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Passion fruit production under different swine wastewater doses treated in a biodigester

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ABSTRACT
Soil fertilization using materials of animal origin, such as biofertilizers, is an important practice to maintain productive soil, as they provide beneficial effects on soil's physical, chemical, and biological properties. This study aimed to evaluate the number of fruits, fruit mass, and yield of yellow passion fruits in the first year of cultivation with the application of swine wastewater (SW) treated in a biodigester. The experiment was set up at the experimental area belonging to IFCE Crato, CE, Brazil, with a spacing of 5.0 m between plants and 3.0 m between rows, using the espalier system of training and drip irrigation. The experiment was conducted in a randomized block design, with five treatments and four replications. Treatments consisted of five SW doses (D1 = 0, D2 = 0.50, D3 = 1.00, D4 = 1.50, and D5 = 2.00 L plant−1) applied at two phenological stages of the crop. The results were subjected to analysis of variance at a 5% significance, followed by the regression test. The increased SW doses influenced all the studied variables, following the linear and quadratic regression models, except for the mean fresh fruit mass. The highest yield was achieved with the highest studied dose, being an interesting alternative for recommendation to farmers in the region.

Keywords: Biofertilizer, organic agriculture, soil quality, fruticulture.

1 INTRODUCTION

The center of origin of passion fruit is Tropical America, with more than 150 species native to Brazil. Yellow passion fruit (*Passiflora edulis* Sims f. *flavicarpa* Deg.) is the most important commercial species, representing 95% of the orchards in Brazil and the most planted in the world (BERNACCI *et al.*, 2008; MELETTI *et al.*, 2011). Brazil is the center of origin of several species of the family Passifloraceae and the largest producer of this fruit since the 1990s, being a crop of great economic importance (RODOLFO JUNIOR *et al.*, 2009).

Swine manure has a high nutrient concentration and may contaminate the soil and watercourses when improperly disposed of in the environment, leading to environmental impacts (ARAÚJO *et al.*, 2012; SCHERER *et al.*, 2010). Thus, considering the risks of environmental pollution, many production units have started to store wastewater in tanks for subsequent release into the soil in different crops (MENEZES *et al.*, 2017; SOUZA *et al.*, 2009).

The use of swine wastewater (SW) as a soil fertilizer has been based on economic aspects and sustainability of agricultural production systems, as it represents an internal resource of farmers and contains nutrients and organic matter with the potential to improve crop yield, being essentially an adequate treatment and management (PEREIRA *et al.*, 2010).

The importance of SW going through the biodigester first implies the mineralization of the organic matter of common biofertilizers, being a process that requires a certain amount of time, as the speed at which mineralization occurs depends mainly on the chemical composition of organic matter (MARROCOS *et al.*, 2012; TEJADA *et al.*, 2016). Thus, humic substances interact with manure compounds and, consequently, provide readily available nutrients for plant nutrition.

Considering SW characteristics, its application can contribute to improving soil physical and chemical attributes, reducing environmental pollution, and improving the quality of agricultural products (DA ROS *et al.*, 2017). Mellek *et al.* (2010) observed that SW has advantages in improving soil physical conditions through aeration and porous space of the root system of plants. Similarly, Singh *et al.* (2011) reported improved fertility by increasing the population and diversification of soil microorganisms.

Moraes *et al.* (2014) and Alves Neto *et al.* (2016) obtained maximum corn yields of 10.05, 12.88, and 6.24 Mg ha^{-1} with SW applications of 143, 91.83, and 140 m^3 ha^{-1}, respectively. Also, Lima *et al.* (2019) reported a linear response of up to 100 m^3 ha^{-1} of SW, with an increasing dose.

Reis *et al.* (2018) demonstrated significant differences in the mean yield between different passion fruit cultivars at the end of six months of harvest with the topdressing SW application at a dose of two liters per plant.

Similarly, Alves Neto *et al.* (2016) reported an increase of 124.81 kg ha^{-1} in soybean yield compared to the control up to the dose of 105 m^3 ha^{-1} $year^{-1}$, but the dose of 140 m^3 ha^{-1} showed a yield reduction trend of 50.58 kg ha^{-1} compared to the dose of 105 m^3 ha^{-1}.

