Swine biosolids in initial growth of eucalyptus

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., 2016). In this context, Goiás is the fourth greatest pork producer in the country and represents 9.5% of pork exports (ABPA, 2016).

2. Materials and Methods

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 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.

3. Results

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 irradiation 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.

4. Discussion

5. Conclusions

6. References
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 sabar. Rio Verde – Goiás. 2012.**

<table>
<thead>
<tr>
<th>pH</th>
<th>Ca</th>
<th>Mg</th>
<th>Al</th>
<th>H+Al</th>
<th>K</th>
<th>K</th>
<th>PMel</th>
<th>S</th>
<th>O.M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cmolc dm⁻³</td>
<td></td>
<td>mg dm⁻³</td>
<td></td>
<td>g dm⁻³</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.10</td>
<td>0.73</td>
<td>0.23</td>
<td>0.04</td>
<td>2.8</td>
<td>0.05</td>
<td>19.6</td>
<td>3.07</td>
<td>16.73</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>Fe</td>
<td>Mn</td>
<td>Zn</td>
<td>Co</td>
<td>Na</td>
<td>Cu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mg dm⁻³</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.23</td>
<td>62.85</td>
<td>14.83</td>
<td>0.57</td>
<td>1.44</td>
<td>2.0</td>
<td>4.60</td>
<td></td>
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</tr>
</tbody>
</table>

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.**

<table>
<thead>
<tr>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>S(SO₄)</th>
</tr>
</thead>
<tbody>
<tr>
<td>g kg⁻¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.5</td>
<td>91.5</td>
<td>10.2</td>
<td>55.5</td>
<td>7.0</td>
<td>4.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fe</th>
<th>Mn</th>
<th>Cu</th>
<th>Zn</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>g kg⁻¹</td>
<td>kg dm⁻³</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.02</td>
<td>1.19</td>
<td>0.56</td>
<td>1.30</td>
<td>0.45</td>
</tr>
</tbody>
</table>

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.
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 65°C 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).

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

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).

![Figure 1. Quantities of nitrogen (N), phosphorus (P) and potassium (K) available in each treatment calculated from data in table 2.](image-url)
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. $P \leq 0.01$ and $p \leq 0.05$, 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).
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 growing 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


