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Substrates, emergence and initial development of passion fruit seedlings

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Abstract

The propagation of any crop is understood as a crucial stage for the success of the crop, being the main form of propagation of passion fruit to sexual, through seedlings. The production of quality seedlings depends on the choice of the most suitable substrate for each crop. The objective was to evaluate the influence of different substrates on the emergence and initial development of yellow passion fruit (*Passiflora edulis*) seedlings. The experimental design was in randomized blocks with 6 treatments and 4 repetitions with 25 seeds per experimental unit, sown in tubes of 280 mL. The treatments were composed by different types of substrates in the proportion of 3:1, being: pure soil; soil + poultry manure; soil + ox manure; soil + Natufert®; soil + humus; soil + coffee peel. Plant height (cm) was evaluated; the number of leaves; the diameter of the collection (mm); the length of the root (cm); the green mass of the leaves; the green mass of the roots; the dry mass of the leaves and the dry mass of the roots. The substrate resulting from the mixture of soil + coffee peel proved to be the most suitable for the emergence and initial development of yellow passion fruit seedlings.

Keywords: Growth, *Passiflora edulis*, propagation

Introduction

The Passion fruit is botanically defined as a climbing plant, it belongs to the *Passifloraceae* family and the *Passiflora* genus, which contains more than 500 cataloged species. Native to Tropical America, it is a fruit of great acceptance by populations around the world (Silva et al., 2019a). The most cultivated species in Brazil and in the world are yellow passion fruit (*Passiflora edulis f. flavicarpa*), purple passion fruit (*Passiflora edulis*) and sweet passion fruit (*Passiflora alata*) (Pires et al., 2011).

In Brazil, this fruit is of great economic importance, since the country occupies the position of the world's largest producer and, at the same time, the world's largest consumer, being responsible for approximately 60% of the world's production (Ribeiro et al., 2018). According to Faleiro et al. (2016), the country reached an amount of approximately 1 million tonnes per year^{-1} and the productivity of 14 tonnes per hectare^{-1} per year^{-1} in 2016, but with potential for expansion in the national territory.

In addition to the great productive extension of this fruit in the Brazilian states, the cultivation of passion fruit has great social importance in generating jobs in the field, moving the sectors of sale of inputs, agro-industries in addition to being an income option for small, medium and large producers.

To obtain quality seedlings it is necessary to use good training techniques and, among these important factors, is the substrate. The seedlings produced must present a high quality standard, so that they can be successfully established in the final planting site (Duarte et al., 2015).

The substrate is a porous medium, formed by solid particles and pores. Solid particles, of mineral, organic or synthetic origin can vary a lot in physical aspects such as appearance, shape, size and specific mass (Fermino & Kampf, 2012). In the formation of seedlings, it is important

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to use substrates that have adequate physical-chemical properties and that provide the necessary nutrients for the development of the plant (Almeida et al., 2011). In addition, good quality substrate is an important factor in seed germination and seedling development (Duarte et al., 2010).

Due to the diversity of substances used as substrate, and the lack of studies that mention poultry manure and natufert fertilizer and coffee peel as a substrate for the production of passion fruit seedlings, there is a tendency to gradually replace the soil with other source materials. plant or animal (Santos et al., 2013). According to Carvalho et al. (2013), different mixtures of substrates have been tested for the production of fruit seedlings, with a view to improving seedling quality, not forgetting the economic aspect and local availability.

The research was carried out with the objective of evaluating the effect of different substrates mixed with the soil in the emergence and initial development of yellow passion fruit seedlings.

Materials and Methods

The research was conducted at the seedling nursery of the Federal Institute of Espírito Santo (IFES), Campus Santa Teresa, between March and July 2019, located in the Central Espírito-Santense region, city of Santa Teresa-ES, geographic coordinates 19°56'12" S and 40°35'28" W, with an altitude of 155 m. The region's climate is characterized as Cwa, mesothermal, with dry season in winter and heavy rainfall in summer (Köppen classification) (Alvares et al., 2013), with an average annual rainfall of 1,404.2 mm and an average annual temperature of 19.9 °C, with a maximum of 32.8 °CC and a minimum of 10.6 °C (Incaper, 2011).

The experimental design adopted was in randomized blocks, composed of 6 treatments and 4 repetitions with 50 seeds per experimental unit. The seeds were collected in the Santa Teresa region, removed from the mucilage and sown in tubes with a capacity of 280 mL.

The treatments were composed by different types of substrates in the proportion of 3 part of soil and 1 part of each substrate (V/V), being: pure soil, soil + humus; soil + cattle manure, soil + poultry manure, soil + Natufert®, soil + coffee peel. cattle and poultry manure was used after 6 months in storage for tanning and the humus came from cattle manure decomposed by earthworms after 4 months of decomposition.