Therefore, there is an optimal dose, with risks of soil salinization and contamination of ground and surface water when this value is exceeded. In this sense, the amount applied should be monitored, as an excess can also cause negative impacts.

Considering the importance of organic inputs to sustainable agricultural production, this study aimed to evaluate the number of fruits, the fresh mass of fruits, and the yield of yellow passion fruit in the first year of cultivation with the application of doses of swine-wastewater treated in a biodigester.

2 MATERIAL AND METHODS

The experiment was conducted at the Experimental Field of the Federal Institute of Education, Science and Technology of Ceará (IFCE), a campus of Crato, CE, Brazil, with approximate geographic coordinates at the central point of the area of 07°12′ S and 39°27′ W, with an altitude of 660 m above sea level. The regional climate, according to the Köppen classification, is Aw, corresponding to a humid tropical climate, with a mean annual precipitation of 850 mm, mean air temperature of 27 °C, and relative humidity of around 75%.

Passion fruit seeds of the yellow variety were used for seedling formation. The seeds were sown in polyethylene bags with dimensions of 0.15 × 0.28 m filled with quartz sand, hydromorphic soil, and cured bovine manure at a proportion of 2:2:1 (v/v). Sowing was carried out on September 24, 2016.

The seedlings were transplanted to the field when they reached 0.30 to 0.40 m in height, on January 3, 2017. The spacing was 5.0 m between plants and 3.0 m between rows and three useful plants were evaluated per plot, totaling 60 plants occupying an area of 900.0 m^2.

Chemical and physical analyses were performed from the initial collection of soil samples carried out in October 2016 at a depth of 0.00–0.20 m, according to the methodology suggested by EMBRAPA (2011).

The soil has an acidic reaction, low available phosphorus contents, very low potassium contents, low calcium contents, medium magnesium content, low base and aluminum saturation, medium cation exchange capacity values, and low organic matter contents (SBCS, 2004). Physically, the soil has a loamy sandy texture (Table 1) and is classified as an Argissolo (Ultisol), according to the Brazilian Soil Classification System (EMBRAPA, 2006).

Table 1. Results of soil chemical and physical analysis in the experimental area.

Chemical attributes										
pH	OM	P	K^+	Ca^{2+}	Mg^{2+}	Na^+	H^++Al^{3+}	Al^{3+}	CEC	V
water 1:2.5	kg ha^{-1}	mg kg^{-1}	$cmol_c$ kg^{-1}							%
4.9	13.34	9	0.36	1.20	1.00	0.06	2.81	0.3	5.43	48.25
Physical attributes										
CS		FS	S	C	NC	DF	Ds	Dp	TC	
g kg^{-1}						g 100 g^{-1}	g cm^{-3}			
580		234	65	112	40	64	1.5	2.7	Loamy sandy	

OM – organic matter; CEC – cation exchange capacity [Ca^{2+} + Mg^{2+} + Na^+ + K^+ + (H^++Al^{3+})]; V – base saturation [(Ca^{2+} + Mg^{2+} + Na^+ + K^+/CEC) × 100]; CS – coarse sand; FS – fine sand; S – silt; C – clay; NC – natural clay; DF – degree of flocculation; Ds – soil density; Dp – particle density; TC – texture classification.

A vertical espalier system, with a wire at 2.0 m high, was used to train the crop. Wooden posts and stakes were used to construct the espalier system of training. Irrigation was performed based on the potential reference evapotranspiration (ETo), calculated according to the methodology of Hargreaves & Samani, described by Lima et al. (2016), and using passion fruit crop coefficients (Kc) of 0.65, 1.13, 1.25, and 0.82 for the phenological stages formation, flowering, fruiting, and fruit maturation, respectively, found by Medeiros *et al.* (2009) and Araújo *et al.* (2006). The irrigation had a daily frequency, totaling an irrigation depth of 943 mm during the study period (January to November 2017).

