http://journal.unoeste.br/index.php/ca/index
DOI: 10.5747/ca.2022.v18.n2.a488
ISSN on-line 1809-8215

Colloquium Agrariae

Submetido: 05/02/2022 Revisado: 04/04/2022 Aceito: 05/04/2022

Organic material as supplementation for substrate in papaya seedlings production

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Abstract
Papaya is among the main fruit species produced in Brazil, representing high socioeconomic importance in productive regions. Changes in production methodologies aim to meet market demands and sector sustainability. In this sense, the use of organic compounds has been successfully used in the production of seedlings. The objective of the study was to evaluate the potential use of different sources of organic material for the composition of substrates used in the production of papaya seedlings, identifying the effects on the emergence and development of plants. Therefore, the treatments were composed of different substrates, namely: T1 – Soil; T2 – 75% soil and 25% chicken litter; T3 - 75% soil and 25% earthworm humus; T4 - 75% soil and 25% tanned cattle manure. When evaluating the characteristics, it was found that substrates composed of the fractions of earthworm humus and cattle manure allowed increases in the characteristics of shoot length, number of leaves, leaf area and stem circumference, while the presence of chicken litter interfered negatively on all the variables studied. It was concluded that organic compounds have the potential to favor the production of papaya seedlings. In this sense, the composition of the substrate alters the emergence and development of papaya seedlings, and the use of a fraction of 25% of earthworm humus allows the formation of seedlings with greater vigor, while the use of chicken litter in this same proportion should be avoided.
Keywords: organic fertilization; seedling production; alternative sources; *Carica papaya* L.

Material orgânico como suplementação para substrato na produção de mudas de mamoeiro

Resumo
O mamão está entre as principais espécies frutíferas produzidas no Brasil, representando elevada importância socioeconômica nas regiões produtivas. As alterações nas metodologias de produção visam atender às demandas do mercado e à sustentabilidade do setor. Nesse sentido, o emprego de compostos orgânicos tem sido implementado com sucesso na produção de mudas. O objetivo do estudo foi o de avaliar o potencial de diferentes fontes de material orgânico para a composição de substratos utilizados na produção de mudas de mamoeiro, identificando os efeitos sobre a emergência e o desenvolvimento das plantas. Para tanto, os tratamentos foram compostos pelos diferentes substratos, sendo eles: T1 – Solo; T2 – 75% solo e 25% cama de aviário; T3 - 75% solo e 25% húmus de minhoca; T4 - 75% solo e 25% esterco bovino curtido. Ao se avaliar as características, obteve-se que substratos compostos pelas frações de húmus de minhoca e esterco bovino possibilitaram incrementos das características de comprimento da parte aérea, número de folhas, área foliar e circunferência do caule, enquanto que a presença da cama de aviário interferiu negativamente sobre todas as variáveis estudadas. Concluiu-se que os compostos orgânicos possuem potencial para favorecer a produção de mudas de mamoeiro. Neste sentido, a composição do substrato altera a emergência e o desenvolvimento das mudas de mamoeiro, sendo que a utilização de uma fração de 25% de húmus de minhoca possibilita a formação de mudas com maior vigor, enquanto a utilização da cama de aviário nessa mesma proporção deve ser evitada.
Palavras-Chave: adubação orgânica; produção de mudas; fontes alternativas; *Carica papaya* L.

Introduction

Fruit growing represents one of the main productive chains of Brazilian agribusiness, generating income and development of producing regions. This fact is favored by the diversity of edaphoclimatic characteristics, which allows the exploration of a range of species. Papaya is among the ten main fruits produced in Brazil, occupying a productive area of approximately 28.5 thousand hectares, producing more than 1.2 million tons of fruits and generating an amount of more than US$ 180,000,000 in 2020 (IBGE, 2021).

As in other sectors of agriculture, there is a frequent demand for the insertion of sustainable techniques in the fruit production process. This demand ranges from government actions aimed at the productive sector to the demand imposed by the consumer market. In this sense, the use of organic inputs, also including waste from the agroindustry itself, has been explored, either for the production of seedlings (SILVA JÚNIOR *et al*., 2018; AIRES *et al*., 2020) or for field production (PACHECO *et al*., 2016; RIBEIRO *et al*., 2020).

Organic substrates have also been used efficiently for the production of fruit, including papaya, its applicability has evolved with the continuous interest of research, which results in satisfactory returns in agriculture. This fact is evidenced in studies on the use of goat manure (SOUZA *et al*., 2015), sheep manure (OLIVEIRA *et al*., 2015), cattle manure (MATIAS *et al*., 2019) and the combination of different organic compounds (ARAUJO *et al*., 2015; PEREIRA *et al*., 2015).

