Materials and Methods

The experiment was carried out at the University of Rio Verde (Campus Fazenda Fontes do Saber), 50°57'59' 'W and 17°46'30'' S with average altitude of 784 m.

The soil, classified as medium-textured dystrophic red latosol (EMBRAPA 1997), was collected at a depth of 0-20 cm, and its fertility was characterized before the beginning of the experiment, following the methodologies proposed by Silva (2009) (Table 1).

Table 1. Characteristics of dystrofic red latosol. Fazenda Fontes do saber. Rio Verde – Goiás. 2012.

pH	Ca	Mg	Al H+Al	K	K	PMel	S	O.M
$CaCl^2$	---------------- cmolc dm^{-3} --------------------				-------- mg dm^{-3} ---------			g dm^{-3}
5.10	0.73	0.23	0.04 2.8	0.05	19.6	3.07	16.73	20
B		Fe	Mn	Zn	Co		Na	Cu
---------------- mg dm^{-3} ------------------								
0.23		62.85	14.83	0.57	1.44		2.0	4.60

Stabilized swine biosolids were collected from a piglet production farm at the University of Rio Verde and determinations of chemical characteristics were performed by the UniRV soil laboratory using the methodologies described by Malavolta et al. (1997) (Table 2).

Table 2. Chemical characteristics and swine biosolids density. University of Rio Verde - Goiás.

N	**P**	**K**	**Ca**	**Mg**	**S(SO4)**
g kg^{-1}					
24.5	91.5	10.2	55.5	7.0	4.9
Fe	Mn	Cu	Zn		Density
g kg^{-1}					**kg dm^{-3}**
5.02	1.19	0.56	1.30		0.45

The experiment was conducted in an unprotected experimental area, using pots with capacity of 18 dm filled with 15 kg of soil and lasts for 120 days.

The experiment was performed in a complete randomized design with five treatments: four doses of swine biosolids 0, 0.57, 1.14 and 2.28 kg per pot which corresponds to 0, 3.8, 7.6 and 15.2% of the substrate composition and 200 g of inorganic fertilizer in NPK formulation 4:30:10 and a control treatment (without fertilization) in three replicates. Each plot consisted of five pots containing a 3-month-old eucalyptus hybrid seedling *Urograndis* 3281 (GG 100).

The application of biosolids and inorganic fertilizer in the soil was performed with the aid of trays. They were homogenized manually with spatula and returned to the pots. The amounts of N, P and K applied in each treatment are shown in Figure 1.

