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Short Research Articles

Alternative substrates for production of tomato seedlings of the cherry group

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ABSTRACT

The cherry tomato crop has a high production cost but can be reduced in part through the use of alternative substrates. The present research had the objective of evaluating the different alternative substrates for production of tomato seedlings of the cherry group. The experiment was conducted in a completely randomized design, in which five treatments (T1: Bioplant® commercial substrates (control); T2: earthworm humus; T3: Soil; T4: 50% Soil + 50% earthworm humus; T5: 75% Soil + 25% earthworm humus) in four replicates. At 28 days after sowing the seedlings were collected and evaluated, where a significant effect of the substrates was observed in relation to plant height, leaf number, fresh mass aerial part and dry mass of the aerial part, in which the alternative substrates have had similares performances and even superior to the commercial substrate. There are alternative substrates capable of replacing the commercial, being the T5 treatment the most indicated, since it did not differ from the commercial substrate in relation to the agronomic characteristics, and presented 24% less in the cost of production.

Key-words: initial development; production cost; tomato seedlings; organic compounds.

1. INTRODUCTION

The tomato (*Solanum lycopersicum* Lam.) is a plant originating in the Andean region that covers part of Chile, Colombia, Ecuador, Bolivia and Peru [1]. It is cultivated and consumed in almost all over the world, due to its organoleptic and nutritional characteristics, being rich in lycopene, vitamins of complex A and ofcomplex B and important minerals such as phosphorus and potassium, as well as folic acid, calcium and fructose [2].

The world's largest tomato producer is China with 52 million tonnes, followed by India, the United States and Egypt with 18, 14 and 8 million tonnes, respectively. Brazil ranks ninth in the ranking of the world's largest tomato producers with 4 million tonnes [3].

There are five main groups of tomato in the country: Santa Cruz, Salad or Saladete, Cherry, Italian and Agroindustrial [4], among them the cherry group that has superior quality and with taste better than traditional table tomatoes. Nowadays, the search for healthier and higher quality foods has made the cherry group gain prominence. However, only a small portion of society has access to this tomato group, due to its cost of production, culminating in a high cost product for the consumer [5].

In this sense, the most advantageous system in the production of horticultural seedlings has been in trays, which has shown superior in several aspects, since the economy with substrate reduction up until the area used in the greenhouse, with the advantage of lower

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cost for the control of pests and diseases, increased quality of seedlings produced, index high of glue of molt after transplanting, lower manpower utilization, reduction of the amount of seeds used, improvement of phytosanitary control, in addition to having an earlier harvest [6]. The success of this system depends mainly on the quality of the substrate used, being more commercial substrates employed, which add a higher cost to the final product than the alternative substrates made by the farmers themselves [7].

Thus, note the importance of the production of alternative substrates by the farmers themselves. The substrates may be formed from mineral source materials, organic or synthetic, of only one material or of the mixture of two or more materials, being essential that this has desirable chemical, physical and biological characteristics [8]. The alternative substrate made on the property should contain readily available materials in the region, that are are low cost, besides providing conditions favorable to the development of the root system, of seedling nutrition and less possibility of contamination by phytopathogens [9].

In view of the foregoing, the objective of this work was to evaluate the influence of alternative substrates for of tomato seedlings of the cherry group.

2. MATERIAL AND METHODS

The experiment was carried out in a greenhouse at the Agricultural Sciences Center of the Federal University of Alagoas (CECA/UFAL), located in the municipality of Rio Largo-AL (09° 28' 02" S; 35° 49' 43" W; 127 m), in february 2016.

Five substrates were evaluated, which were constituted as follows: T1: Bioplant® commercial substrate (control); T2: earthworm humus; T3: Solo; T4: 50% Soil + 50% earthworm humus; T5: 75% Soil + 25% earthworm humus, whose chemical compositions are presented in Table 1.

Table 1. Chemical composition of the five substrates used in the production of tomato seedlings of the cherry group. Rio Largo-AL, UFAL, 2016.

