AUSTRALIAN JOURNAL OF CROP SCIENCE | SUBMITTED: 30-AUG-2016 | REVISED: 05-NOV-2016 | ACCEPTED: 05-DEC-2016

Australian Journal of
Crop Science
AJCS

AJCS 11(12):1504-1507 (2017)
ISSN:1835-2707
doi: 10.21475/ajcs.17.11.12.pne315

Emergence and early development of tomato seedlings cv. santa clara in alternative substrates

Tarciana Silva dos Santos[1], Wéverson Lima Fonseca[2], Alan Mario Zuffo[3], Tiago de Oliveira Sousa[4], Fernandes Antonio de Almeida[4], Ananda Rosa Beserra Santos[1], Glauciany Soares Lopes[4], Wéverton José Lima Fonseca[4]

[1]Department of phytopathology, Federal University of Pernambuco, 52171-900, Recife, Pernambuco, Brazil
[2]Department of Crop Production, Federal University of Ceará, 60020-181, Fortaleza, Ceará, Brazil
[3]Department of Crop Production, State University of Mato Grosso do Sul, 79540-000, Cassilândia, Mato Grosso do Sul, Brazil
[4]Department of Biological Sciences, Federal University of Piauí, 64900-000, Bom Jesus, Piauí, Brazil

***Corresponding author email: alan_zuffo@hotmail.com**

Abstract

A quality substrate is essential to ensure the proper conditions for the emergence and early development of seedlings. The aim of the present study was to evaluate different proportions of termite mound substrate in the emergence and early development of tomato seedlings. The experiment was performed in a completely randomized design, with five treatments constituted by the substrates, with four replications: T_1: Washed sand (100%); T_2: Washed sand (75%) + termite mound material (25%); T_3: Washed sand (50%) + termite mound material (50%); T_4: Washed sand (25%) + termite mound material (75%) and T_5: termite mound material (100%). The Santa Clara cultivar (tomato) of Topseed® was used. The seeds were distributed in gerbox boxes. Emergence, emergence speed index, shoot height, number of leaves, shoot dry mass, root length and root dry mass of tomato seedlings development were evaluated after 25 days. The use of termite mound substrates is a viable alternative to the emergence and development of tomato seedlings. In general, the substrate of termite mound material (100%) was the most promising in the increment of all variables.

Keywords: *Solanum lycopersicum*; propagation; termite mound material.

Abbreviations: CPCE_Cinobelina Elvas Campus; UFPI_Federal University of Piaui; SE_Seedling emergence; ESI_Emergence speed index; SH_Seedling heigh; NL_Number of leaves; SDM_Shoot dry mass; RL_Root length; RDM_Root dry mass.

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important and expressive crops in the worldwide agricultural area. Its fruits stand out in commercialization (*in natura*) and in extraction industry (Souza et al., 2013). Thus, olericulture is an agricultural activity which is recognized for its positive impacts on job and income generation in society, meeting the needs of small properties, by enabling profitability and concentrating work labour, providing greater food supply (Diniz et al., 2006). On the other hand, the increased consumption and utilization of vegetables, resulting in business activity, has generated consumers with higher demands for quality products and food safety (Coelho, 2007). The demand for quality vegetables is increasing, and this has driven changes in production techniques (Klein et al., 2009). Producers with greater technological support have started using new cultivation practices in industrial tomato production, such as drip irrigation combined with fertirrigation, *mulching* application and the use of high quality hybrid seeds (Souza et al., 2013). However, there are still few studies that indicate adequate or alternative substrates for the emergence and development of tomato seedlings, especially the ones that may reduce or replace commercial products and reduce the costs for tomato seedlings production. Thus, the search for knowledge of new management forms to contribute to the development of new technologies for the olericulture aims to assist the growth and sustainability of the sector (Santos et al., 2015).

Currently, organic substrates are being widely used by nurserymen, not only because they meet the plants needs but also due their low cost and especially because they are not pollutants, contributing to the preservation of the environment (Silva Júnior et al., 2014). Thus, the search for alternative materials for the mixture formulation that can be used as substrate for plant growth has become a growing concern, aiming to reduce the use of industrial inputs, causing economic and ecological benefits that are able to promote sustainable agricultural systems (Oliveira, 2011).