The positive results of the use of organic compounds are largely due to their nutritional composition and the dynamics of decomposition and release of nutrients to the substrate, increasing the levels of nutrients in forms that can be assimilated by plants and microbial activity (MEDEIROS *et al*., 2015). Also, the high levels of organic matter in the compounds allow for increased aeration of the substrate (SILVA JÚNIOR *et al*., 2018), facilitating the drainage of excess water from irrigation. The combination of these factors makes it possible to increase root development and aerial organs (MEDEIROS *et al*., 2015)

Despite the results obtained, there is a continuous demand for information that leverages the production of papaya seedlings, since the species is responsive to the application of different techniques during its establishment (CABRAL *et al*., 2020). Thus, the aim of the study was to evaluate the of different sources of organic material for the composition of substrates used in the production of papaya seedlings, identifying the effects on the emergence and development of plants.

Material and Methods

The experiment was conducted in Inhumas, Goiás, Brazil. The geographical coordinates of the place are: Latitude: 16° 36' 9311" South and Longitude: 49° 49' 2121" West, located at an altitude of 742 meters above sea level. The soil used in the experiment had its physical and chemical characteristics previously analyzed, with the following results: Ca^{2+}: 3.40 $cmol_c\ dm^{-3}$, Mg^{2+}: 0.80 $cmol_c\ dm^{-3}$, K^{+}: 177.10 mg dm^{-3}, P (Mehlich I): 10.80 mg dm^{-3}, organic matter: 17.00 g kg^{-1}, Al^{3+}: 0.0 $cmol_c\ dm^{-3}$, H+Al: 1.80 $cmol_c\ dm^{-3}$ and pH values ($CaCl_2$): 6.10, cation exchange capacity: 6.49 $cmol_c\ dm^{-3}$, base saturation: 72.25% and clay, silt and sand in the 0-20 cm layer: 47.00, 11.00 and 42.00 g kg^{-1}, respectively.

The design used was randomized blocks, with five replications. The treatments, in a total of four, were composed by the different substrates: T1 – Soil; T2 – 75% soil and 25% tanned chicken litter; T3 - 75% soil and 25% earthworm humus; T4 - 75% soil and 25% tanned bovine manure.

Sowing was carried in plastic bags for seedlings with dimensions of 30 cm x 40 cm, equivalent to a volume of 8 dm^3, containing the aforementioned substrates. In these, 10 papaya seeds, cultivar "Sunrise", were sown and kept in an open environment, with sunlight in the morning and shade in the afternoon. The experiment was irrigated twice a day, maintaining soil moisture. After emergence, thinning was performed using scissors, which was carried out 35 days after sowing, leaving only one plant per container.

Emergence index was evaluated 12 days after sowing, when the stability was verified. At 163 days after sowing, the following variables were analyzed: shoot length, number of leaves, leaf area, stem circumference and root length. Thus, for measuring shoot and root length, as well as for stem circumference, a graduated tape was used. For the analyzed variable number of

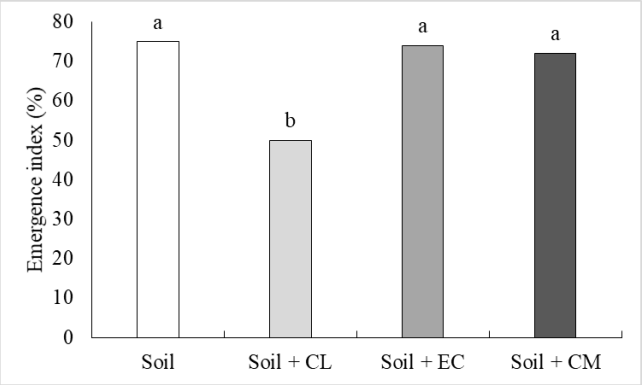
leaves, the number of true leaves per plant was counted, while the leaf area variable (cm²) was obtained using the Easy Leaf Area Free application (EASLON; BLOOM, 2014).

Data were subjected to analysis of variance (F test) and the averages were compared by the Scott-Knott test, at 5% probability. The analyzes were performed using the statistical software Sisvar® 5.6 version for Windows (FERREIRA, 2014).

