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Production of yellow passion fruit seedlings on substrates with different organic compounds

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The production of passion fruit seedlings constitutes one of the important stages of the production system and the importance of substrate for the seedlings growth and plant performance in the field. Therefore, the objective of this study was to evaluate the effects of different composting organic wastes in the substrate composition for production of yellow passion fruit seedlings. The experiment had been conducted in the Centre of Human, Social and Agricultural Sciences at The Federal University of Paraíba. The experimental design was randomized block design, with six treatments, goat composite + soil (CCP+S), poultry composite + soil (AC+S), bovine composite + soil (CB+S), rabbit composite + soil (CCO+S), earthworm humus + soil (MH + S), and soil (S) and S in the ratio of 2:1 (v/v) and five repetitions. Emergency speed index, emergency percentage, stem diameter, seedling height, leaf number, root length, fresh root mass, shoots fresh mass, total of fresh mass, dry mass of root, dry mass of branches, total dry mass, chlorophyll *a*, *b* and total, and Dickson quality index were assessed. The compounds in the constitution of substrates exerted significant effect on the characteristics evaluated in the passion fruit, which may be related to the availability of nutrients to the substrate. The substrates containing CCP+S and CCO+S provided better growth, chlorophyll contents and quality of "Serra" yellow passion fruit seedlings.

Key words: Initial growth, *Passiflora edulis* Sims f. *flavicarpa* Deg., waste reuse, chlorophyll indexes.

INTRODUCTION

The yellow passion fruit (*Passiflora edulis* Sims f. *flavicarpa* Deg.) is native from tropical America, with more than 150 native species of Brazil, intensively cultivated in tropical and subtropical countries (Faleiro et al., 2008). This culture has a significant importance in the Brazilian agricultural sector, mainly due to the physicochemical qualities and pharmacy-therapeutic fruits, besides the high acceptance by the consumer

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market (Natale et al., 2006).

It is a fruit with wide adaptation in Brazil and considered a cultural entity that employs large amount of workers, characterizing it as a family agricultural activity (Silva et al., 2010). Brazil is the world's largest producer of passion fruit and domestic production currently accounts for about 1.5% of the fruits produced in the country, totaling in 2005 more than 479,000 tons of fruit (IBGE, 2012).

For Cavalcante et al. (2005), the Brazilian Northeast is recognized as a region that offers edaphic aptitude and climate for fruticulture and among the fruit the yellow passion fruit stands out, with favor conditions for their growth, production and fruit quality (Pires et al., 2008).

This species may be sexually and asexually propagated but cultivation through seed is the most used way (Ferreira et al., 2001). The seedling production constitutes one of the most important stages of the production system in the horticulture, since it determines the final performance of the plant in the field (Echer et al., 2007). In this sense, the substrate has a fundamental role in the plant growth requiring secure the shoot growth and development of root system (Silva et al., 2010).

According to Silva et al. (2001) for good seedlings quality, it is necessary to use substrates, which must provide appropriate physical and chemical properties and provide nutrients necessary for the plant development. Allied to this, the quality of the substrate depends primarily on the proportions and materials that make up the mixture.

Composting is the controlled decomposition of plant debris and manure. This decomposition occurs by the action of microorganisms and the soil fauna, the compound being a source of slow release of macro and organic micronutrients, serving as a soil builder and allows the increase in organic matter, favoring increased retention capacity water, increasing the CTC, nutrient retention in the soil and reducing the acidity of the soil over time, to form organic complex and retain bases providing best condition for resistance to pests and diseases (Penteado, 2007). The organic inputs provide improved microbiological substrate and increasing population and diversity of soil fauna of the soil (Sall et al., 2015).

In this context, the objective was to evaluate the effects of different composting organic waste in the substrate composition for production of yellow passion fruit seedlings (*P. edulis* Sims f. f*lavicarpa* Deg.).