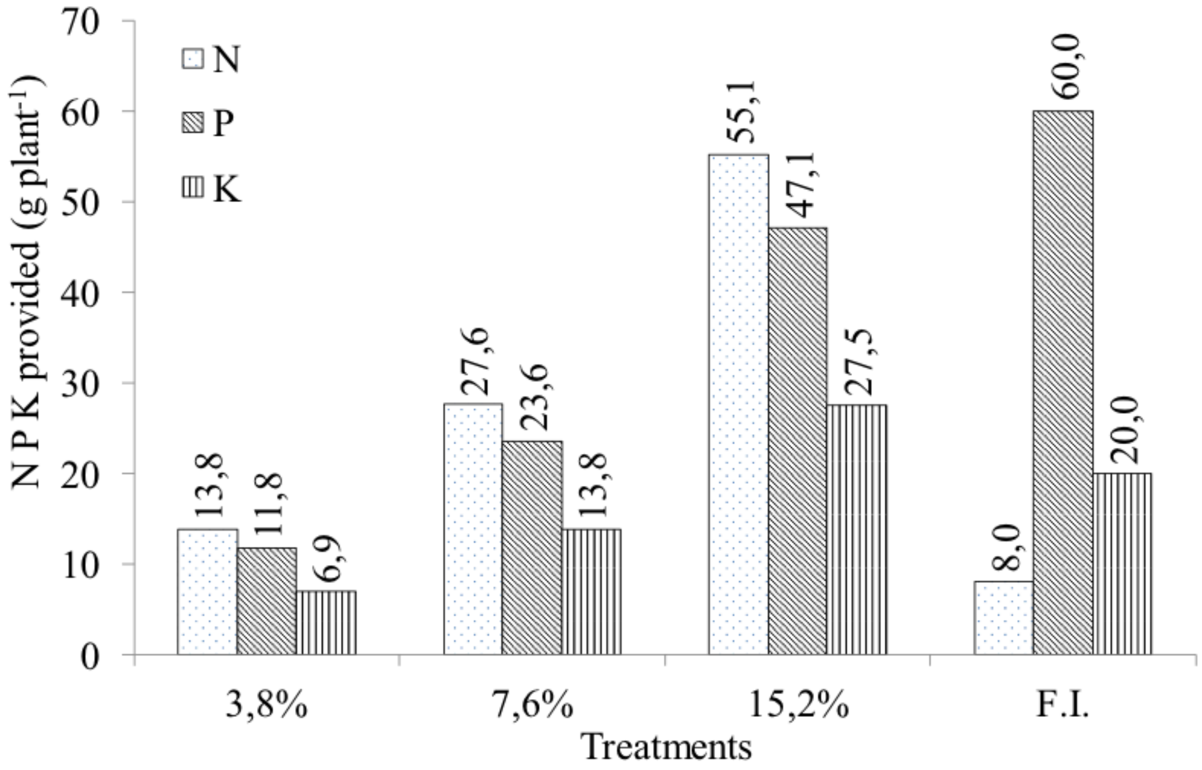


Figure 1. Quantities of nitrogen (N), phosphorus (P) and potassium (K) available in each treatment calculated from data in table 2.

Irrigation was performed daily, using water from an artesian well with initial volume of 250 mL adjusted according to plants needs. From the 1st to the 75th day the volume was 250 mL, 350 mL from the 76th to the 85th day, 450 mL from the 86th to the 99th day and 500 mL from the 100th to the 120th day of the experiment.

After 120 days, the following characteristics were evaluated by sampling five plants per plot: plant height and stem diameter. Sampling two plants per plot: leaf area, shoot fresh mass, shoot dry mass, root dry mass, total dry mass, root and total dry mass ratio.

Plant height (AP) was determined in cm using a measuring tape from soil surface to the plant apex. Stem diameter (SD) was calculated with a digital caliper. Leaf area was expressed as cm^2, determined by scanning the leaves of each plant and processing the images in the program "QuantROOT version 1.0" - (UFV). For the evaluation of fresh mass (FM), shoot part was weighed in a digital scale of two decimal places. Shoot dry mass (SDM) was packed in Kraft paper bags and taken to induced air circulation oven at 65oC until constant weight. Subsequently, the material was weighed in a precision balance of 0.01 g. Through running water, roots and soil were separated and root dry mass (RDM) was determined. The material was packed in kraft paper bags and transferred to induced air circulation oven at 65°C until constant weight. Total dry mass (TDM) was calculated by the sum of SDM, RDM and RDM / TDM ratio.

Data were submitted to statistical analysis using mean comparison test for all treatments and regression for quantitative treatments with equidistant values (0, 3.8, 7.6 and 15.2%) through SISVAR program (Ferreira, 2011).

3. Results

Plant height, stem diameter, shoot fresh mass, shoot dry mass and root dry mass of eucalyptus were greater with the application of biosolids compared to the control treatment. Mainly in treatment with 15.2% of swine biosolids.