The chemical composition of the substrates used in the mixture with the soil is shown in Table 1.

Table 1. Chemical composition of the substrates used in the research.

Component	cattle manure	Poultry manure	humus	Natufertil®	Coffee peel
Nitrogen (N) (%)²	0.59	1.95	0.68	0.85	1.46
Phosphorus (P_2O_5) (%)³	0.52	6.92	1.64	3.4	0.19
Potassium (K_2O) (%)³	2.50	3.24	0.83	1.3	3.0
Calcium (Ca) (%)³	1.40	11.10	1.4	12.0	0.37
Magnesium (Mg) (%)³	0.30	0.94	0.74	2.0	0.19
Sulfur (S)³ (%)³	0.43	0.43	0.42	0.1	0.09
Iron (Fe)³ (%)³	2.25	0.45	1.42	0.1	0.12
Zinc (Zn)³ ppm	170.0	540.0	206.1	-	21.22
Copper (Cu)³ ppm	180.0	450.0	42.5	-	5.0
Manganese (Mn)³ ppm	210	484.1	531	-	110
Boron (B)⁴ ppm	2.03	27.1	13.8	-	2.09
OM Total (%)	22.76	48.06	49.35	100	92.82
OM Compostable (%)	12.50	40.50	46.73	60	55.69
Organic Carbon (%)¹	22.45	23.50	25.84	17	21.67
Relation C/N	38/1	12/1	38/1	20/1	15/1
pH in $CaCl_2$	5.31	9.31	6.42	9.0	5.4

Equivalence between units: ppm=mg/kg; %=g/kg÷10; %= ppm÷10.000;

Methodology recommended by the Ministry of Agriculture (MAPA, 2013).

Results based on dry matter (mass/mass; [1]/ Oxidation with potassium Bichromate; [2]/ Sulfuric digestion; - Analysis wasn't solicited; [3]/ Nitro Perchloric digestion; [4]/ Dry digestion. Source: author's analyzes.

After thirty days of sowing (DS) the percentage of emergence was evaluated (E) and ninety days after sowing the height of the plants (HP, cm) was evaluated with the help of a measuring tape; number of leaves (NL); collection diameter (CD, mm) with digital caliper; root length (RL, cm) with the aid of a measuring tape; leaf green mass (LGM, $g.pl^{-1}$); green root mass (RGM, $g.pl^{-1}$); leaf dry mass (LDM, $g.pl^{-1}$); root dry mass (RDM, $g.pl^{-1}$) weighed on a precision digital scale.

The data obtained were subjected to analysis of variance, according to the model's assumptions by the Shapiro-Wilk test to verify normality and the treatment means compared by the Tukey test at a $p<0.05$ probability level.

Results and Discussion

The increase in substrates with organic sources (humus, cattle manure, poultry manure, coffee peel and Natufert® fertilizer) showed a significant increase in the percentage of germination compared to the control treatment with pure soil, in which all substrates mixed with soil presented statistical difference in relation to the control (Table 2).

Table 2. Emergence and initial development of passion fruit seedlings.

Treatments	E	HP	NL	CD	RL
Pure soil (Control)	70 c	7.92 c	5,.05 c	1.56 d	17.84 c
Soil + húmus	97 a	28.61 b	6.45 b	3,.6 ab	20.90 ab
Soil + cattle manure	83 b	21.80 c	6,.75 b	2.92 b	21.31 ab
Soil + Poultry manure	97 a	29.67 b	7.15 b	3.16 ab	20.40 b
Soil + Natufert®	96 a	14.89 d	7.2 ab	2.32 c	22.54 a
Soil + Coffee Peel	96 a	41.35 a	8.2 a	3.46 a	20.93 ab
CV (%)	7.68	19.75	16.8	13.43	9.01

Average values, followed by the same letters in the columns do not differ statistically by the Tukey test at 5% probability.

E= emergence (%); HP= height of the plants (cm); NL= number of leaves; CD= collection diameter (mm); RL = root length (cm).

All mixtures of substrates in the soil were statistically superior to the control in the variables plant height, collection diameter, number of leaves per plant and root length, and the soil + coffee peel mixture showed absolute values statistically superior to the other treatments in all development variables, with no statistical difference with soil + Natufert® treatment in the number of leaves, soil + humus and soil + poultry manure in the variable diameter of the stem and soil + Natufert®, soil + cattle manure and soil + humus in the length of the root (Table 2).

According to table 2, we can see that the soil-based substrate + coffee peel acted positively, presenting the best results with statistical difference when compared to the other treatments.

Similar results were observed by Silva et al. (2019b) evaluating the emergence and development of yellow passion fruit seedlings in different substrates where they observed the highest plant heights in substrates that received coffee residues. These authors corroborate this work when they also observed that the addition of organic matter to the substrates resulted in significant development gains for seedlings compared to that containing 100% soil.