The application of termite mound material during the plant growth is not a common practice, but in some studies, positive results were verified by this practice adopted by some low-income producers from northern Brazil (Souza et al., 2011). Researches with termite mound material have been held with lettuce (Oliveira and Paiva, 1985), sorghum (Novelino et al., 2001) and passion fruit (Souza et al., 2011) and have shown satisfactory results. However, there are no reports testing this material during the growth and development of tomato seedlings.

In this context, in communities where there is a shortage in material resources, as it occurs in settlements and in small farms, the termite mound material can be a viable source of organic matter and nutrients to the plants. Thus, the aim of the present study was to evaluate different proportions of termite mound substrate in the emergence and early development of tomato seedlings.

Results and Discussion

In general, there was a significant treatment effect ($p \leq 0.01$) for all the evaluated traits. A significant effect of the mound material in the development of lettuce and passion fruit seedlings was verified by Oliveira and Paiva (1985) and Souza et al. (2011), respectively.

Effect of substrate in the emergence process

The emergence of seedlings has shown higher means in T_3: washed sand (50%) + termite mound material (50%); T_4: Washed sand (25%) + termite mound material (75%); and T_5: termite mound material (100%) (Fig. 1a). However, for the emergence speed index, it was observed that all treatments with termite mound material (T_2, T_3, T_4, T_5) were statistically superior to T_1: washed sand (100%) (Fig. 1b). The high values for ESI on termite mound substrates can be attributed to the possible capacity of the material to maintain the moisture close to the seeds, since it presents considerable amounts of organic matter (Table 1). Substrates with a high content of organic matter provide a high number of pore spaces, and a low apparent density (Steffen et al., 2010). The porosity is a very important factor for the full development of plants, since it can provide adequate aeration and drainage, making the substrate structured and with greater water retention capacity (Diniz et al., 2006).

Effect of the substrate on early seedling growth

For seedling height (SH), there was a significant difference between treatments, especially for termite mound material in T_3: washed sand (50%) + termite mound material (50%); T_4: Washed sand (25%) + termite mound material (75%) and T_5: termite mound material (100%), which were statistically superior to T_1: Washed sand (100%), with respective SH increases of 78.57%, 92.86% and 114.29% (Fig. 2a). The addition of this variable may be related to the favoring of chemical and physical properties of the substrate (Table 1), mainly for the supply of calcium which has an important role in plant growth due to its performance in the cell division and elongation (Villas-Boas, 2014). In a research conducted by Souza et al. (2011), regarding the growth of passion fruit seedlings (*Passiflora edulis)* with boron-based and termite mound material fertilization, the maximum plant height (14.1 cm) could be achieved with doses of 75 g dm^{-3} of termite mound material, with 0.76 mg dm^{-3} of B.

Regarding the number of leaves per plant (NL), all treatments with termite mound material were effective in increasing this variable, especially the T_5: termite mound material (100%), which showed NF values 60% higher than T_1: washed sand (100%) (Fig. 2b). The termite mound material presents great calcium, magnesium, phosphorus and potassium content (Table 1). This fact may have caused higher leaf development in seedlings, with increase in the carbohydrate metabolism, light radiation interception and photosynthetic activity. For Scalon et al. (2003) the leaf area can be considered a productivity index, due to the importance of photosynthetic organs in biological production. Souza et al. (2011) observed that the maximum leaf area of passion fruit (429.1 cm^2/ pot) can be obtained with the combined doses of 75 g dm^{-3} of termite mound material and 0.81 mg dm^{-3} of B.

The shoot dry mass (SDM) was significantly affected by the treatments, with higher values in descending order for $T_5 > T_4 > T_3 > T_2 > T_1$ (Fig. 2c). Oliveira and Paiva (1985) evaluating the production of lettuce, found that the application of 50 g of termite mound material (whole crushed mound) increased in 288% the shoot mass of this crop, compared to the control. Novelino et al. (2011) verified that the dose of 76.2 g of termite mound material increased in 62% the shoot dry mass production of sorghum. Souza et al. (2011) found a maximum shoot dry mass production of passion fruit (2.88 g/pot), with the application of 75 g dm^{-3} of card material and 0.90 mg dm^{-3} of B.

The root length (RL) was positively affected by the increase in concentration of termite mound, where T_3: washed sand (50%) + termite mound material (50%); T_4: washed sand (25%) + termite mound material (75%) and T_5: termite mound material (100%) differed significantly from T_1: washed sand (100%), culminating in RL increase in 46.46%, 51 52% and 61.62%, respectively (Fig. 2d). The increase in root growth could be influenced by the low aluminum content in the termite mound material as well as by the dynamics of nutrients in this compound (Table 1). According to Souza et al. (2013) the formation of longer roots allows the seedlings to exploit better the volume of the substrate that is available, enabling a greater water, nutrients and oxygen absorption to the breathing process.