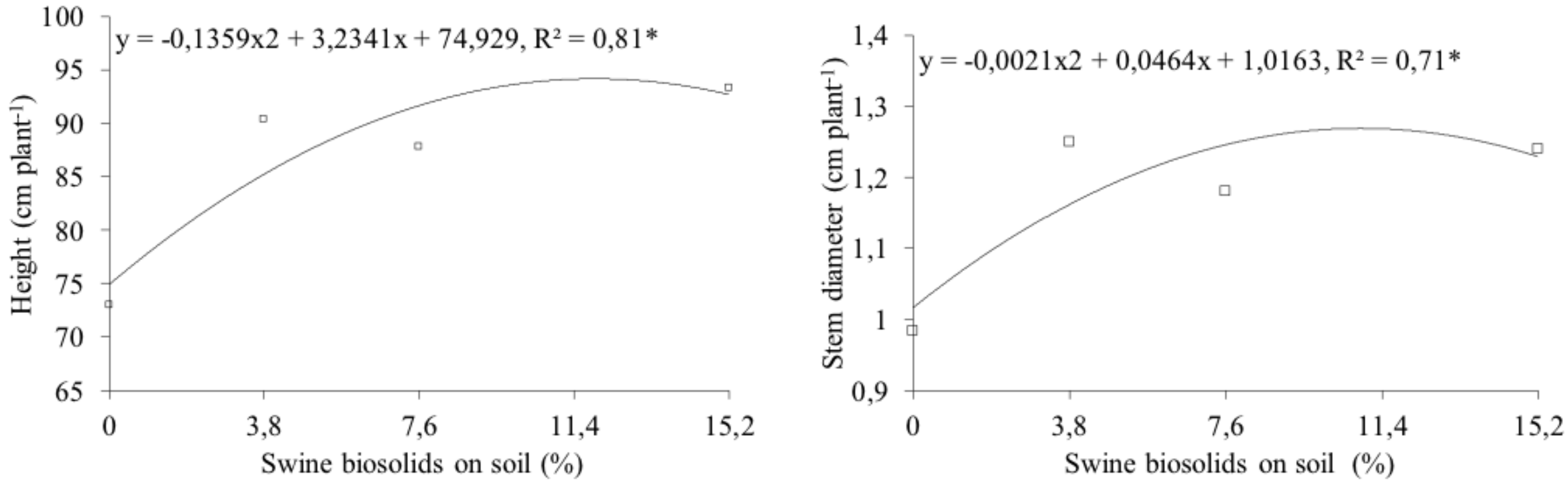
Root and total dry mass ratio showed a different result when compared to the other characteristics. The control treatment was superior than the others (Table 3). There were no differences regarding the use of inorganic fertilizer in comparison to organic fertilization for the evaluated traits.

Table 3. Mean values of plant height (PH), stem diameter (SD), leaf area (LA), shoot fresh mass (SFM), shoot dry mass (SDM), root dry mass (RDM), total dry mass (TDM) and root and total dry mass ratio (RDM /TDM) and moisture (M) of eucalyptus seedlings according to soil dilutions of swine biosolids in comparison with inorganic fertilizer (IF).

Dilution	PH	SD	LA	SFM	SDM	RDM	TDM	RDM/TDM
Control	73,00b	0,98b	20,7b	92,8b	37,9c	17,5b	55,5c	0,31a
3,8%	90,40a	1,25a	46,9a	243,4a	68,5b	19,9b	88,4b	0,22b
7,6%	87,80a	1,18ab	46,8a	237,3a	84,2a	22,7b	106,9ab	0,21b
15,2%	93,33a	1,24a	57,4a	253,6a	89,3a	30,3a	119,6a	0,25b
IF	87,67a	1,31a	56,7a	233,6a	76,7ab	22,9 ab	99,5ab	0,23b

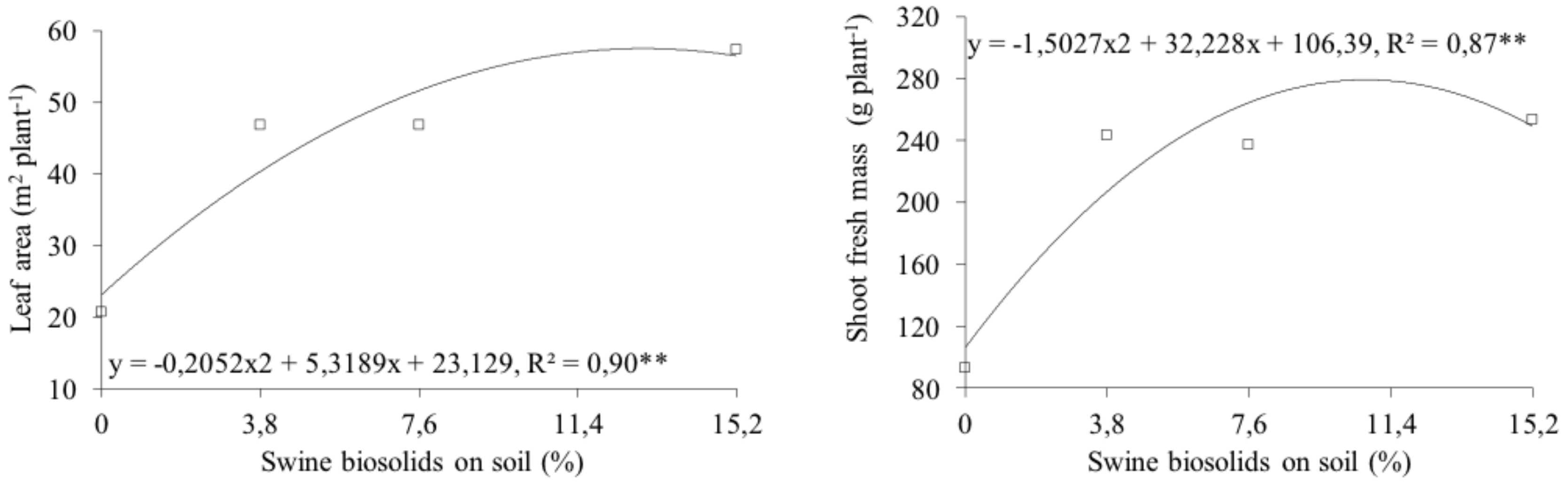
Means followed by the same lowercase letter in the column do not differ significantly from each other by Tukey test at 5% probability