MATERIALS AND METHODS

The experiment was conducted in the seedling production nursery in Sector of Agriculture in the Centre of Human, Social and Agricultural Sciences at The Federal University of Paraíba., located in the Paraíba's swamp region, Bananeiras-PB county. The climate according to Koppen is As' type and corresponds to sub-Mediterranean climate (BRASIL, 1972). The values for rainfall and temperature during the months of experiment conduction (June to September) are as shown in Figure 1.

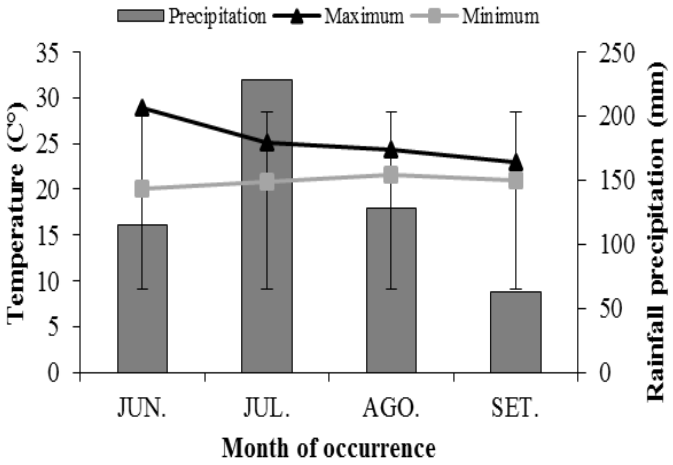

Figure 1. Rainfall precipitation and temperature in the Bananeiras-PB County, 2013.

Initially, four composting cells were prepared, using different manure (cattle, goats, poultry and rabbits), crop residues (bean, corn, citronella, jack fruit leaves and jambolan) and grasses, attempting to use the material available on site. After the material had been collected, all plant materials were ground for better uniformity and decrease the decomposition time.

The pile built with dimensions of 1.5 m wide × 1.20 m high. To better preparation was placed around each pile, a nylon screen in order to prevent loss of the used material. The pile temperature and humidity were monitored and 90 days after the compost piles, it was observed that they were ready to start the sieving process and use.

The experiment was carried out using the passion fruit Serra cultivar, obtained by mass selection by producers in the Nova Floresta County donated by Canteiro Cheiro Verde in the Picuí-PB. Sowing was done using polyethylene bags with dimensions of 18 × 30 cm, placing three seeds per bag. After the emergency, the thinning was carried out, leaving only one plant/bag and the experimental plot consisted of five seedlings.

The experimental design was a randomized block with six composite treatments goat composite + soil (CCP+S), poultry composite + soil (AC+S), bovine composite + soil (CB+S), rabbit composite + soil (CCO+S), earthworm humus + soil (MH + S) and soil (S), with the ratio of 2: 1 v/v and five replications. The results of chemical analysis are shown in Table 1.

Plants were harvested at 60 days after emergence, when they reached the point of being taken to the field. Emergency speed index (ESI), emergency percentage (% EER), stem diameter (SD), height plant (HP), number of leaves (NL), root length (RL), fresh root mass (FRM), fresh weight of aerial part (FWA), total fresh weight (TFW), root dry mass (RDM), dry mass of shoots (DMS), total dry matter (TDM), chlorophyll *a* indexes (Cl *a*), chlorophyll *b* indexes (Cl b), total chlorophyll indexes (Cl *t*) and Dickson's quality index (IQD) were evaluated.