A gravity-fed drip irrigation system with a self-compensating emitter per plant was used to provide a flow rate of 4.0 L h^{-1}. The irrigation was carried out to complement the water depth that represented the volume of applied SW doses.

A randomized block design with four replications was used. The treatments consisted of SW doses (D_1 = 0, D_2 = 0.50, D_3 = 1.00, D_4 = 1.50, and D_5 = 2.00 L $plant^{-1}$), calculated based on related research (REIS *et al.*, 2018; LIMA *et al.*, 2019; ALVES NETO *et al.*, 2016) from the IFCE swine production unit, campus of Crato, CE, Brazil.

The SW chemical analysis was carried out using the methodology of the Standard Methods for the Examination of Water and Wastewater: Metals by Plasma Emission Spectroscopy (Method 3129), using an inductively coupled plasma optical emission spectrometer, with previous sample digestion, following the guidelines of the Application Book (SK-10 High-Pressure Rotor), with results shown in Table 2.

Table 2. Chemical characterization of swine wastewater treated in a biodigester and applied to the treatments.

Macronutrient contents (mg L^{-1})		Micronutrient contents (mg L^{-1})	
N	377.5	Cu	1.9
P	47.8	Mn	4.0
K	188.1	B	5.67
Ca	85.0	Fe	2.55
Mg	74.6	Mo	0.03
		Zn	31.11
pH	6.5	EC	1.45 dS m^{-1}

N – nitrogen; P – phosphorus; K – potassium; Ca – calcium; Mg – magnesium; Cu – copper; Zn – zinc; Mn – manganese;B – boron; Fe – iron; Mo – Molybdenum; EC – electrical conductivity.

The values were lower than those applied by Da Cruz *et al.* (2008) on yellow passion fruit seedlings and higher than those applied by Junior *et al.* (2009) on the growth and production of yellow passion fruit, except for K and Zn.

After transplanting, plants at the initial vegetative growth stage were tied and had their lateral shoots pruned, in a single stalk. Leaf sprayings and chemical fertilizers were not applied during the plant formation period.

The first SW application was carried out at the vegetative period, two months after transplanting, with the second application conducted at the beginning of flowering, with half of the SW dose at each stage, according to the treatment.

The first and last planting row and the first and last plants of each row were used as borders. Harvesting started in the eighth month after transplanting, during the first week of August 2017. Fruits with more than 30% yellow, as well as those that fell, were harvested once or twice a week, with monthly sums for statistical analysis.

The number of commercial fruits (60 to 110 mm in transversal diameter) was evaluated by counting all the fruits harvested from the useful area of each plot. The fruit mass (g) and the mean production per plant (g) were also determined. The yield estimate was obtained by multiplying the mean production per plant by the number of plants per hectare (666.7 plants ha^{-1}).

The data were subjected to analysis of variance using the F-test at a 5% probability to verify significance. The evaluation of SW doses applied to the passion fruit plants was carried out by regression analysis, using the statistical program SISVAR v. 5.3 (FERREIRA, 2011).

3 RESULTS AND DISCUSSION

The weather variables related to precipitation (mm), relative air humidity (%), maximum, minimum, and mean temperatures (°C), and wind speed (m s^{-1}) that occurred during the passion fruit development and production (January to November 2017) are shown in Figures 1 and 2.

Figure 1. Precipitation (mm) and relative air humidity (%) were observed from January to November 2017. Weather Station of Barbalha, CE, Brazil, 2020, 20 km away from the experimental site. Source: BDMEP–INMET Network.

