Effect of textile industry biosolids for soil fertility and sugar cane production

Efeito do biossólido de indústria têxtil para a fertilidade do solo e para a produção da cana-de-açúcar

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ABSTRACT

Biosolids are the sludge that comes from an effluent treatment plant, with a significant amount of organic matter and nutrients in its composition that makes it usable in agriculture as fertilizer. Studies have proven the good results that this practice usually brings to the soil, implanted culture and economic viability of cultivation. The present work aimed to evaluate the effect of the biosolid produced by the effluents treatment plant (ETP) of a textile industry to soil fertility and sugar cane production. In this way, an experiment was carried out on an experimental farm in the municipality of Pedras de Fogo-Paraíba, Brazil. The experimental design used was randomized blocks, composed of 6 (six) treatments and two repetitions: without fertilization, conventional fertilization, 1x, 2x, 4x and 8x the dose of biosolid recommended by CONAMA Resolution 375/06, with three repetitions each, totaling 18 (eighteen) experimental plots. Soil samples were collected at a depth of 0-20 cm and soil fertility analysis were carried out according to the methodology described by EMBRAPA at the Soil Chemistry and Fertility Laboratory of the Agricultural Sciences Center of the Federal University of Paraíba. The soil of the experimental area was classified as Arenic Orthic Ferroluvic Spodosso, of sandy texture, low natural fertility, poor drainage and medium organic matter content, with presence of impediment layers and high risk of contamination of the water table and flooding. Based on the results it was observed that the areas with application of biosolids had a higher availability of phosphorus, thus, this element favoured the supply for plant growth in these plots. For the pH results, values between 6.4 and 6.8 were found, though did not change the availability of nutrients for the culture. Regarding maturation, it was observed that there was equal maturation in all plots with the use of biosolids. Regarding the amount of organic matter in the soil, it was observed that there was no improvement in this parameter. This significant fall in organic matter may have occurred due to leaching, once the region where the experiment was located had extended periods of rain. The use of biosolids showed as a viable fertilizer, providing essential nutrients, nitrogen and phosphorus, to the development of the plant in the Spodosso da Paraíba.

Keywords: Fertilization, Forage plant, Nutrients, Saccharum officinarum.

RESUMO

O biosólido é o lodo proveniente de estação de tratamento de efluente, tendo em sua composição uma quantidade significante de matéria orgânica e nutrientes que o tornam utilizável na agricultura como adubo. Estudos comprovam os bons resultados que esta prática normalmente traz para o solo,
a cultura implantada e a viabilidade econômica do cultivo. O presente trabalho teve como objetivo avaliar o efeito do biossólido produzido pela ETE de uma indústria têxtil para a fertilidade do solo e produção da cana-de-açúcar. Para isto, foi realizado um experimento em fazenda experimental no município de Pedras de Fogo-PB. O delineamento experimental utilizado foi o de blocos casualizados, compostos por 6 (seis) tratamentos: sem adubação, adubação convencional, 1x, 2x, 4x e 8x a dose de biossólido recomendada pela Resolução CONAMA 375/06, com três repetições cada, totalizando 18 (dezoito) parcelas experimentais. As amostras de solo foram coletadas a uma profundidade 0-20 cm e as análises de fertilidade do solo foram realizadas segundo metodologia descrita pela EMBRAPA no Laboratório de Química e Fertilidade do Solo do Centro de Ciências Agrárias da Universidade Federal da Paraíba. O solo da área experimental foi classificado como ESPODOSSOLO FERRI-HUMILÚVICO Órtico espessarênico, de textura arenosa, baixa fertilidade natural, má drenagem e de médio teor de matéria orgânica, presença de camadas de impedimento e risco elevado de contaminação do lençol freático e de alagamento. Com base nos resultados observou-se que as áreas com aplicação de biossólido tiveram uma maior disponibilidade de fósforo, assim, esse elemento favoreceu no suprimento para o crescimento vegetal nessas parcelas. Para os resultados de pH foram encontrados valores entre 6,4 e 6,8, o que não alterou a disponibilidade dos nutrientes para a cultura. Em relação à maturação, observou-se que houve maturação em igualdade em todas as parcelas com uso do biossólido. Em relação à quantidade de matéria orgânica no solo, pôde-se observar que não houve melhorias neste parâmetro. Esta queda significante de matéria orgânica pode ter ocorrido por lixiviação, uma vez que a região onde esteve localizado o experimento teve períodos prolongados de chuva. O uso do biossólido comportou-se de forma viável como fertilizante, disponibilizando nutrientes essenciais, Nitrogênio e Fósforo, para o desenvolvimento da planta no Espodossolo da Paraíba.