For the root dry mass (RDM), all the treatments with termite mound substrate differed from the substrate treatment T_1: washed sand (100%), especially T_4: washed sand (25%) + termite mound material (75 %) and T_5: termite mound material (100%) with means for RDM of 94.77% and 107.23%, respectively, superior to T_1 substrate: washed sand (100%) (Fig. 2e). These results emphasize the importance of using termite mound material as alternative substrate for emergence and early development of tomato, since it offers considerable amounts of nutrients, particularly calcium (Table 1). According to Luz et al. (2004) the dry matter weight allows to know which substrate will provide higher amounts of nutrients.

Despite the benefits that have been seen in the emergence and early development of tomato seedlings cv. santa clara with the use of termite mound material in the composition of substrates, future studies in nursery conditions should be performed to make the use of this material viable in the production of tomato seedlings**.**

Materials and Methods

Experimental area location

The experiment was performed at the Phytopathology Laboratory at Professor Cinobelina Elvas Campus (CPCE) of the Federal University of Piaui - UFPI, located in Bom Jesus-PI from March 19 to April 3, 2014.

Experiment installation and conducting

The experiment was performed in a completely randomized design, with five treatments constituted by the substrates, with four replications: T_1: Washed sand (100%); T_2: Washed sand (75%) + termite mound material (25%); T_3: Washed sand (50%) + termite mound material (50%); T_4: Washed sand (25%) + termite mound material (75%) and T_5: termite mound material (100%). The termite mound material (soil and other waste built by termites) was collected near the CPCE at UFPI at unsheltered areas with dystrophic Yellow Latosol, with a very clayey texture. Subsequently, they were

Table 1. Termite mound chemical and texture attributes.

pH	$Ca^{2+} + Mg^{2+}$	Ca^{2+}	Al^{3+}	K	P	OM
H_2O	------------------------ $cmol_c\ dm^{-3}$	------------------------			$mg\ dm^{-3}$	dag/kg^{-1}
6.35	5.45	1.91	0.1	0.3	86.9	84.8

Sieve distribution (%)		
Sand	Silt	Clay
54.09	11.68	34.23

Chemical Attributes: P, Na, K, - Mehlich extractor 1; Ca, Mg and Al - KCl Extractor - 1 mol / L; H + Al - SMP extractor; SB = Sum of exchangeable bases; CEC (t) - Exchange Capacity Effective Cation; CTC (T) - Exchange Capacity Cation pH 7.0; V = Base Saturation Index; m = Aluminium Saturation Index; . Org Matter (OM) - oxidation:. Na2Cr2O7 4N + H2SO4 10N. Sieve Distribution (%) sodium hydroxide extractor (NaOH).Soil Analysis Laboratory of the Federal University of Piauí, Campus Professor Cinobelina Elvas, Bom Jesus - PI.index.

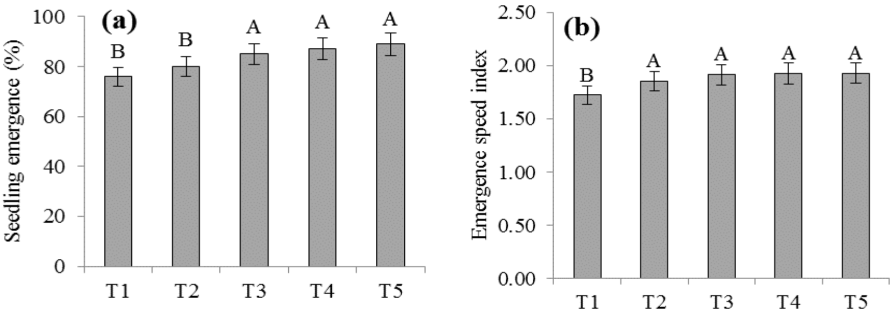

Fig 1. Mean values for the characteristics: seedling emergence (a) and emergence speed index (b) of tomato seedlings in alternative substrates. Means followed by the same letter in the column do not differ statistically by Scott and Knott test at 5% probability. Data refer to mean values (n = 4) ± standard error.