Increasing doses of swine biosolids, there was an increase in plant height, stem diameter, leaf area, shoot fresh mass, shoot dry mass and root dry mass (Figure 2).



c

d



e

f

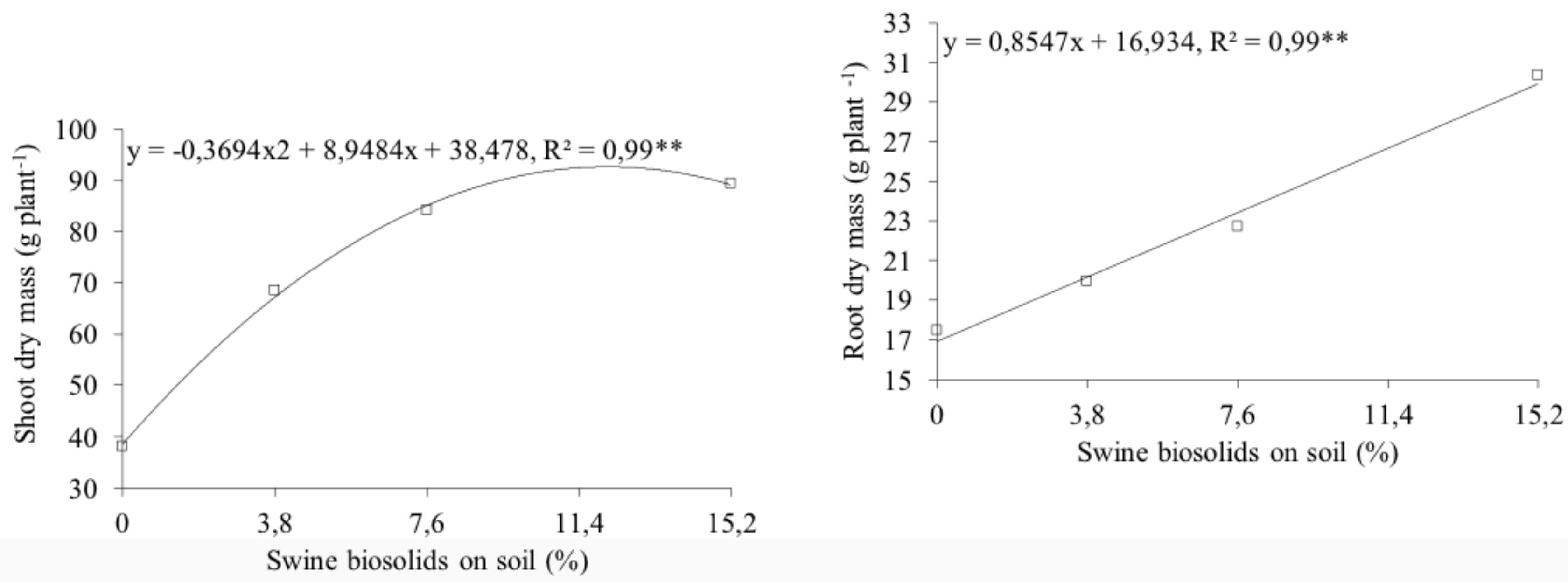


Figure 2 Regression equations for plant height (a), stem diameter (b), leaf area (c), shoot fresh mass (d), shoot dry mass (e), root dry mass (f), according to doses of swine biosolids. **, *, significant at 1% and 5% probability respectively by test F. P ≤ 0.01 and p ≤ 0.05, respectively.