Palavras-Chave: Fertilização, Saccharum officinarum, planta forrageira, nutrientes.

1 INTRODUCTION

Saccharum officinarum L. is a semi-perennial crop and has an average cycle of four years from the planting to the renewal of planted areas. According to Paoliello (2006), sugarcane is commonly grown in tropical and subtropical regions, as it needs a hot and rainy season for vegetative development, and a cold and/or dry season for enrichment in sugars.

The sugar cane it was one of the first agricultural activities explored in the Brazilian history. Furthermore, the demand for products in the energy sector is growing worldwide. According to data from the National Supply Company, Conab (2018), Brazil is the largest producer of sugarcane, with approximately 633.3 million tons of sugarcane in the 2017/2018 harvest, and a cultivated area of 8.729.5 thousand hectares.

Research has shown that the application of sludge generated in an effluent treatment plant (ETP) in tropical soils benefits the productivity and sucrose yield of the sugarcane crop (SILVA et al., 1998). This is characterized by changing the physical properties of the soil, improving its density, porosity and water retention capacity from the organic matter in it. In addition, it improves your fertility level, raising the pH, decreasing the exchangeable aluminum content, increasing the cation...
exchange capacity (CEC) and the ability to supply nutrients for the plants. For containing high levels of organic matter and other nutrients in its constitution, the sludge also promotes the growth of organisms in the soil, essential for the cycling of the elements (MALTA, 2001).

The agricultural alternative for disposal of the sludge generated in ETP is the most promising, since it is safe and economically viable for its disposal and also brings with it a lots of advantages associated with its agricultural use as it is a source of nutrients, organic matter and a conditioner of soil properties (ABREU JÚNIOR et al., 2015).

The present work aimed to evaluate the effect of the biosolid produced by the effluents treatment plant (ETP) of a textile industry for soil fertility and sugar cane production.

2 MATERIAL AND METHODS

The experiment was conducted at the experimental farm Bica, located in the city of Pedras de Fogo, in the state of Paraíba, in Northeast Brazil, with the following geographical coordinates: 07°19´59.6´´ South and 35°03´55.2´´ West. The municipality is located in the microregion of the Southern coast of Paraíba. This microregion has a type am climate, hot and humid, according to the Köppen climate classification, with rainfalls concentrated in autumn and winter (PEEL et al., 2007).

The rainy season usually starts in February and ends in October, with an average annual rainfall of 1.634 mm (CLIMATE-DATE, 2018). In this study, eighteen 2 m × 2 m plots were delimited in a randomized block design, with six treatments and two repetitions in each block. The blockswere arranged as shown in Figure 1.

![Figure 1. Schematic representation of the experimental design (Silva, 2018).](image-url)
The experiment was conducted in the years 2016, 2017 and 2018 consecutively with the application of biosolids in this area, which have never received biosolids before. The soil in the experimental area was classified as Arenic Orthic Ferroluvic Spodosol, sandy texture, low natural fertility, poor drainage and medium content of medium organic, presence of impediment layers and high risk of contamination of the water table and flooding (SANTOS et al., 2015a).

The biosolid used in the experiment was produced by a textile industry located in the industrial district of João Pessoa-Paraíba, Brazil, and characterized according to Table 1.

Table 1. Physical-chemical characterization of the biosolid used in the experiment.

| Parameter                  | Quantity          |
|----------------------------|-------------------|
| Total organic carbon       | 0.23 g/kg         |
| Lead                       | < 1 mg/kg         |
| Copper                     | 275 mg/kg         |
| Thermotolerant coliforms   | 92 NMP/g de ST    |
| Phosphor                   | 1.780 mg/kg       |
| Nitrate                    | < 6.1 mg/kg       |
| Nitrite                    | < 1.2 mg/kg       |
| Ammoniacal nitrogen        | 238 mg/kg         |
| Total nitrogen             | 7.320 mg/kg       |
| pH (5% suspension)         | 7.90 mg/kg        |
| Potassium                  | 3.450 mg/kg       |
| Moisture                   | 15%               |
| Zinc                       | 34.5 mg/kg        |

Source: (Silva, 2018).