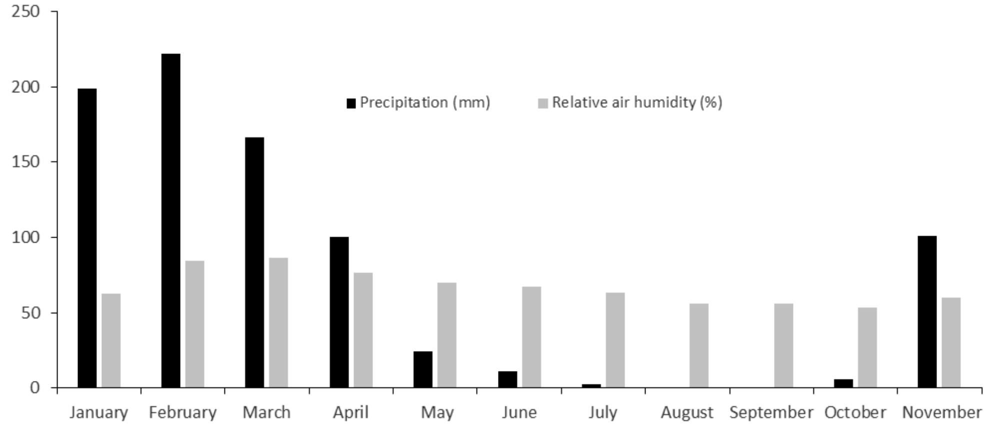
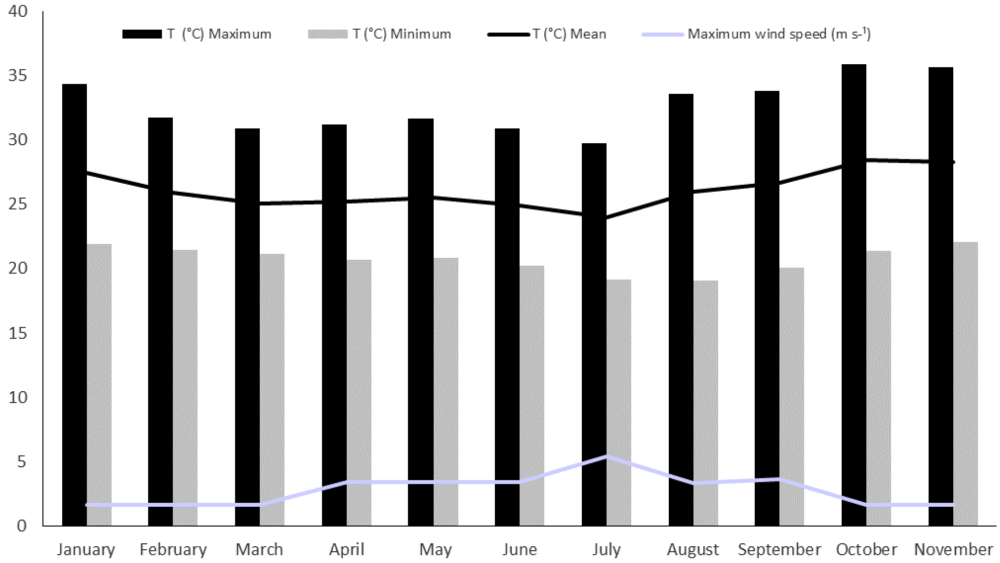


Figure 2. Maximum, minimum, and mean temperatures (°C) observed from January to November 2017. Weather Station of Barbalha, CE, Brazil, 2020, 20 km away from the experimental site. Source: BDMEP–INMET Network.



The highest precipitations occurred during the first four months (199, 222, 166, and 100 mm), but the period from May to October 2017 showed practically no precipitation, with accumulated values reaching 832 mm. The relative air humidity ranged from 63 to 87%, with the lowest values recorded in the hottest months. The maximum, minimum, and mean temperature values indicated little variation during the year, with values of 33, 21, and 26 °C, respectively.

The maximum wind speed values did not exceed 5 m s^{-1}, not causing damage to flowering and fruiting.

Table 3 shows the mean number of commercial fruits (NCF) as a function of the months of production for different SW doses. The regression analysis presented a significant effect for NCF in all months, with a high coefficient of determination (R^2) (89.85 to 99.06%). The linear regression model was the best fit ($p < 0.05$) for August and September and also for the means, that is, NCF increased as SW doses increased. On the contrary, the quadratic regression model was the best fit ($p < 0.05$) for October, that is, NCF increased up to the SW dose of 1 L $plant^{-1}$, with a slight decrease under higher doses.