Total dry mass increased with the increase of swine biosolids doses (Figure 3a). Root and total dry mass ratio decreased with the increase of biosolids, showing that control plants had most of their total mass in the root system when compared to the other treatments (Figure 3b).

a

b

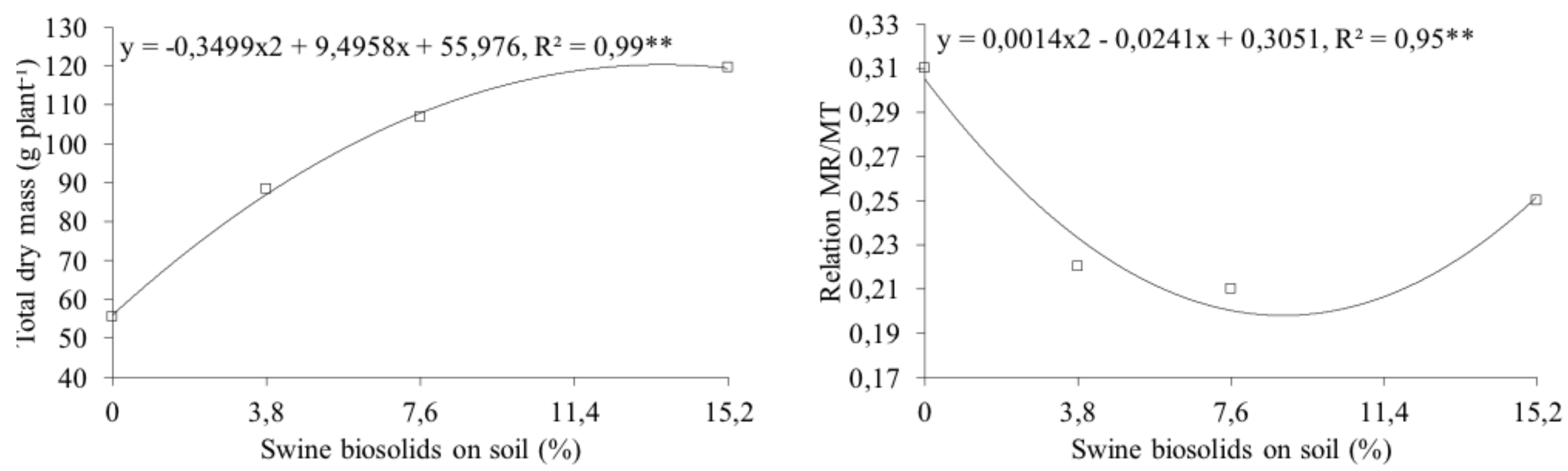


Figure 3 Regression equations for total dry mass (a), root and total dry mass ratio, according to biosolids doses.
** significant at 1% probability by F test. ($p \leq 0,01$).

4. Discussion

During the experiment, there was no plant mortality, evidencing the non-phytotoxicity of swine biosolids. Applying swine sludge in *Urograndis* eucalyptus (AEC 1528), Ribeiro et al. (2015) documented an increase in plant height, fresh mass and dry mass.

In general, swine biosolids present high nutrient content with high concentrations of nitrogen and potassium, exceeding the levels of these nutrients in chemical fertilizers. Swine biosolids associated with soil can provide improvements in plant growth and development. Freier et al. (2006) observed that increasing biosolids doses there were positive effects on eucalyptus seedlings, increasing height, stem diameter, leaf area, number of leaves and shoot dry mass of *E. citriodora* seedlings cultivated in pots.

Swine biosolids can be associated with other fertilizers as nutrient source for plants at low costs. Studying the feasibility of using biosolids as substrate component for the production of eucalyptus seedlings, Trigueiro and Guerrini (2003) observed that the use of 50% biosolids in the substrate composition promoted seedling growth similar to treatment with commercial substrate. The association of swine biosolids with inorganic fertilizers also showed positive results (Silva et al., 2003; Faustino et al., 2005).

The use of organic waste with agricultural potential can be an alternative for farmers. According to Magalhães et al., (2016), there were gains in quality of seedlings irrigated with different wastewater from sewage treatment.

Although treatments with swine biosolids present lower root and total dry mass ratio, it is believed that the high nutrient content found in this residue is associated with the lower proportion of root compared to the shoot part. As swine biosolid doses increased, there was less root development, saving energy to obtain nutrients. Plants present lower root growth with high availability of nutrients in the soil layer close to the surface (Pittker, 2000).