According to Conama Resolution 375/06 (BRASIL, 2006), the application rate is calculated from the amount of nitrogen in the biosolid and the requirement of this same element for the development of the crop to be cultivated. Thus, the rate of application of the biosolid was calculated by equation 1:

Equation 1:

Application rate (t/ha) = N recommended (kg/ha)/ N available (kg/t) (1)

Where:

Recommended N = Amount of nitrogen recommended for the crop, according to the official recommendation of the State;
N available = Calculated according to annex 3 of Conama Resolution 375/06.

Herewith, the amounts for the biosolid of 2x, 4x and 8x were calculated, which dosages were higher in 2, 4 and 8 times the amount calculated according to Conama Resolution 375/06 (BRASIL, 2006). Thus, we can observe the values of the amount of biosolid applied in the experiment.

Equation 2:

\[ N_{\text{disp}} = \left( \frac{F_M}{100} \right) \times (K_{\text{J}}-N_{\text{NH3}}) + 0.5 \times (N_{\text{NH3}}) + (N_{\text{NO3}} + N_{\text{NO2}}) \]  

\( F_M = \) fraction of nitrogen mineralization (%);

\( K_{\text{J}} = \) Kjeldahl nitrogen = total organic nitrogen + ammoniacal nitrogen (KjN) (mg/kg);

\( N_{\text{NH3}} = \) Ammoniacal nitrogen (mg/kg);

\( N_{\text{NO3}} + N_{\text{NO2}} = \) Nitrogen Nitrate and Nitrite (mg/kg).

Vitti et al. (2015), recommends the fertilization of sugar cane as follows:

- Soil with clay content <25% use 100 to 150 kg of P\(_2\)O\(_5\)/ha in total area, plus 100 kg of P\(_2\)O\(_5\)/ha in the planting furrow.
- In quartzose sands (quartzarenic neossols) and oxisols, apply a maximum of 100 kg of K\(_2\)O/ha in the planting furrow, and the rest in coverage, before the closure of the cane field.

Using the biosolid characterization data, it was possible to calculate the doses, according to Table 2.

Table 2. Quantity of the biosolid, calculated according to Conama Resolution 375/06 (Brasil, 2006) and applied to lots in the experimental area.

| Biosolid    | Quantity     |
|-------------|--------------|
| Biosolid 1x | 2.4 kg/lot   |
| Biosolid 2x | 4.8 kg/lot   |
| Biosolid 4x | 9.6 kg/lot   |
| Biosolid 8x | 19.2 kg/lot  |

Source: Author

The treatment system used by the company is the biological system of activated sludge of prolonged aeration followed by an ultrafiltration system. Before being applied, the sludge went through an alkaline stabilization process by increasing its pH with the addition of hydrated lime, both to reduce pathogens and to reduce the attraction of vectors, in compliance with the first article of the Conama Resolution 375/06 (BRASIL, 2006).
Tests were transported out in the laboratory with crude biosolids with lime according to the methodology required by Conama Resolution 375/06 (BRASIL, 2006).

From the concentration of 30% of lime in the dry sludge, the samples attended the necessary requirements for pH above 12 after 48 hours and pH above 11.5 after 24 h. Therefore, the ratio of 30% of lime to the amount of sludge on a dry basis was reached.

The application rate of commercial fertilizer, according to the information collected from professionals of the plants and producers in the region, were proportions of 80 kg P₂O₅/ha per year, 80 kg KCl/ha per year and 100 kg N/ha using urea. All were applied at once to the furrow. Thus, we sought to apply the fertilization used by local producers for a fair comparison compared to plots with biosolids.

To implement the experiment, some care issues with the terrain were required. Therefore, the land was manually cleaned followed by mechanical traction plowing. For Lopes (2004), soil preparation must be done in order to facilitate the sprouting of seedlings and seed germination.

Planting was realized out by furrows of approximately 15 cm deep.