Similarly, the quadratic model was the best fit for November, with effects of increased NCF only for the highest SW doses (1.5 and 2.0 L $plant^{-1}$) and a slight decrease in NCF probably due to the end of the production cycle, with reduced flowering and fruiting at this period.

The comparison of the same SW dose applied between the production months also presented the same trend, with October showing the highest variation probably due to higher temperatures and relative air humidity, which provided better plant performance in a less favorable for pest and disease proliferation.

Table 3. The mean number of commercial fruits (NCF) for the production months as a function of the application of different doses of swine wastewater treated in a biodigester.

Treat.	Production period				Mean
	August	September	October	November	
D_1	1.25 Bb	2.63 BAb	11.13 Cb	6.42 Ab	5.36 Bb
D_2	1.58 Bba	5.00 Bba	23.57 Ab	5.17 Bb	8.84 Bba
D_3	2.08 Bba	5.79 Ba	26.75 Ab	4.75 Bb	9.85 Ba
D_4	3.50 Bba	7.50 Ba	26.33 Ab	12.88 BAba	12.55 BAa
D_5	4.50 Ba	8.00 Ba	18.46 Ab	18.25 Aa	12.30 Ba
Mean	2.58	5.78	21.25	9.49	9.78
CV (%)	54.26	23.38	35.94	50.71	20.04
R^2 (%)	93.92*	95.16*	99.06*	95.36*	89.85*
Model	Linear	Linear	Quadratic	Quadratic	Linear

Regression equations – August: $y = 0.842x + 0.058$; September: $y = 1.325x + 1.809$; October: $y = -3.159x^2 + 20.702x - 6.1$; November: $y = 1.557x^2 - 6.202x + 10.977$; Mean: $y = 1.761x + 4.496$. Means followed by the same uppercase letter (month comparison) and the same lowercase letter (different doses) do not differ from each other by the F-test at the 5% significance level.

The variation in NCF during the harvest months may have occurred due to climate variations at the plant vegetative development stages, variations in the number of flowers per plant to be pollinated, the formation pruning management, and nutrient availability, such as N, P, and K in the soil from SW, as indicated by Gomes Filho *et al.* (2001). The values are lower than those found by Menezes *et al.* (2017) in the "Guinezinho" and "Gigante Amarelo" genotypes, which reached means of 35.15 and 34.15 fruits plant^{-1}, respectively, using the maximum fertilizer dose (40%) and responding linearly to the biofertilizer doses.

The values were also lower than those found by Rodrigues *et al.* (2009) with super macro biofertilizer and potassium (1.43, 0.26, 1.01, 0.49, and 0.26 g kg^{-1} of N, P, K, Ca, and Mg, respectively, and 439, 332, 155, 961, and 1699 mg kg^{-1} of B, Cu, Fe, Mn, and Zn, respectively, with pH 4.6 and electrical conductivity of 13.18 dS m^{-1}) compared to the highest applied SW dose (0.76, 0.09, 0.38, 0.17, and 0.15 g L^{-1} of N, P, K, Ca, and Mg, respectively, and 11.34, 3.8, 5.1, 0.1, and 62.22 mg L^{-1} of B, Cu, Fe, Mn, and Zn, respectively, with pH 6.5 and electrical conductivity of 1.45 dS m^{-1}), which ranged from 80 to 96 fruits plant^{-1} and presented an overall mean of 86.6 fruits plant^{-1}. Moreover, Collard *et al.* (2001) found 139 fruits plant^{-1} in a field sprayed monthly with agrobio (0.63, 0.17, 1.2, 1.59, and 0.48 g L^{-1} of N, P, K, Ca, and Mg, respectively, with pH ranging from 5 to 6). Similarly, Cavalcante *et al.* (2007) recorded between 52 to 65 fruits plant^{-1} in soil treated with supermagro (13.1 and 8.5, 2.9 and 8.5, 6.7 and 8.2, 4.3 and 19.2, and 0.8 and 1.9 g kg^{-1} of N, P, K, Ca, and Mg in mixtures with water, with an electrical conductivity of 2.8 and 4.6 dS m^{-1}, respectively).