According to Almeida et al. (2011) yellow passion fruit seedlings have a better development when subjected to organic substrates containing tanned manure in their composition, a fact not observed in this research with passion fruit, as the soil + coffee peel treatment was statistically superior to the soil + cattle manure treatment.

As for the plant height and number of leaves, it is observed that the soil + coffee peel treatment showed the best performance, and, as verified by Bosa et al. (2019), the results can be explained due to the high nitrogen concentration in coffee peel, which provided greater leaf development, as well as the adequate balance of nutrients found in commercial fertilizers that use simultaneous organic and mineral sources.

In the diameter of the collection, the soil + coffee peel treatment also showed the best absolute performance, statistically equal to the treatments soil + humus and soil + poultry manure and higher than the control.

Regarding the root length, it is noted that the most satisfactory values were found in the substrates soil + Natufert®, soil + cattle manure, soil + coffee peel and soil + humus respectively. This characteristic is of great importance in the quality of a seedling, since a longer root system has the capacity to explore larger areas in the soil, with greater possibilities of nutrient acquisition (Sousa, 2010).

It can be observed in Table 3 that all treatments that received an increase in organic source in the formulation of the substrate showed higher values for all the variables analyzed in relation to the control (Pure soil).

The production of green leaf and root mass is of great importance as an indicator of quality, as it reflects its growth as a function of the amount of nutrients absorbed from the substrate. It is observed that the treatment soil + coffee peel, showed results statistically superior to all other treatments.

In Table 1, we have the nutritional values of the substrates, where it is observed that coffee peel has more nitrogen than cattle manure, humus and Natufert®, which may justify the better development of the aerial part of the seedlings. It is also observed that poultry manure has more Nitrogen than coffee peel, but its high pH may make essential nutrients unavailable for the proper development of seedlings.

Although the nutritional levels found in poultry manure are in the medium to high range, the pH above nine may have hindered the absorption of nutrients by the seedlings, negatively influencing the quality of the seedling produced (Paixão et al., 2012).

In the development of the root system, it is observed that the organic substrates acted positively for the production of green and dry mass, in which the treatments soil + humus, soil + cattle manure, soil + poultry manure and soil + coffee peel, presented superior the witness without statistical difference between them (Table 3).

Table 3. Green and dry mass production in passion fruit seedlings.

Treatments	LGM	RGM	LDM	RDM
Pure soil (Control)	0.462 d	0.554 c	0.307 d	0.298 d
Soil + húmus	4.153 b	2.550 a	2.389 b	1.579 a
Soil + cattle manure	3.088 c	2.6481 a	2.299 b	1.413 ab
Soil + Poultry manure	4.920 b	2.331 a	2.579 b	1.357 ab
Soil + Natufert®	2.216 c	1.375 b	1.277 c	0.746 c
Soil + Coffee Peel	6.663 a	2,.337 a	4,.402 a	1.384 ab
CV (%)	27.65	34.83	36.52	27.39

Average values, followed by the same letters in the columns do not differ statistically by the Tukey test at 5% probability.

LGM= green mass of the leaves (g.pl^{-1}); RGM= green mass of the root (g.pl^{-1}); LDM= dry mass of the leaves (g.pl^{-1}); RDM= dry mass of the root (g.pl^{-1}).

Paixão et al. (2012) working with papaya seedlings, observed that the high pH of the manure (9.31), with high % of calcium, caused the length of the seedling roots to grow, however, the root mass was reduced in relation to the pattern. This fact did not alter the root development of passion fruit seedlings, despite the high pH found in poultry manure (Table 1), the production of mass in the roots was not affected as in the production of leaf mass, due to the low production of roots.

Higashikawa et al. (2010), also found in poultry manure, pH above 7, a value higher than the ideal range for most cultures, showing that the use of poultry manure for some cultures is conditioned to the mixing of some product that can lower its pH.

Moschini et al. (2018), corroborate the results found in this research, citing that the increase with humic acid enabled a better root development in tomato seedlings. In addition, all the increments used in the substrates are rich in organic matter and according to Cunha et al. (2015) organic matter is considered one of the most useful indicators for assessing soil quality, as its interaction with various soil components has a direct effect on water retention, aggregate formation, soil density, pH, buffering capacity, Cation-exchange capacity, mineralization, infiltration and microbial activity.

Conclusions

All treatments with the addition of different organic substrates to the pure soil were superior in the emergence and development of seedlings in relation to the use of pure soil, showing to be efficient for the production of yellow passion fruit seedlings.

The soil + coffee peel mixture showed the best results for emergence, height of seedlings and production of green and dry leaf mass, characterizing among the substrates used a better development of yellow passion fruit seedlings, which can be recommended for the production of seedlings of this species.

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