Results and Discussion

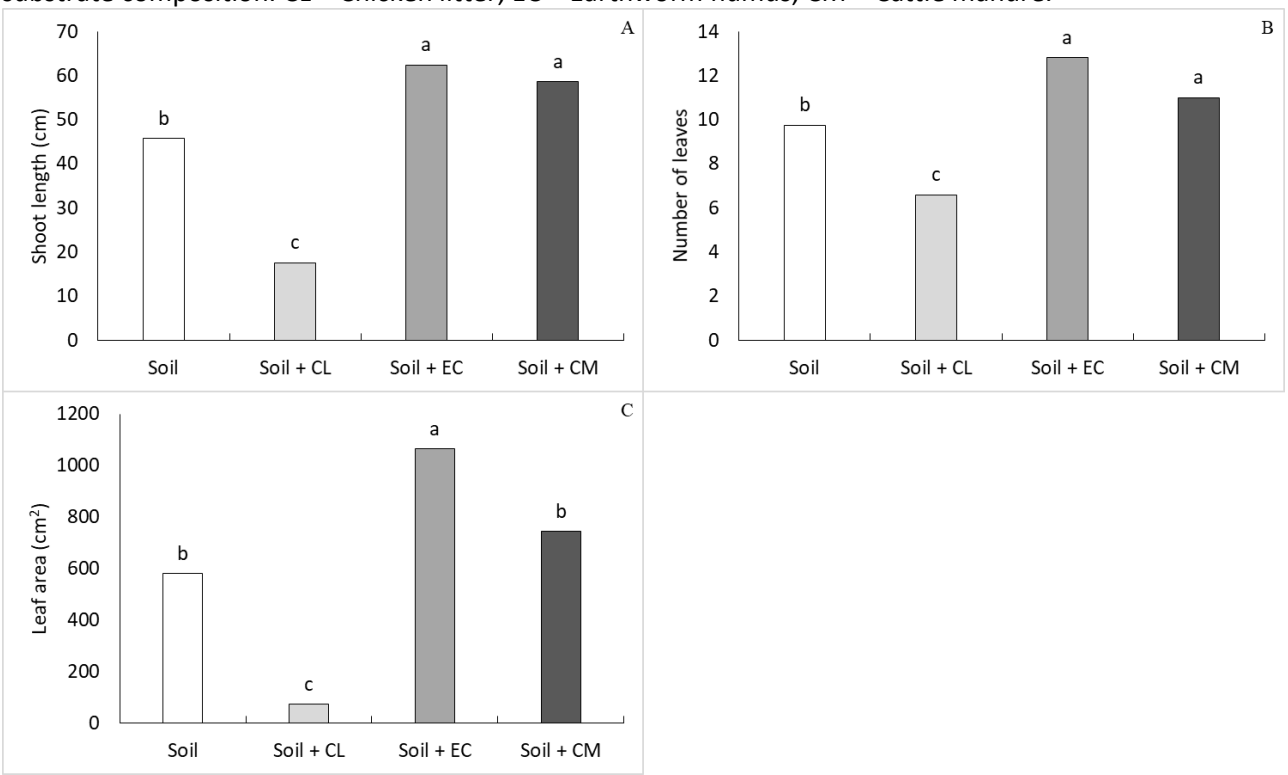
It was found that the use of chicken litter affected the emergence index of papaya seedlings, with a reduction close to 25% in relation to the other treatments (Figure 1).

Figure 1. Emergence index of papaya seedlings in different substrate composition. CL = Chicken litter; EC = Earthworm humus; CM = Cattle manure.



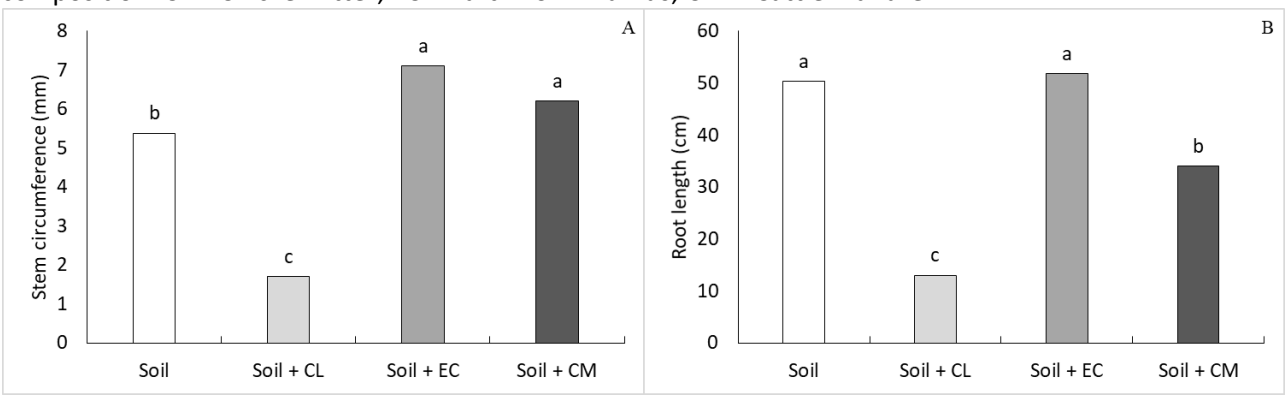
For the variables of shoot length and number of leaves, there was superiority of treatments composed of soil and earthworm humus fraction or tanned bovine manure (Figures 2A and 2B). The treatment composed of soil and earthworm humus also stood out in relation to the others in terms of leaf area (2C) and for all three characteristics the treatment composed of the chicken litter fraction resulted in losses of approximately 68%, 41% and 91%, respectively, in relation to the averages of the other treatments.