The highest fruit production reported by the authors compared to the data from the present study shows higher efficiency of the input, its chemical complexity, which increases the availability of some nutrients, the higher concentration, and more frequent application.

Dias *et al.* (2017) evaluated passion fruit production and quality after fertilization with nitrogen and potassium (0–0, 50–125, 100–250, 150–375, 200–500, and 250–625 kg ha^{-1} year^{-1} of N and K_2O) and found that the number of fruits per plant ranged from 192 to 298, which are higher than the values found in the present study when comparing the nitrogen and potassium contents found in the applied SW doses (126–75, 253–150, 378–226, and 503–301 kg ha^{-1} year^{-1} of N and K_2O), even with higher N amounts. Furthermore, the number of fruits per plant results found in the present study were lower than those observed by Oliveira (2017), who verified that an increase in nitrogen up to the dose of 203 kg ha^{-1} provided the highest number of fruits (165) per plant.

The obtained coefficients of variation ranged from 20.04 to 54.26%, not showing a good precision of the assays. This oscillation may be due to the high precipitations at the time of the first application of the doses, the vegetative state, the management and plant training conditions, with variations in the number of productive branches per plant, the non-use of artificial pollination method, and the natural soil fertility.

The mean fresh fruit mass (FFM) (Table 4) as a function of production months for the different

SW doses showed a significant difference for August, when only D_1 provided a difference from the other doses, with values ranging from 132.59 to 229.39 g.

The regression analysis of the mean fresh fruit mass (FFM) for the different SW doses in the different harvest months (Table 4) did not fit the linear or quadratic regression models, with significance found only for the cubic model for August, with higher FFM for the treatment that did not receive the SW dose probably due to the lower number of fruits that had the highest initial development with the natural soil fertility and, consequently, higher mass, with also an oscillation of FFM for the other doses.

The comparison of the applied SW doses between production months showed that August and October had higher FFM variation, especially for the D_1 and D_5 doses, probably due to the natural soil fertility and the initial contributions of the nutrients supplied by SW.

Table 4. Mean fresh fruit mass (FFM) (g) for production months as a function of the application of different doses of swine wastewater from treated in a biodigester.

Treat.	Production period				Mean
	August	September	October	November	
D_1	229.39 Aa	139.56 Bb	157.62 BAb	92.50 Bb	140.95 Bb
D_2	132.59 Bb	102.71 Bb	140.37 Bb	96.95 Bb	130.11 Bb
D_3	202.99 Bba	148.63 Bb	155.84 Bb	113.85 Bb	146.43 Bb
D_4	194.39 Bba	122.32 Bb	132.99 Bb	120.37 Bb	130.61 Bb
D_5	212.28 Aba	142.79 BAb	151.88 BAb	100.65 Bb	136.69 Bb
Mean	194.33	131.20	147.74	104.86	136.96
CV (%)	20.87	37.66	22.94	25.85	19.11
R^2 (%)	67.50*				
Model	Cubic				

Regression equation – August: $y = -11.726x^3 + 116.271x^2 - 338.411x + 458.228$. Means followed by the same uppercase letter (month comparison) and the same lowercase letter (different doses) do not differ from each other by the F-test at the 5% significance level.

The results found in this study for August are very close to the values reported by Reis *et al.* (2018) for monthly applications using swine wastewater at a dose of 2 L plant^{-1} throughout the cycle of different passion fruit varieties, being significant for March, with a mean mass ranging from 171 to 238 g fruit^{-1}.

Similarly, Andrade *et al.* (2017) found a fresh mass of yellow passion fruit cv. Redondo Amarelo weighing 201.8 g, in plants formed with 25-day seedlings with organic and mineral fertilization. This value is also higher than those found by Nascimento *et al.* (2003), Hafle *et al.* (2009), and Cunha (2013), who obtained mean fruit masses of 193, 161.6, and 123.8 g for the cultivar Redondo Amarelo, respectively.

The value was also lower than that found by Rodolfo Junior *et al.* (2008) for the first production season (November/2005 to February/2006), with a value of 181.4 g corresponding to plots treated with common and supermagro biofertilizers in the absence of the NPK mineral fertilizer, and even lower than the results found by Santos (2004), who obtained values of 176 and 180 g per fruit with the use of common and supermagro biofertilizer.