Parameters	Substrates*				
	T1	T2	T3	T4	T5
pH (CaCl)	5.00	7.40	5.10	6.30	5.70
H+Al (cmol.dm^{-3})	3.70	1.70	4.00	2.90	3.40
Al (cmol.dm^{-3})	0.01	0.01	0.04	0.02	0.03
MO (g.dm^{-3})	21.80	30.10	16.70	23.40	20.10
Ca (mmol.dm^{-3})	22.00	56.00	26.00	41.00	33.50
Mg (mmol.dm^{-3})	12.00	46.00	18.00	32.00	25.00
K (mmol.dm^{-3})	16.30	6.50	2.10	4.30	3.20
P (mmol.dm^{-3})	5.90	8.00	0.30	4.20	2.20
SB (mmol.dm^{-3})	50.00	108.50	48.00	78.30	63.10
CTC (mmol.dm^{-3})	87.00	125.50	88.00	106.80	97.40
V (%)	58.00	86.50	54.40	70.40	62.40
Mn (mg.dm^{-3})	4.70	140.20	11.40	75.80	43.60
Fe (mg.dm^{-3})	113.10	76.10	236.00	156.10	196.00
Cu (mg.dm^{-3})	21.20	1.00	0.40	0.70	0.50
Zn (mg.dm^{-3})	28.20	71.00	1.80	36.40	19.10

* T1: Bioplant® commercial substrates (control); T2: earthworm humus; T3: Soil; T4: 50% Soil + 50% Worm humus; T5: 75% Soil + 25% earthworm humus.

A completely randomized design with five treatments and four replications was used. The sowing was done in trays of 98 cells, where the experimental portion consisted of the 98

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seedlings of the cells, being the useful area the 40 central seedlings of the tray. Before sowing the cells of the trays were filled with the substrates corresponding to the treatments, then a space of 1 cm of depth was made to deposit the seed of the Carolina cultivar. The seedlings were irrigated once a day until they were 28 days old, where the following characters were evaluated: height of the plant (AP), in cm; number of leaves (NF), in unit; fresh weight of aerial part (MFPA), in g; dry weight of aerial part (MSPA), in g; diameter of the collar (DC), in mm; root length (CR), in cm; emergency (E) in%; emergency velocity index (IVE), dimensionless; mean time of emergence (TME), in days/seeds; cost of production of substrates (CPS), in R$.t^{-1} and US$.t^{-1}, adopting the average price of the region; relative cost (CR), in %, cost of the alternative substrates in comparison to the commercial substrate.

For AP, a millimeter ruler was used, where it was measured from the surface of the substrate until the inserted of last leaf. The DC was measured using a digital caliper, at the high of lap of the seedling. For MFPA the seedlings were cut and then weighed in analytical balance. Already for MSPA, the seedlings were cut and placed in paper bags, then brought into forced ventilation oven at 65 °C for 72 hours and then weighed on analytical balance. The NF was counted per unit and CR was measured at the root of longer length with millimeter ruler. The variables E, IVE and TME were calculated by the respective formulas below:

$E = \frac{N}{A} \times 100$, on what:

N - Total number of germinated seeds;

A - Total number of seeds sown;

$IVE = \frac{E1}{N1} + \frac{E2}{N2} + \cdots + \frac{En}{Nn}$, on what:

E1, E2, ..., En - Number of normal seedlings emerged in the first, second to last count;

N1, N2, ..., Nn - Number of days of sowing to first, second to last count;

$TME = \frac{\sum ni \times ti}{\sum ni}$, on what:

ni - Number of seeds emerged per day;

ti - Incubation time (days);

Analyzes of variance were performed, in case the significant F test, the Tukey test was applied at (P = 0.05) using the computational software Minitab 17.

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3. RESULTS AND DISCUSSION

There was significant effect at P=0,01 and P=0,05 by the F test between the substrates in the NF and AP, MFPA and MSPA variables, respectively (Table 2). The coefficient of variation for these variables was between 12.94 % and 18.28 %, being considered regular according to Ferreira [12].

Table 2. Mean results of height of the plant (AP), number of leaves (NF), fresh weight of aerial part (MFPA) and dry weight of aerial part (MSPA) in tomato seedlings of the cherry group cultivated in trays with alternative substrates. Rio Largo-AL, UFAL, 2016.