The determination of plant height and root length was performed with a ruler graduated in centimeters, for determining the stem diameter, a digital caliper was used with values expressed in millimeter. Chlorophyll levels were quantified (a, b total = a + b) by reading made in chlorophyll. The ClorofiLOG® model was used and the readings were taken from three sheets exposed to solar radiation (from top to bottom) starting from the third changes of the sheet. To determine the fresh weight of roots and shoots, the plants were weighed after harvest, dry mass of roots and shoots was determined with the dry material in an oven with forced air at 65°C

Table 1. Chemical characterization of substrates consisting of compounds obtained from different animal manures and crop residues

Source	**pH	P	K^+	Na^+	H^+Al^{+3}	Al^{+3}	Ca^+	Mg^{+2}	SB	CTC	V	m	M.O.
	H_2O	mg/dm^3				$cmol_c/dm^3$					%		$g\ kg^{-1}$
*CB + S	7.67	136.0	12.31	1.51	0.91	0.00	6.40	5.40	25.59	26.50	96.57	0.00	179.6
CCO + S	6.84	233.5	9.53	2.67	4.54	0.00	6.30	6.70	25.18	29.72	84.72	0.00	164.0
CA + S	6.71	477.3	9.98	3.53	2.56	0.00	8.40	7.95	29.84	32.40	92.10	0.00	29.66
CCP + S	6.83	136.8	9.53	1.22	4.62	0.00	8.50	5.45	24.68	29.30	84.23	0.0	141.1
HM + S	6.67	397.8	9.68	1.8	5.69	0.00	7.40	12.00	30.86	36.55	84.43	0.00	142.0
S	4.57	16.17	0.26	0.09	12.46	0.55	2.40	1.45	4.21	16.67	25.25	11.55	9.48

**pH = active acidity, P = available phosphorus, K^+ = available potassium, Na^+ = exchangeable sodium, H^+ Al^{+3} = potential acidity, Al^{+3} = exchangeable acidity, Ca^+ = calcium exchangeable Mg^{+2} = magnesium exchangeable, SB = sum of bases, CTC = effective cation exchange capacity, V = base saturation, m = Al^{+3} saturation, MO = Organic matter. *Goat composite + soil (CCP+S), poultry composite + soil (AC+S), bovine composite + soil (CB+S), rabbit composite + soil (CCO+S), earthworm humus + soil (MH + S) and soil (S), with the ratio of (2: 1, v / v).

until they reach constant weight.

The IQD proposed in the present research is a balanced formula that includes the relations of morphological characteristics, such as total dry weight, shoot dry weight, dry weight of the root system, shoot height and stem diameter (Dickson et al., 1960) by the formula:

$$IQD = \frac{MST}{\left(\frac{ALP}{DIC}\right)+\left(\frac{MSP}{MSR}\right)} \quad (1)$$

Where IQD = Dickson's quality index, MST = total dry matter, ALP = plant height, DIC = stem diameter, DMAP = shoot dry mass, MSR = root dry mass.

Data were subjected to analysis of variance and means were compared by Tukey test at 5% probability, using the statistical software ASSISTAT version 7.7 beta (Silva and Azevedo, 2002).

RESULTS AND DISCUSSION

Treatments with CCP+S and CCO+S provided better speed of emergence index and emergency percentage (Table 2), possibly these substrates have adapted better moisture retention conditions sufficient to allow for better germination, combined with good aeration of the substrate (Smiderle and Minami, 2002; Penteado, 2007). In work carried out by Silva et al. (2010), the best results for the IVE, the possible maintenance of humidity Plantmax® substrate.

The treatment used consisting of CCP + S provided increment in the height of passion fruit seedlings "Serra" (Table 2). The lower growth was observed in the control, data that can be explained by the chemical conditions and soil fertility. The pH was considered with high acidity and all other attributes in conditions that do not favor plant growth, results corroborate that by Fey et al. (2010) where they evaluated the initial growth of yellow passion fruit seedlings due to increasing doses of superphosphate.

The substrates containing CCP+S+S and CA provided increases in stem diameter of passion fruit seedlings (Table 2). Cavalcante et al. (2009) when working with different textures on substrates significant effects on stem diameter of passion fruit seedlings. Palácio et al. (2011) when using different substrates formulated with dung: sand: soil and manure: Land noted that the yellow passion fruit seedlings had increase in stem diameter when cattle manure added to the substrate.