The sugarcane stalks were cut into pieces with three yolks in a linear meter of furrow. There is a wide range of planting recommendations by farmers in the region. On October 10th of 2017, after approximately one month of experiment, the seedlings that did not sprout were replanted, to eliminate the possibility of quality difference between the seedlings. On that occasion, germinations were also counted.

The spacing used between seedlings was 1 m. Sugarcane seedlings taken from neighborhood properties where the experiment was carried out were used, in which the variety is known as RB 92579. 1 m spacing was used, as it is the spacing normally used by farmers in the region, where they indicate that there is greater production and prevent competition and entanglement between stalks in the furrows and plant development.

For irrigation, 16-mm-thick polyethylene irrigation tubes were used, with drippers spaced 0.50 m apart, with a nominal flow rate of 1.5 L/h. Each dripper is 0.7 mm thick. One irrigation tube was installed per elephant grass row. A digital thermometer (Incoterm 7,665.02.0.00) was also installed in the experimental field to measure the maximum and minimum temperatures, utilized in the calculation of the daily irrigation dose as described by Hargreaves; Samani, (1982).

Where:

Equation 3:
ET₀ = 0.0023 * (Tₘéd + 17.78) * (Tₘₐₓ - Tₘᵢₙ) 0.5 * (RA * 0.408) (3)

ET₀ - Reference evapotranspiration (mm/h)
Tₘₐₑₙ - Mean temperature
Tₘₐₓ - Maximum temperature
Tₘᵢₙ - Minimum temperature
ER - Extraterrestrial radiation (MJ/m²)

To use this equation, the maximum and minimum temperatures were collected daily for the final calculation of the irrigation time required for the day. The average temperature was calculated according to equation 4.

Equation 4:
Tₘₐₑₙ = (Tₘₐₓ - Tₘᵢₙ) / 2 (4)

After the reference evapotranspiration was calculated, the evapotranspiration of the culture was determined using equation 5.

Equation 5:
ETₖ = ET₀ * Kc (5)
Where:
ET₀ - Reference evapotranspiration;
CE - Crop evapotranspiration (mm/h);
Ac - Adimensional cultivation coefficient.

Once the ETₖ is calculated, it is possible to calculate the irrigation depth according to equation 6.

Equation 6:
Di = (CE / Wa) * 100 (6)
Where:
Di - Depth irrigation (mm/day);
Wa - Water application efficiency of the irrigation system (%).

Once the irrigation depth was calculated, it was possible to calculate the required irrigation time per day in the system, according to equation 7.

Equation 7:
Ti = Di * 10000 / Np * Ne * fe (7)
Where:
Ti = Time of Irrigation (h);
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Np = Number of plants per hectare;
Ne = Number of emitter per plant;
fe = flow emitter, L/h.

Two soil samplings were carried out: one before starting the experiment, and the other at the end of the cycle, 1 day before the cutting of sugarcane.

For soil sampling before the experiment, 10 samples were collected at a depth of 0-20 cm and mixed to form a composite sample. For samplings before cutting, the same methodology of composite samples was used (SANTOS et al., 2015b).

The samples were sent to the Soil Chemistry and Fertility Laboratory, DSER/CCA/ UFPB for analysis. Among the routine chemical analyzes, the following were analyzed: sodium (Na), potassium (K), phosphorus (P), calcium (Ca), magnesium (Mg), cation exchange capacity (CEC), pH (hydrogen potential) and organic matter (OM). All parameters analyzed were done according the Manual of Methods of Soil Analysis (TEIXEIRA et al., 2017).

The method of determining the stage of maturation is based on the fact that the maturation of sugarcane occurs from the base to the apex of the stem. Regarding this, from the knowledge of the maturation index obtained by the relation between the brix in these parts of the cane, it is possible to predict the stage of maturation of the plant. The method assumes the following steps:

- Select the samples in the sugarcane area;
- Separate the bases and tips of the stems from the samples;
- Make the cuts in these parts in such a way to obtain a sufficient amount of broth to determine the Brix°.

This assessment can be performed in the field using a “portable” field refractometer (CALDAS, 2012). The maturation stage of sugarcane is described in Table 3.

Table 3. Sugar cane maturation stage.

| Maturation index | Maturation stage               |
|------------------|--------------------------------|
| <0.60            | Green cane                     |
| 0.60 – 0.85      | Maturing cane                  |
| 0.85 – 1.00      | Ripe cane                      |
| >1.00            | Sugarcane in decline of maturation |

Source: Adapted from Caldas (2012).
The height of the plants was measured with a measuring tape on the day of the harvest, 11 months after planting, as well as the number of stems in each lot.