However, the FFM values obtained in this study were higher than those found by Abreu *et al.* (2009) under a conventional system, with 129.4 g for the cultivar Gigante Amarelo and 127.8 g for the cultivar Rubi do Cerrado.

The linear regression model best fit ($p < 0.05$) the monthly yield (MY) of passion fruits in tons per hectare as a function of the applied SW doses (Table 5) for August, September, and November, with production increments with an increase in SW doses and a high coefficient of determination (R^2), with values ranging from 72.96 to 96.81%. On the contrary, the quadratic regression model was the best fit ($p < 0.05$) for MY in October, with increments in NCF up to the SW dose of 1.5 L plant^{-1} and a slight decrease under higher doses.

The comparison of the applied SW doses between production months shows that October had a higher MY variation, probably due to the peak of flowering, pollination, and fruiting in August and September, with favorable environmental conditions and the presence of natural pollinators.

Table 5. Mean yield (PM) of passion fruit (t ha^{-1}) for production months as a function of the application of different doses of swine wastewater treated in a biodigester.

Treat.	Production period (t ha^{-1})			
	August	September	October	November
D_1	0.19 Bba	0.25 Bb	1.19 Ab	0.41 Bb
D_2	0.13 Bb	0.39 Bba	2.15 Ab	0.33 Bb
D_3	0.28 Bba	0.59 Bba	2.46 Ab	0.34 Bb
D_4	0.49 Bba	0.61 Bba	2.09 Ab	1.13 BAb
D_5	0.64 Ba	0.76 Ba	1.81 Ab	1.23 BAb
Mean	0.35	0.52	1.94	0.69
CV (%)	64.06	40.33	30.45	85.05
R^2 (%)	87.15*	96.81*	93.33*	72.96*
Model	Linear	Linear	Quadratic	Linear

Regression equations – August: $y = 0.125x - 0.030$; September: $y = 0.125x + 0.147$; October: $y = -0.227x^2 + 1.477x - 0.001$; November: $y = 0.245x - 0.048$. Means followed by the same uppercase letter (month comparison) and the same lowercase letter (different doses) do not differ from each other by the F-test at the 5% significance level.

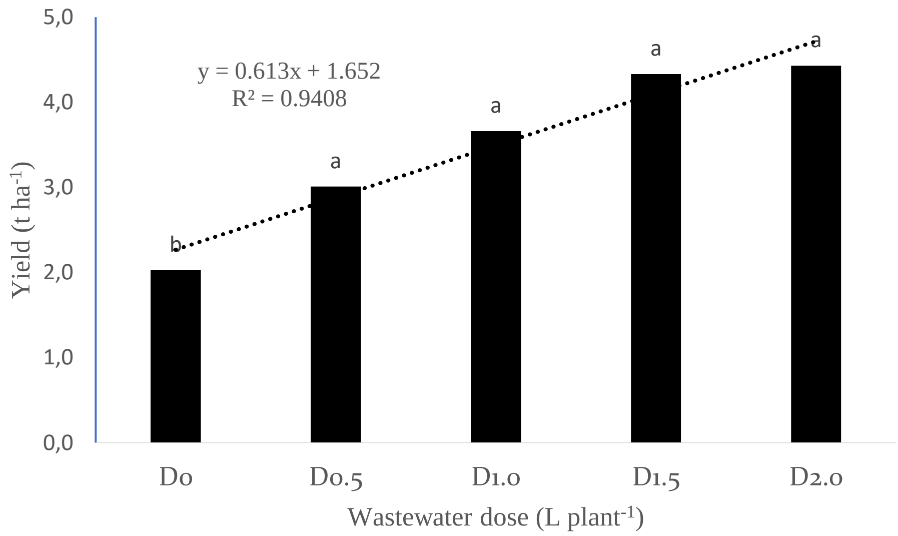
The peak of yield was reached in October, that is, ten months after planting. Low yields were observed per month compared to other studies, such as Reis *et al.* (2018), who studied the same crop at spacings of 5 m between plants and 2.5 m between rows and found a mean monthly yield from 0.69 to 5.53 t ha^{-1} for different cultivars, as the swine wastewater doses were associated with topdressing organic fertilization and NPK applications at production period. However, no significant differences were observed between cultivars in some production months.