Table 2. Analysis of variance for seedling emergence (SE), emergence speed index (ESI), seedling height (SH), number of leaves (NL), shoot dry mass (SDM), root length (RL) and root dry mass (RDM) of tomato seedlings with alternative substrates.

Source of variation	Mean Square						
	SE	ESI	SH	NL	SDM	RL	RDM
Treatments	453.20**	0.031**	11.58**	1.48**	707.50**	1.08**	415.12**
Residue	99.75	0.005	0.25	0.14	5.87	0.04	4.35
C. V. (%)	3.09	3.71	8.88	10.99	5.08	7.46	5.08

** Significant at 1%;^{ns} not significant. C.V. - coefficient of variation. C. V. – coefficient of variation.

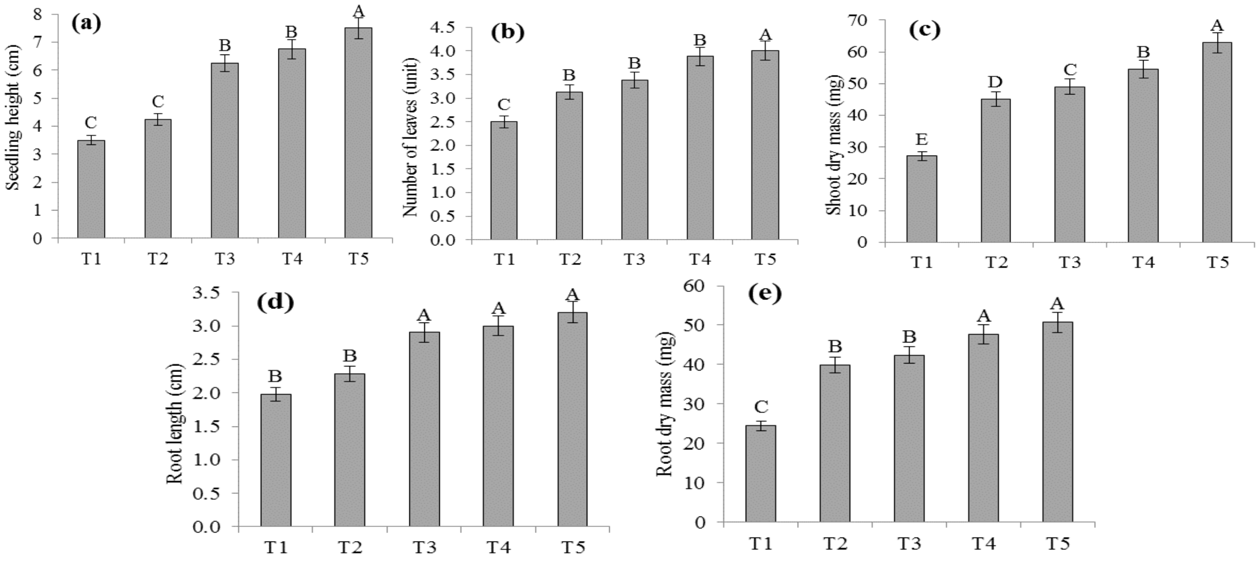

Fig 2. Mean values for the characteristics: seedling height (a), number of leaves (b) and shoot dry mass (c), root length (d) and root dry mass (e) of tomato seedlings in proportions between termite mound substrate and sand. Means followed by the same letter in the column do not differ statistically by Scott and Knott test at 5% probability. Data refer to mean values (n = 4) ± standard error.

stored in fiber bags and autoclaved at 120 °C for 1 hour, then they were sifted and distributed in gerbox boxes. The chemical and physical composition of termite mound material is presented in Table 1.

The cultivar Santa Clara (tomato) Topsed® was used and 20 seeds were sown in gerbox boxes, and then placed in B.O.D chambers at 25°C and 12-alternate-hour photoperiod. After sowing, the treatments were irrigated according to the crop needs.

Evaluated characteristics

Each plot consists of a gerbox (20 seedlings). Ten uniform seedlings were used for all the evaluations except the emergence and emergence speed index (ESI). ESI was daily evaluated by registering the number of seedlings germinated during 25 days after sowing. The ESI calculation was performed according to Maguire (1962): $ESI = [N1 / 1 + (N1-N2) / N2 + (N3-N2) / n3 + ... (Nn-Nn-1) / n]$, where N1, N2, N3, ... Nn correspond to the number of emerged seedlings and 1, 2, 3 ... n, to the number of days after sowing. During 25 days after sowing, seedling height and root length - with the aid of a graduated ruler; count of definitive leaves; evaluation of shoot dry mass (mg) and root system (mg) were also evaluated. The seedlings were washed, weighed and the shoot and root parts were separated, then dried in an oven with circulation and renewal of forced air under 65 °C, until constant weight, and then weighed in a semi-analytical balance and the seedlings weight dry mass was determined in milligrams.