Substrates[1]	AP (cm)	NF (un.)	MFPA (g)	MSPA (g)
T1	9.70 b[2]	17.35 ab	0.70 b	0.11 ab
T2	13.49 a	22.60 a	1.34 a	0.15 a
T3	8.40 b	14.75 b	1.23 a	0.06 b
T4	13.18 a	21.67 ab	1.32 a	0.15 a
T5	13.87 a	22.62 a	1.33 a	0.15 a
QM	24.7470**	50.8400*	0.2966**	0.0067**
P	0.0003	0.0196	0.0002	0.0001
CV (%)	12.94	17.82	13.83	18.28

1/ T1: Bioplant® commercial substrates (control); T2: earthworm humus; T3: Soil; T4: 50% Soil + 50% earthworm humus; T5: 75% Soil + 25% earthworm húmus. 2/ Means with the same letter in the column do not differ by Tukey test at P=0,05. ** Significant at P=0,01 by F test. * Significant at P=0,05 by F test.

The substrates formulated with earthworm humus (T2, T4 and T5), regardless of the proportion, provided higher plant heights, thus, they differed statistically from the substrates (T1 and T3), which presented lower plant heights. It is noted that these substrates were important for this characteristic, since they were superior to the commercial substrate T1 (control). This fact is related to the amount of organic matter present in these materials, where several authors attribute to it the final quality of the seedlings, Araújo Neto et al. [10]. It is important to mention that all the substrates provided higher AP when compared to the substrates studied by Rodrigues et al. [11], which evaluated the production of tomato seedlings, using trays of different cell volumes and substrates based on soil and organic compost, obtaining the maximum value of 5.61 cm, much lower than the values found in the present study, evidencing the potential of the substrates studied.

As for the number of leaves emitted by plants, it was verified that only the substrate T3 differed from the others, this being the one that provided the lowest emission of leaves, something that is not desirable, because the tendency is that with fewer leaves the plant synthesizes fewer photoassimilates, which will reflect in less force and final production. Rocha [12] also mentions the importance of the leaves, which according to him is the main storage organ of dry matter in the tomato crop. The difference of the T3 substrate with the others, regarding NF, can be explained by its chemical composition (Table 1), where the low P content is remarkable. It is known that P participates in several metabolic processes in plants, such as energy transfer, synthesis of nucleic acids, glucose, respiration, synthesis and membrane stability, besides being responsible for the emission of leaves, since this

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element is used for the synthesis of ATP and NADPH, which in turn are used for the synthesis of sugars in the fixation and reduction reactions of CO2 [13]. This statement is also shared by Melo [14] who observed higher NF for treatments that received high amounts of P, however attention is needed because very high doses of P can cause toxicity to the plant.

In the evaluation of the fresh mass of the aerial part (MFPA), it is observed that the substrates T2, T3, T4 and T5 did not differ among themselves, but rather in relation to the commercial substrate. It is clear that there are economically viable alternatives for replacing the commercial substrate, which leads to a decrease in the cost of the seedling. The alternative substrates differed from T1, which provided the smallest fresh mass of aerial part. This fact can be explained by analyzing the foliar tissue, where several authors concluded that the decreasing order of absorption is Ca>N>K and it can be observed in the chemical composition of the substrates (Table 1) that T1 presents the lowest values of Ca and K, so these elements may be the factors that led T1 to have the lowest MFPA Ferreira [15].

Regarding the dry mass of the aerial part (MSPA), it was possible to verify that the substrates T1, T2, T4 and T5 presented the larger developments of the plants, due to the accumulation of photoassimilates, which are statistically similar. It is important to note that most of the alternative substrates had similar behavior to the commercial substrate for MSPA, where it is a feature that will influence the vigor and productivity of the plant. On the other hand, the T3 substrate had the worst result for MSPA, differing from the others. With the exception of T3, the other treatments (T1, T2, T4 and T5) presented MSPA higher than those found by Costa et al. [9] demonstrating that it is possible to replace the commercial substrate with another alternative, without loss of the agronomic quality of the seedlings.

It is observed an association between AP and NF with MSPA, since the increase in AP and NF conferred MSPA increase, that is, these characteristics are somehow dependent. This relationship between AP and NF with MSPA is also cited by Ferreira [15]. For the variables DC, CR, E, IVE and TME, there was no significant difference at P=0,05 by the F test (Table 3). For these characteristics the behavior of seedlings of cherry tomatoes, regardless of the type of substrate used, so it is perceived that the alternative substrates had the same agronomic performance as the commercial one.