The total mean yield (TY) of passion fruit (t ha^{-1}) as a function of the applied SW doses is shown in Figure 3. The linear regression model was the best fit ($p < 0.05$) for TY, with a high coefficient of determination (R^2) of 94.08%. TY ranged from 2.03 and 4.43 t ha^{-1}, with no differences between treatments that received SW doses but differing from the control treatment. An increase in yield from 0.98 t ha^{-1} for the lowest dose (D_2) to 2.4 t ha^{-1} for the highest dose (D_5) was also observed.

Silva *et al.* (2015) evaluated the effect of humic substances and nitrogen fertilization (180, 200, 260, 330, and 350 kg ha^{-1} of N) on passion fruit cultivation in the semiarid region of Brazil (Juazeiro, Bahia) and verified a production value of 17.5 t ha^{-1} at the dose of 350 kg ha^{-1} of N, which is higher than the production found in the present study for the applied SW doses (126, 253, 378, and 503 kg ha^{-1} of N), possibly because nitrogen provides higher vegetative development at the expense of flower and fruit production.

Moreover, Diniz *et al.* (2009) observed that a balanced NPK fertilization favors the mineral nutrition of passion fruit plants, with a mean yield of around 22.1 t ha^{-1} when 244 kg ha^{-1} of N, 72 kg ha^{-1} of P_2O_5, and 285 kg ha^{-1} of K_2O are supplied. However, a lower production is observed even considering the highest SW dose used in the present study (503.33 kg ha^{-1} of N, 145.96 kg ha^{-1} of P_2O_5, and 300.96 kg ha^{-1} of K_2O), which is mainly due to the nutritional imbalance.

Figure 3. The total yield of passion fruit (t ha^{-1}) as a function of doses of swine wastewater treated in a biodigester. Means followed by the same letter do not differ from each other by the F-test at the 5% significance level.



The TY values were lower than those found by Menezes *et al.* (2017) for the genotypes Guinezinho and Gigante Amarelo, with yields of 14.97 and 12.54 t ha^{-1}, respectively, with the application of 40% of biofertilizer. Similarly, Rodolfo Júnior *et al.* (2009) obtained a yellow passion fruit yield of 25.95 t ha^{-1} in the first year of cultivation for soil treated with a common biofertilizer.

Moreover, Neto *et al.* (2009) evaluated the yield and vigor of yellow passion fruit planted in different pit sizes and no-till under organic management and found a mean yield of 10.2 t ha^{-1}. These results were also higher than those found by Reis *et al.* (2018), with values ranging from 16 and 19 t ha^{-1}.

As observed by Krause *et al.* (2012), a factor that may have influenced yield, in addition to the low nutrient supply to the soil by the wastewater, was the lack of manual pollination, which. The manual pollination provided yields of up to 16.46 t ha^{-1}, while the natural pollination provided yields of only 5.92 t ha^{-1}, considering the same cultivars.

A favorable response was observed to the analyzed variables with an increase in SW doses. Gomes Filho *et al.* (2001) observed that wastewater may present nutrients in sufficient quantities for crops after passing through the biodigester, leading to increased production and yield, with two-thirds of nitrogen, one-third of phosphorus, and almost 100% of potassium being found in the mineral form, that is, readily available for crops.

4 CONCLUSIONS

The number of fruits of passion fruit increased with the doses of swine wastewater from a biodigester under the studied conditions. The pattern of increments in the number of fruits was similar in November despite the numerical differences.

No difference was observed between harvest periods for the fresh fruit mass. However, a difference was observed in the final mean yield between the analyzed doses, considering the four production months.

The mean yields achieved with passion fruit cultivation under the highest dose of swine wastewater from a biodigester were considered satisfactory.

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