Swine biosolids present advantages for agricultural and forestry purposes as total or partial replacement of inorganic correctives and fertilizers, mainly N, P, K and Zn, depending on the type, dose and chemical composition of the organic residue (Abreu Junior et al., 2005; Ribeiro et al., 2015). Another alternative for biosolids is their use as substrate, since swine biosolids represent the possibility of associating gains to silviculturist and producer, by increasing crop yield and reducing the use of inorganic fertilizers. It results in benefits to the ones that produce these biosolids and effluents since there are adequate and more economical methods of final disposal (Souza et al., 2006; Pelissari et al., 2009).

In recent years, the acceptance of the use of biosolids in forest systems has been growing, mainly due to research results that have developed the theoretical and practical basis for environmentally acceptable management. This has contributed to the rational disposition of this biosolids in soil, which helps to increase soil fertility (Smith and Carnus, 1997).

5. Conclusions

The increase in doses of swine biosolids in soil promoted a reduction in root and total dry mass ratio; increase in plant height, stem diameter, shoot fresh mass, shoot dry mass, root dry mass and total dry mass of 120-day old eucalyptus.

Inorganic fertilization and swine biosolids present similar influence on the evaluated variables.

Doses of swine biosolids did not affect the development of eucalyptus plants.

Eucalyptus crops are a viable alternative to the final destination of swine biosolids, with an increase in agronomic traits.

References

ABPA. Relatorio annual de 2016. Associação Brasileira de Proteína Animal. 2016. Disponivel em http://abpabr.com.br/storage/files/versao_final_para_envio_digital_1925a_final_abpa_relatorio_anual_2016_portugues_web1.pdf. acesso em 04 de fevereiro de 2017.

Abreu Junior, C. H., Boaretto, A. E., Muraoka, T., Kiehl, J. C. (2005). Uso agrícola de resíduos orgânicos potencialmente poluentes: propriedades químicas do solo e produção vegetal. **Revista Brasileira de Ciência do Solo** n 4, p 391-470.

Amorim, A. C.; Lucas Júnior, J.; Resende, K. T. (2005). Compostagem e vermicompostagem de dejetos de caprinos: Efeito das estações do ano. **Engenharia Agrícola**, v.25, n.1, p.57-66.

Andreazzi, M. A., DOS Santos, J.M.G., Lazaretti, R. M. J. (2015). Destinação dos resíduos da suinocultura em granjas das regiões noroeste e sudoeste do Paraná. **Revista Eletrônica em Gestão, Educação e Tecnologia Ambiental**, v. 19, n. 3, set-dez. 2015, p. 744-751.

EMBRAPA. Centro Nacional de Pesquisa de Solos. (1997). **Manual de métodos de análise de solos**. 2. ed. rev. atua1. Rio de Janeiro. 212 p.

Faustino, R., Kato, M.T., Florência, L., Gavazza, S. (2005). Lodo de esgoto como substrato para produção de mudas de *Senna siamea* Lam. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.9, p.278-282. 2005.

Ferreira, D. F. SISVAR. (2011). a computer statistical analysis system. **Ciência e Agrotecnologia**, v.35, n.6, p.1039-1042.

Freier, M; Malavasi, U. C.; Malavasi, M. M. (2006). Efeito da aplicação de biossólido no crescimento inicial de *Eucalyptus citriodora* Hook. **Revista de Ciências Agroveterinárias**, v.05 n.02, p.102-107.

Lima, I.L. Influência do desbaste e da adubação na qualidade da madeira de Eucalyptus grandis Hill ex Maidem.. 137p. 2005 Tese (Doutorado em Recursos Florestais) - Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Piracicaba.

Magalhães, J. L., Simon, G. A., Menezes, J. F. S., Rodrigues, A. A., Azambuja, U. S., Rodrigues, D. A., Costa, A. C. S. (2016). Growth of eucalyptus seedlings irrigated with different wastewaters. **African Journal of agricultural research**. Vol. 11(46), pp. 4779-4785. 2016 Doi: 10.5897/AJAR2016.11869.

Malavolta, E.; Vitti, G. C.; Oliveira, S. A. (1997). **Avaliação do estado nutricional das plantas: princípios e aplicações**. 2. ed. Piracicaba: POTAFOS. 319p.

Muro_Abad, J. I. **Método de melhoramento, assistido por marcadores moleculares, visando à obtenção de híbridos de** *Eucalyptus* spp. 2000. 74p. Dissertação (Mestrado em Genética e Melhoramento), Universidade Federal de Viçosa. Viçosa-MG. 2000.