Table 3. Average values for the diameter of the lap (DC), root length (CR), emergence (E), emergency speed index (IVE) and mean time of emergency (TME) in tomato seedlings of the cherry group cultivated in trays with alternative substrates. Rio Largo-AL, UFAL, 2016.

Substrates[1/]	DC (mm)	CR (cm)	E (%)	IVE (ad.)	TME (dias)
T1	2.64	12.67	85.71	21.76	5.47
T2	3.02	12.00	82.48	21.54	4.10
T3	2.28	12.15	69.05	16.85	6.24
T4	3.12	13.75	79.76	21.17	5.35
T5	2.95	13.08	89.45	20.66	7.08
QM	0.4646^{ns}	2.0230^{ns}	239.8884^{ns}	16.4016^{ns}	2.7956^{ns}
P	0.1200	0.2059	0.4023	0.7344	0.3739
Average	2.80	12.73	81.29	20.40	5.65
CV (%)	16.45	8.61	18.36	28.00	26.82

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[1/] T1: Bioplant® commercial substrates (control); T2: earthworm humus; T3: Soil; T4: 50% Soil + 50% earthworm humus; T5: 75% Soil + 25% earthworm húmus. [ns] Not significant at P=0,05 by F test.

Results lower than the DC of the present study were observed by Costa et al. [9], where evaluating the effect of different types of substrates obtained for the best treatment the value of 1.76 mm. The CR is an important parameter to discuss, because he is one of the responsible for the glue of the seedling in the transplanting, besides indicating indirectly the aeration of the substrate. Thus, plants with higher CR allow to indicate that the substrate presents low resistance to root penetration, allowing to maintain adequate levels of turgescence of the cells of the seedlings, which will reflect on vigorous seedlings Sampaio et al. [16]. In this aspect, it can be seen that all the alternative substrates (T2, T3, T4 and T5) had the same result as the commercial one and, up until higher to those found by Klein et al. [8].

As for E, IVE and TME, the alternative substrates (T2, T3, T4 and T5) obtained the same performance as the commercial substrate (T1), maintaining with this the same time of permanence of the seedlings in the nursery, which will promote resistance to conditions of the cultivation medium [9]. These substrates probably have interesting characteristics to a good substrate, such as porosity, fertility and sterility. The high values of E, IVE and TME showed that the substrates used had high water retention capacity, besides allowing the movement of water and air, providing an ideal condition for the emergence and development of the seedlings. Similar values of E, IVE and TME can be observed in the works of Rios et al. [17].

When analyzing the cost of production of the substrates it can be observed that the price of the ton of the commercial substrate is relatively higher than the other substrates evaluated (Table 4). The price of the commercial substrate (T1) was US$ 9734.38 per ton, well above the cost of production of the alternative substrates, ranging from 21 to 32% of the T1 cost. These values demonstrate how much the cost of production could be reduced by replacing the commercial substrate with an alternative source. This implies a greater economic return to tomato producers, as well as, to smaller the value of the product in the commerce, consequently, enabling a greater consumption of cherry tomatoes by the population.

Table 4. Economic analysis of the production of the substrates. Rio Largo-AL, UFAL, 2016.

Parameters	Substrates[1/]				
	T1	T2	T3	T4	T5
CPS[2/] ($R\$.t^{-1}$)	3125.00	1000.00	667.00	834.00	750.00
CPS ($US\$.t^{-1}$)[3/]	9734.38	3115.00	2077.71	2597.91	2336.25
CR[4/] (%)	----	32.00	21.34	26.69	24.00

[1/] T1: Bioplant® commercial substrates (control); T2: earthworm humus; T3: Soil; T4: 50% Soil + 50% earthworm humus; T5: 75% Soil + 25% earthworm humus. [2/] CPS: Production cost of the substrates for one tonne of the substrate, with average prices of the region. [3/] Converted price in dollar by exchange rate of 3.115. [4/] CR: Relative cost of the alternative substrate compared to the commercial substrate.

4. CONCLUSION

From the results presented in this work, it can be concluded that there are alternative substrates that can replace the commercial, being the substrates T2, T4 and T5 recommended, since there is no loss of quality and vigor of the seedlings and will still cost

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varying from 24 to 32% in relation to the commercial substrate, which will lead to a better financial result for the producer, and enables people more to access the cherry tomatoes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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