Sugarcane was cut and three samples from each lot were randomly selected according to the criterion of the middle column, that is, the cane that was in the middle row was used, so that it would not be influenced by the other lots.

In the study carried out with sugar cane and elephant grass in Pedras de Fogo-Paraíba, Brazil, Neves (2017) and Silva (2018), randomly selected three plants from the middle line of each lot and the results were presented as an average. Due to the similarity of the experiments with this experimentation, the same methodology was used.

In the field, stalks (quantity), height, biomass and Brix° were quantified so that they could be performed according to the methodologies described by Caldas (2012). After the cutting, the total weight of the plants in each batch was measured using an industrial scale.

The Test, proposed in 1965 by Shapiro; Wilk (1965), was used, and aims to verify the hypothesis of normality of a population from a sample. A great advantage of this test is that it is very sensitive, even in small amounts of samples.

The data collected were subjected to analysis of variance (ANOVA) through the F Test, using the Tukey Test to compare means, with the significance levels set at p < .01 and p < .05. And the analyzes were performed using the R Statistical Program (R CORE TEAM, 2018).

3 RESULTS AND DISCUSSION

The study was limited to the choice of the main fertility parameters, in the case of nutrients, such as phosphorus, potassium and organic matter, as well as the CEC of the soil.

Tables 4 and 5 shows the result achieved from the chemical analysis of the soil, in the soil fertility parameters, one day before the sugarcane harvest.

According to the data presented in Tables 4 and 5, it was possible to observe that for the pH parameter, both before and after the implementation of the experiment, there was no significant increase on it, with the pH between 6.4 to 6.8 (Table 4) and 6.0 to 6.4 (Table 5), because, when compared with reference values classified by Sobral et al. (2015), these results fits in weak acidity, which does not cause problems for sugarcane or in the availability of nutrients for the soil.

According to Jones Jr. (2012), soils with accumulations of salts directly affect the entire development process of the implanted crops, damaging the roots, increasing the toxicity by specific
ions from sodium, magnesium and calcium, consequently changing the chemical conditions of the soil.

Even so, it can be identified that the sodium levels found in the soil under study, after the sugarcane harvest, are considered low, when compared with the results found before the implementation of the experiment.

Usman et al. (2012) highlight in their study with the use of sewage sludge in agriculture, that the levels of calcium, magnesium and sodium are important for the identification of soil salinity.

The means levels of potassium observed in Tables 4 and 5 show that with the use of biosolids this content tends to decrease.

This condition of element decrease was expected due to the low concentrations of potassium in the biosolid used and the plants absorbing this element to maintain its life cycle.

It may also have occurred because the soil in the area is very sandy and easily leached.

Table 4. Chemical analysis of the soil where the experiment was carried out before experimental cultivation.

| Treatments       | P (mg/d m³) | pH (H₂O) | Ca²⁺ (cmolc/d m³) | Mg²⁺ (cmolc/d m³) | H +Al³⁺ (cmolc/d dm³) | Na⁺ (cmolc/d m³) | K⁺ (cmolc/d m³) | CEC (cmolc/d m³) | M.O. (g/kg) |
|------------------|-------------|----------|------------------|------------------|---------------------|-----------------|----------------|-----------------|-------------|
| Control          | 21.0        | 6.5      | 2.7              | 0.09             | 2.9                 | 0.09            | 0.1            | 5.8             | 15.3        |
| Fertilizers commercial | 18.0      | 6.4      | 3.2              | 1.00             | 1.3                 | 0.07            | 0.7            | 6.3             | 23.5        |
| Biosslid 1x      | 20.0        | 6.6      | 2.6              | 0.91             | 2.0                 | 0.11            | 0.6            | 6.2             | 15.6        |
| Biosslid 2x      | 24.3        | 6.7      | 2.8              | 0.95             | 2.1                 | 0.09            | 0.6            | 6.5             | 17.4        |
| Biosslid 4x      | 34.0        | 6.8      | 3.8              | 1.10             | 2.5                 | 0.09            | 0.7            | 8.2             | 19.2        |
| Biosslid 8x      | 27.7        | 6.5      | 1.8              | 0.83             | 2.0                 | 0.08            | 0.7            | 5.4             | 32.3        |

Source: Author.