The best responses to the variable number of leaves were observed for the treatments PCC+S and S+CCO (Table 3). Negreiros et al. (2005), studying different substrates in the formation of the papaya seedlings from "Solo" group, it was observed that a greater number of leaves per plant in the substrate consisting of cattle manure, soil, sand and vermiculite in the proportion of 2: 1: 1: 1 v/v.

Dantas et al. (2012) using different percentages of bovine manure on substrates, observed that the use of cattle manure in the substrate promoted positive effects on the number of leaves and in the initial development of yellow passion fruit.

There was no significant effect on root length of seedlings of yellow passion fruit (Table 3). Costa et al. (2011) when using different volumes of commercial substrates, soil and organic compound observed no significant effect of treatment on the formation of yellow passion fruit

Table 2. Emergence speed index (ESI), emergency percentage (EP), plant height (PH) and stem diameter (SD), passion fruit "Serra" grown in different compositions of substrates.

Treatment	ESI	EP (%)	PH (cm)	SD (mm)
CB + S	1.14[b]	78.40[b]	26.83[b]	4.73[ab]
CCO + S	1.47[a]	95.80[a]	30.24[ab]	5.12[a]
CA + S	1.12[b]	75.60[b]	18.40[c]	4.17[b]
CCP + S	1.52[a]	97.20[a]	32.92[a]	5.30[a]
HM + S	1.11[b]	71.60[b]	17.28[c]	4.29[b]
S	1.00[b]	61.20[c]	6.90[d]	2.42[c]
Mean	1.23	79.96	22.09	4.33
CV (%)	7.28	6.26	12.78	7.91

Means followed by the same letter in the columns do not differ by Tukey test at 5% probability.

Table 3. Number of leaves (NL), root length (RL), fresh weight of root (FWR) and fresh mass of the aerial part (FMAP) of passion fruit of the "Sierra" grown in different compositions of substrates.

Treatment	NL	RL (cm)	FWR (g)	FMAP (g)
CB + S	8.16[ab]	19.20[a]	9.56[b]	10.59[b]
CCO + S	9.00[a]	19.55[a]	13.74[a]	13.99[a]
CA + S	7.60[ab]	19.35[a]	8.20[b]	7.41[c]
CCP + S	9.80[a]	21.83[a]	14.26[a]	15.55[a]
HM + S	7.00[ab]	20.88[a]	10.69a[b]	7.98[bc]
S	5.24[b]	17.76[a]	1.96[c]	1.61[d]
Mean	7.80	19.76	9.73	9.52
CV (%)	19.03	12.20	19.40	14.00

Means followed by the same letter in the columns do not differ by Tukey test at 5% probability.

seedlings.

The fresh weight of roots and shoots were increased on substrates with CCP and CCO+S+S (Table 3). Treatment with soil was inferior to other substrates in the fresh matter accumulation, a result that may be related to the conditions of fertility, even as high acidity, low base saturation and organic matter content, conditions that do not favor the development of seedlings with quality.

Using different settings, containers and substrates, Costa et al. (2010) observed that in individual, cages environments with shading of 50% polyethylene bags containers and substrates using soil and compost had the best fresh mass accumulation of roots. Ramos et al. (2008) observed a significant effect on fresh weight of aerial part of yellow passion fruit trays and testing tubes with Plantmax® substrate, charcoal, earth and sand, 1:1:1:1 v/v.

For total fresh weight, dry weight of roots, dry weight of shoot and total dry matter (Table 4), it was observed that the substrates that showed superiority contained CCP and CCO+S+S.

Barros et al. (2013) found significance in the dry root mass when evaluating different substrates made with compounds of green manure and application of foliar biofertilizers in seedlings of yellow passion fruit, however, the substrate with manure, provided dry mass increase and should be the best fertility conditions provided to the substrate.