Pelissari, R. A.Z., Sampaio, S. C., Gomes, S. D., Crepalli, M. S., (2009). Lodo têxtil e água residuária da suinocultura na produção de mudas de *Eucalyptus grandis* (W, Hill ex Maiden). **Engenharia Agrícola**, Jaboticabal, v.29, n.2, p.288-300. 2009.

Poggiani, F. (2004). Características do sistema radicular das árvores de *Eucalyptus grandis* em resposta à aplicação de doses crescentes de biossólido. **Scientia Florestalis**, v.65, p.207-218. 2004.

Põttker, D. (2000). Recentes avanços no manejo químico do solo para a cultura do milho. In: Sandini, I. E.; Fancelli, A L. Milho: estratégias de manejo para a região sul. Guarapuava: **Fundação Agrária de Pesquisa Agropecuária**. p. 63-88.

Ribeiro, E. P., Magalhães, J. L., Rodrigues, A. A., Rodrigues, D. A., Frazão, M. A., Rodrigues, C. L. (2015).Análise inicial do super clone de eucalipto adubado com lodo de efluente suíno. **Pesquisa florestal brasileira**, Colombo, v. 35, n. 84, p. 399-407, out/dez. Doi:10.4336/2015.pfb.35.84.913.

Rizzoni, L.B., Tobias, A.C.T., Bianchi, M., Garcia, J.A.D., (2012). Biodigestão anaeróbia no tratamento de dejetos de suínos. **Revista Científica Eletrônica de Medicina Veterinária**, Garça.

Sediyama, M.A.N., Vidigal, S. M., Pedrosa, M.W., Pinto, C.L.O., Salgado, P.L.T., (2008). Fermentação de esterco de suínos para uso como adubo organic. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.12, n.6, p.638–644.

Silva, E.P., Mota, S., Aquino, B. F., (2003). Potential of the use of slude from textile industry wwtp as agricultural fertilizer. **Engenharia Sanitária e Ambiental**, v.8, n.1, p.69-76.

Silva, F.C.da. **Análise química de tecido vegetal**. In: Manual de Análises Químicas de Solo, Plantas e Fertilizantes. 2 ed. Brasília: Embrapa Informação Tecnológica, 2009. p.193-204.

Silveira, R. B., (2008). Análise da rentabilidade potencial de investimentos em reflorestamento de eucalipto no leste de Mato Grosso do Sul e Norte do Paraná. 2008. 41f. Tese (Mestrado em Produção e Gestão Industrial). Universidade para o Desenvolvimento do Estado e da Região do Pantanal, Campo Grande, Mato Grosso do Sul, 2008

Smith, C. T., Carnus, J. M. Bio solids planning and design. In: INTERNATIONAL SYMPOSIUM ON THE USE OF RESIDUALS AS SOIL AMENDMENTS IN FOREST ECOSYSTEMS, 1997, Seattle, Proceedings, Seattle: University of Washington, 1997. p.45-52.

Souza, C.A.M., oliveira, R.B., Filho, S.M., Souza, J.L.S. (2006). Crescimento em campo de espécies florestais em diferentes condições de adubação. **Ciência Florestal**, Santa Maria, v.16, n.3, p.243-249. 2006.

Trigueiro, R.M., Guerrini, I.A., (2003). Uso de biossólido como substrato para produção de mudas de eucalipto. **Sciencia Florestalis**, v.64, p.150-162.

---

1. Universidade de Rio Verde - UniRV. P.O. Box 104, CEP 75901-970, Rio Verde, GO- Brasil.

2. Universidade de Rio Verde - UniRV. P.O. Box 104, CEP 75901-970, Rio Verde, GO- Brasil.

3. Instituto Federal Goiano, Campus Rio Verde. Ciências Agrárias - Agronomia. Brasil. arthuralmeidaeng@gmai.com

4. Universidade de Rio Verde - UniRV. P.O. Box 104, CEP 75901-970, Rio Verde, GO- Brasil.

5. Universidade de Rio Verde - UniRV. P.O. Box 104, CEP 75901-970, Rio Verde, GO- Brasil.

6. Universidade de Rio Verde - UniRV. P.O. Box 104, CEP 75901-970, Rio Verde, GO- Brasil.

7. Universidade de Rio Verde - UniRV. P.O. Box 104, CEP 75901-970, Rio Verde, GO- Brasil.

Revista ESPACIOS. ISSN 0798 1015
Vol. 38 (Nº 41) Año 2017

[Índice]