Table 5. Chemical analysis of the soil one day before cutting sugar cane.

| Treatments | P (mg/d m³) | pH (H₂O) | Ca²⁺ (cmolc/d m³) | Mg²⁺ (cmolc/d m³) | H +Al³⁺ (cmolc/d dm³) | Na⁺ (cmolc/d m³) | K⁺ (cmolc/d dm³) | CEC (cmolc/d m³) | M.O. (g/kg) |
|------------|-------------|----------|------------------|------------------|----------------------|-----------------|----------------|-----------------|-------------|
| Control    | 29.77       | 6.0      | 2.3              | 0.93             | 5.1                  | 0.07            | 0.1            | 8.5             | 16.4        |
Jones Jr. (2012) points out that potassium and phosphorus are important macronutrients in the nutritional essentiality of crops, due to this, the lower the content of these nutrients in the soil, the greater the risk of interrupting the plant's development.

Neves (2017) reveals that the biosolid provides significant amounts of nitrogen and phosphorus, and little amount of potassium, when is available in the soil, requiring nutritional supplementation with phosphate fertilizer, which can assist in the provision of these nutrients to plants.

As for CEC, it was possible to see in Table 4 that this parameter was very low, making it visible that in the lots applied with biosolids, there was a significant increase in this soil fertility index highlighted in Table 5.

According to Sobral et al. (2015) CEC is an important data to be considered in the management of fertilization.

The same author reports that in soils with low CEC nitrogen and potassium splitting is necessary, avoiding then leachate losses.

Some authors point out that the ideal index for CEC in sandy soils is 10 cmolc/dm³ (LOPES, 1998; JONES Jr., 2012), thus, it was observed that the most significant values were in the treatments with biosolids, corroborating with Silva (2018) that had good results with the application of biosolids.

From the interpretation of Table 4 in relation to organic matter, we can see that this index has not had so many improvements, when compared with the indexes found in Table 5.

This significant drop in organic matter may have occurred due to leaching, once the region where the experiment was located had prolonged periods of rain.
However, Usman et al. (2012) point out that organic matter in sandy soils, even in small quantities, plays an important role in the soil retention process, as well as making the environment conducive for the action of microorganisms that mineralize soil nutrients.

The contribution of organic matter to the soil is fundamental and important, as it improves its productive potential and causes beneficial effects to the physical, chemical and microbiological properties of the soil (BARBOSA et al., 2002).

Table 6 describes the results found for the variables that refers to the productivity of the sugarcane used in this study. According to the data analyzed through the F statistics, we observed that there was no significant difference between the variables steams and Brix° at the level of 5% significance by the F Test, while a significant difference was observed between the variables height and biomass at the level of 5% significance by Test F.

Table 6. Results (p-values) associated with the main sources of variation in a randomized block design for the variables: Stems, Height, Biomass and Brix°.

| F. Variation | G.L | Est. F | p-valor |
|--------------|-----|--------|---------|
| Stems        | 2   | 2.32   | 0.149   |
|              | 5   | 2.3    | 0.123   |
| c.v          |     | 14.21% |         |
| S-W          | 0.96536  | p=0.70 |         |
| Height       | 2   | 5.36   | 0.026*  |
|              | 5   | 6.37   | 0.00657** |
| c.v          |     | 9.97%  |         |
| S-W          | 0.94071  | p=0.29 |         |
| Biomass      | 2   | 1.31   | 0.311   |
|              | 5   | 13.686 | 0.0003** |
| c.v          |     | 10.25% |         |
| S-W          | 0.9356  | p=0.24 |         |
| Brix°        | 2   | 1.69   | 0.233   |
|              | 5   | 1.32   | 0.331   |
| c.v          |     | 11.27% |         |
| S-W          | 0.95133 | p=0.44 |         |

* F-Fisher test at the 5% level of significance indicates rejection of the null hypothesis stating that there is a difference between treatments.

** Shapiro-Wilks normality test p <0.05 indicates that the null hypothesis is rejected.

Source: Author.