Statistical analysis

The data obtained for each treatment were submitted to normal analysis by Shapiro-Wilk test and variance analysis by the "F" test at 5% of significance, with the aid of "R" software version 3.1.3. When the means were significant, they were compared by the Scott and Knott test at 5% of probability.

Conclusion

The use of substrates made from termite mound is a viable alternative to the emergence and early development of tomato seedlings. The substrate with termite mound material (100%) was the most promising in the increment of all variables.

References

Coelho KS (2007) Perfil do consumidor de hortaliças frescas e processadas no município de campos dos Goytacazes – RJ. 73p. Dissertation (Masters in Crop Production) - State University of Norte Fluminense, Goytacazes – RJ.

Diniz KA, Guimaraes STMR, Luz JMQ (2006) Húmus como substrato para a produção de mudas de tomate, pimentão e alface. Bioscience J. 22(3):63-70.

Klein MR, Pereira DC, Souza HWC, Monteiro VH, Bernardi FH, Costa LAM, Costa MSSM (2009) Substratos alternativos para produção de mudas de tomate tipo cereja. Rev Bras Agroec. 4(2):3339-3342.

Luz JMQ, Brandão FD, Martins ST, Melo B (2004) Produtividade de cultivares de alface em função de mudas produzidas em diferentes substratos comerciais. Bioscience J. 20(1):61-65.

Maguire JD (1962) Speed of germination aid in selection and evaluation for seeding emergence and vigor. Crop Sci. 2(2):176-177.

Novelino JO, Cunha LAG, Marchetti ME (2001) Material de termiteiro do cupim-de-montículo (Isoptera: Termitidae) e níveis de fósforo influenciando o crescimento do sorgo granífero. In: Brazilian Congress of Soil Science, Londrina. Summaries... Londrina: Brazilian Society of Soil Science, 161p.

Oliveira LA, Paiva WO (1985) Utilização de cupinzeiro e esterco de galinha como adubo em alface num Podzólico Vermelho-Amarelo da região de Manaus. Acta Amaz. 15(1-2):13-18.

Oliveira EAG (2011) Desenvolvimento de substratos orgânicos, com base na vermicompostagem, para produção de mudas de hortaliças em cultivo protegido. 65 f. Dissertation (Masters in Crop Production) - Rural Federal University of Rio de Janeiro, Rio de Janeiro.

Santos ACM, Carneiro JSS, Junior JMF, Silva MCA, Silva RR (2015) Produção de mudas de tomateiro cv. Drica sob substratos alternativos. Agrop Cien Sem. 11(4):01-12.

Scalon SPQ, Mussury RM, Rigoni MR, Filho HS (2003) Crescimento inicial de mudas de *Bombacopsis glabra* (Pasq.) A. Robyns sob condição de sombreamento. Rev Árvore 27(3):753-758.

Silva Júnior JV, Beckmann MZ, Silva LP, Brito LPS, Avelino RC, Cavalcante IHL (2014) Aproveitamento de materiais alternativos na produção de mudas de tomateiro sob adubação foliar. Rev Cienc Agron. 45(3):528-536.

Souza GG, Novelino JO, Scalon SQP, Marchetti ME (2011) Crescimento de mudas de maracujazeiro em função de adubação à base de boro e material de cupinzeiro. Pes Agrop Trop. 41(2):170-178.

Souza EGF, Júnior APB, Silveira LM, Santos MG, Silva EF (2013) Emergência e desenvolvimento de mudas de tomate IPA 6 em substratos, contendo esterco ovino. Rev Ceres 60(6):902-907.

Steffen GPK, Antoniolli ZI, Steffen RB, Machado RG (2010) Casa de arroz e esterco bovino como substratos para a multiplicação de minhocas e produção de mudas de tomate e alface. Acta Zool Mex. 26(2):333-343, 2010.

Vilas-Boas AAC (2014) Qualidade pós-colheita de frutos de tomateiro em função de fontes de cálcio. 2014. 94p. Dissertation (Masters in Agronomy - Crop Science) - Federal University of Lavras, Lavras.