Cruz et al. (2008) observed that the use of swine wastewater in irrigation of sour passion fruit seedlings provided increase in the amount of dry matter of seedlings, supplying the nutritional demand of seedlings without the supply of commercial fertilizers. Costa et al. (2011) observed that the containers with dimensions of 15.0 × 21.5 cm in environments with shading showed higher accumulation of total dry matter in the yellow passion fruit seedlings.

It is observed (Table 5) that the substrate containing goat compost expressed the best results for chlorophyll indices, b and total, which can be explained by the balanced availability of nutrients, aeration, and the possible increment of humic substances to the substrate. The plant chlorophyll is a factor that is directly linked with the photosynthetic efficiency. It is from the photosynthesis process the way that the plant gets energy to grow and develop (Cavalcante et al., 2013).

Silva et al. (2010) when using different substrates found that treating soil+cattle manure afforded increase in

Table 4. Total fresh weight (TFW), root dry weight (RDW), dry matter of the aerial part (DMAP), total dry matter (TDM) of yellow passion fruit plants "Sierra" grown in different compositions of substrates.

Treatment	TFW (g)	RDW (g)	DMAP (g)	TDM (g)
CB + S	20.16[b]	3.17[b]	2.43[b]	5.61[bc]
CCO + S	27.73[a]	5.06[a]	4.26[a]	9.32[a]
CA + S	15.61[b]	2.61[b]	1.57[c]	4.18[c]
CCP + S	29.81[a]	5.16[a]	4.89[a]	10.05[a]
HM + S	18.67[b]	3.48[b]	2.38[b]	5.83[b]
S	3.57[c]	0.43[c]	0.51[d]	0.9[4d]
Mean	19.25	3.31	2.67	5.98
CV (%)	13.13	17.65	12.24	12.40

Means followed by the same letter in the columns do not differ by Tukey test at 5% probability.

Table 5. Average of chlorophyll indices (Cl), indexes chlorophyll b (Cl b), chlorophyll index (Cl t) and Dickson quality index (IQD) of yellow passion fruit plants "Sierra" grown in different substrate compositions.

Treatment	Cl *a*	Cl *b*	Cl *t*	IQD
CB + S	27.34[ab]	6.92[ab]	34.50[ab]	1.80[cd]
CCO + S	28.02[ab]	8.10[a]	36.12[ab]	2.42[ab]
CA + S	24.14[bc]	6.98[ab]	31.12[bc]	1.58[d]
CCP + S	29.76[a]	8.90[a]	38.66[a]	2.60[a]
HM + S	25.98[ab]	6.92[ab]	32.90[ab]	2.13[bc]
S	20.36[c]	4.92[b]	25.28[c]	1.54[d]
Mean	25.93	7.12	33.09	2.01
CV (%)	10.16	20.15	8.94	10.15

Means followed by the same letter in the columns do not differ by Tukey test at 5% probability.

chlorophyll content in passion fruit leaves, probably not only by nutrient supply provided by the presence of organic matter, but also the improvement of microbiological content and increase in population and diversity of soil fauna in the substrate (Sall et al., 2015).

For the IQD, CCP + S substrates and CCO + S, provided better quality of passion fruit seedlings (Table 5). Almeida et al. (2011) also noted the significance of IQD when substrates containing soil + cattle manure in 1: 1 v/v were used for the production of passion fruit seedlings in trays. According to the authors, the results may be related to water retention, since this mixture has hardened earth and cattle manure, materials having high water retention and sand, which is highly porous, and facilitates aeration. IQD has been mentioned as a promising integrated morphological as Johnson and Cline (1991) and cited as good indicator of quality seedlings.

Conclusion

Substrates made up of goat composite +soil and rabbit composite + soil provide better growth, chlorophyll contents and quality of yellow passion fruit “Serra” seedlings.

Conflict of Interests

The authors have not declared any conflict of interests.

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