Figure 2. Shoot length **(A)**, number of leaves **(B)** and leaf area **(C)** of papaya seedlings grown in different substrate composition. CL = Chicken litter; EC = Earthworm humus; CM = Cattle manure.



For stem circumference, the superiority of treatments composed of soil and fractions of earthworm humus or tanned bovine manure (Figure 3A) was observed, while for root length, treatments composed only of soil or soil with a fraction of earthworm stood out (Figure 3B). In addition, as for the other characteristics, the treatment composed of the chicken litter fraction resulted in a decrease of the characteristics of stem circumference and root length by an average of 71% and 73%, respectively, in relation to the averages of the other treatments.

Figure 3. Stem circumference **(A)** and root length **(B)** of papaya seedlings grown in different substrate composition. CL = Chicken litter; EC = Earthworm humus; CM = Cattle manure.



The results obtained are related to a series of factors, such as the nutritional composition, the ability to condition the soil and the physical characteristics of the organic compounds used together with the soil. Thus, the emphasis observed for earthworm humus and tanned bovine manure demonstrates such positive characteristics.

The slight superiority of earthworm humus in relation to cattle manure can be explained by the higher content of nutrients in its composition, its structure that results in better maintenance of moisture, as well as the lower C/N ratio, which allows greater availability of nutrients to the developing plant (BARDIVIESSO *et al*., 2014). Earthworm humus also provides greater biological activity in the substrate, in which the microorganisms acting on its decomposition promotes the continuous release of CO_2 molecules, NH^{4+}, micronutrients and P and S ions, which favor physiological activity of plants (ARMOND *et al*., 2016).

Similar effects were obtained for the development of different fruit species of economic interest, such as tamarind (SILVA *et al*., 2020) and, mainly, of vegetable species such as lettuce (WATTHIER *et al*., 2019), cucumber (SALLES *et al*., 2019; 2018). The authors also relate the effects to the chemical composition and physical characteristics of the compound, which are beneficial to root and shoot development.

For tanned cattle manure, the positive responses regarding seedling development are due to factors similar to those observed for earthworm humus. The degradation of organic fractions present in plant residues is largely broken down during the manure tanning process, increasing the surface area, decreasing its C/N ratio and releasing nutrients. These characteristics allow manure to act as a soil conditioner, increasing base saturation and decreasing aluminum saturation, as observed by Lisboa *et al*. (2018). These authors also verified that the proportion of manure that significantly favored the development of *Handroanthus heptaphyllus* seedlings is between 21% and 28%, covering the proportion used in the present study.

Corroborating the results obtained in the present study, Silva *et al*. (2019), found that the use of cattle manure together with peaty commercial substrate led to the development of pepper and sweet pepper seedlings. Also, for the pepper crop, it was found that the use of tanned cattle manure has a positive effect when used during production, increasing the development and productivity of the crop (RIBEIRO *et al*., 2020).

In relation to chicken litter, although this compost has high levels of nutrients and physical characteristics favorable to the substrate, its use in a fraction of 25% was too high. In this sense, it appears that high concentrations of this compound can result in high amounts of volatilized ammonia, which can interfere with root development and, consequently, with other plant characteristics (QI *et al*., 2012). This reaction was also deleterious to the production of passion fruit seedlings, for which the toxic effect of chicken litter doses was verified when they exceeded 10% of the total volume of the substrate (BRUGNARA, 2014).

Although organic compounds have interesting characteristics for the development of seedlings, their composition and dosage must be observed at the time of use. Excess compounds or even the action of microorganisms present can interfere negatively, resulting in a decrease in the development and physiological activity of plants and, consequently, causing damage to producers.

Conclusion

The composition of the substrate alters the emergence and development of papaya seedlings, and the use of a fraction of 25% of earthworm humus allows the formation of seedlings with greater vigor, followed by the tanned cattle manure, while the use of chicken litter in this same proportion should be avoided.

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