It was possible to verify that there is a difference between the variables height and biomass, and there was no difference between the other variables through the F Test. Thus, it was necessary to
apply the Tukey Test to compare the means of the height and biomass variables, showing that there was a significant difference according to Table 7.

According to the Shapiro-Wilks normality Test (SW), we observed that all treatments had a normal distribution, that is, the null hypothesis was accepted indicating that these data were extracted from a population with normal distribution SW (p> 0.05).

It is also observed that the coefficient variation (c.v) of all variables involved in the analysis was less than 20%, indicating a good homogeneity of the data according to Pimentel-Gomes; Garcia (2002).

Table 7. Results associated with the variables Stems, Height, Biomass and Brix° for different types of fertilization dosages for sugar cane.

| Steams (quantity) | Height (m) | Biomass (kg) | Brix° |
|-------------------|------------|--------------|-------|
| Biossolid 8x = 99.00 a | Biossolid 8x = 2.58 a | Biossolid 8x = 107.36a | Biossolid 8x = 21.33 a |
| Biossolid 4x = 80.00 a | Biossolid 4x = 2.10 ab | Biossolid 4x = 95.70 ab | Biossolid 4x = 19.66 a |
| Biossolid 2x = 73.00 a | Biossolid 2x = 1.96 b | Biossolid 2x = 67.58c | Biossolid 2x = 21.00 a |
| Biossolid 1x = 78.30 a | Biossolid 1x = 1.76 b | Biossolid 1x = 81.50 bc | Biossolid 1x = 19.00 a |
| Fert. Commer= 76.00 a | Fert. Comm. = 1.87 b | Fert. Comm. = 58.36 c | Fert. Comm. = 17.66a |
| Control = 72.00 a | Control = 1.86 b | Control = 92.21ab | Control = 18.30 a |

* Means followed by the same letter do not differ by Tukey's test at the 5% level of significance.

Source: Author.

Regarding the maturation of sugarcane, Table 7 shows that in the parameters streams and Brix° there was no difference in the maturation stage, consequently, the sugarcane in all batches reached maturation in equality.

Contrary to these results, Silva (2018) in his experimentation with the use of biosolids for sugarcane, achieved superior results for both streams and Brix° in the batches in which he used the biosolids.

For the results of height, it can be seen that the biosolid 1x did not differ from the commercial fertilizer or the control, with intersection in the treatments offertilizer commercial, biosolid 2x and control, demonstrating that these batches that were treated with biosolids did not obtain superior efficiency, with the biosolid 8x having the most expressive result, with larger plants than those of the biosolid solid 1x, in which has the dosage recommended by Resolution Conama 375/06 (BRASIL, 2006).
Regarding the biomass variable, it was observed that there was no significant difference at the level of 5% by the Tukey test in the biosolids 4x and witness lots.

The batches where biosolid 8x was applied were the ones that showed the best results in the production of biomass, showing the efficiency of this amount of biosolid for the increase of biomass.

Both in this study and in the study by Silva (2018), it can be seen that the use of biosolids showed expressive results regarding biomass, especially when the dosages were higher than the ones recommended by Resolution Conama 375/06 (BRASIL, 2006), resulting in biomass gains for the sugar cane.

Some authors such as Oliveira (2016); Neves (2017); Silva (2018) state that the use of biosolids for the production of sugarcane showed good results, highlighting that the higher the dosage with the biosolids, the better the conditions of the variables related to biomass and height.

However, even with the good results, these authors suggest that other studies should be carried out, thus being able to verify whether there will be damage to the soil or culture from successive applications of the biosolid.

4 FINAL CONSIDERATIONS

There is feasibility of using the biosolid generated in effluents treatment plant of textile industry as a fertilizer for the production of sugar cane, providing essential nutrients and improving soil fertility characteristics, without harming production.

It was also possible to observe and verify that the sugarcane maturation period was the same for all treatments, that is, at the same time, the plant was able to fully develop, regardless of the amount of biosolid used and even in the treatment with commercial fertilizer. Thus, there is no difference in the amount of sugar available in it.

With the application of biosolids in agriculture, it is possible to take advantage of a waste that was wasted in landfills, giving a final destination and adapting it to the current legislation and reducing the use of commercial fertilizers. Thus, this practice, which can reduce fertilizer costs for farmers, is also presented in a sustainable way.

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