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Research Article

Mycorrhizal Fungi in the Formation of Seedlings of Passion Fruit, in Organic and Commercial Substrates

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Abstract

The genus *Passiflora* is one of the species of greatest economic interest in all Brazilian regions. The main obstacle to the best development of fruit growing is the availability of selected seedlings. The objective of the present work is to develop alternatives to improve seedling production, reducing production costs, characterizing the effect of organic and commercial substrates, associated with the mycorrhizal fungus *Glomus etunicatum*, on the growth of passionflower seedlings in the region of Imperatriz-MA. The work was developed at the Center of Technological Diffusion (CDT), area of the INFRAERO of Imperatriz-MA. The experimental design was the fully updated with five treatments and six replicates, being distributed as: T1: Bioplant 100%; T2: Black soil, rice straw and chicken manure in the proportion of 2: 2: 1; T3: Black soil, rice straw and bovine manure in a ratio of 1: 1: 1; T4: 100% black earth; T5: 100% black earth and 5 g of mycorrhizal fungi. The analyzed variables were: number of leaves, shoot growth, stem diameter, fresh and dry mass of root and shoot. The treatment corresponding to the soil + mycorrhiza (*Glomus etunicatum*), was similar to the treatment with commercial substrate (Bioplant). Bioplant and soil + mycorrhizal substrates obtained better results regarding stem diameter, root growth, fresh biomass and dry biomass compared to the other substrates. Treatment with bovine manure substrate presented lower vegetative growth.

Keywords: Waste; Substrate; Manure; *Passiflora edulis*; *Glomus etunicatum*

Introduction

Brazilian fruit growing is booming, watching small and large producers using high technology. The genus *Passiflora* has more than 400 species and about 200 of them are native to Brazil [1,2].

Although Brazil is considered the largest producer and consumer of passion fruit, there are some obstacles to better production of the crop (COELHO., *et al.* 2016). This plant is interesting for small producers and small properties, because it represents a good choice among fruit fruits for offering rapid economic return, as well as a well distributed production for most of the year [3]. Being a very explored plant in the national fruit sector.

For the formation of an orchard the use of vigorous seedlings is of great importance. With this, uniformity in cultivation, increased productivity and precocity of the first production are granted, these factors are considered fundamental prerequisites for the success of the activity [4,5].

The system for seedling production is dependent on the use of commercial substrates, this causes high costs in this production segment in Brazil. For this reason, alternative materials have been sought to commercial substrates, taking advantage of agricultural and industrial waste in the composition of substrates, as a way to minimize production costs, as well as promote higher seedling quality. The use of waste in the formulation of substrates is becoming an agricultural practice of a sustainable nature, aiming to minimize the environmental impact [6,7].

Several materials can be used as substrates, with difficulty in building a material alone that can meet all specific requirements of a given species. Vermiculite, sand, charred rice husk, charcoal mill, peat, sawdust, are materials used more frequently in the production of passion fruit seedlings [8,9].

The high cost and difficulty of acquisition limits the obtaining of commercial products, especially for the small producer, requiring it to use materials present in the production region [10].

Mycorrhizal fungi are nitrogen-fixing organisms that, by associating symbiotically with plants, offer benefits regarding the use of substances by roots [11,12].

This work aims to develop alternatives to improve seedling production, in reducing production costs, characterizing the effect of organic and commercial substrates, associated with the mycorrhizal fungus *Glomus etunicatum*, on the growth of marawhosezeiro seedlings (*Passiflora edulis*) in the Empress-MA region.

Material and Methods

The experiment was carried out at the Greenhouse of the Technological Diffusion Center of the Ogic Technol Diffusion Center - CDT, infraero area, Empress, Maranhão.

Fifty treatments with 6 replications totaling 30 experimental units were used. The formulations were elaborated according to technical information obtained with producers in the region and

compared to commercial substrate, being distributed as follows: T1 (Commercial substrate Bioplant 100%); T2 (Dark Soil, rice straw and chicken manure in the proportion of 2:2:1) ; T3 (Dark Soil, rice straw and bovine manure in the proportion of 1:1:1); T4 (DarkSoil 100%); T5 (Dark Soil 100% and 5 g of mycorrhizal fungi of the genus *Glomus etunicatum*).

Each 5 g polyethylene container of *Glomus etunicatum* was added, corresponding to approximately 20 spores per plant. The application of the yezycose mycorr fungi occurred by depositing the material in the pit, before the seeds.

The substrates were packed in polyethylene bags 10x20 cm and three seeds were seeded to each container. The irrigations were carried out daily in order to maintain the moisture of the substrate according to the field capacity. The experiment occurred in a period of 55 days from sowing, and the completely randomized design (IHD) was used.

Thinning was performed 20 days after emergence, when the plants reached a size of 6.3 cm on average, performing thinning.

The variables analyzed were: number of leaves per plant, shoot length (cm), stem diameter (mm), root length (mm), fresh shoot mass (g), fresh root mass (g), shoot dry mass (g) and dry root mass (g).

For the length of the shoot, it was measured from the lap to the kaolin apex of the plant and the length of the root was performed from the neck to the apex of the pivoting root, with the aid of millimeter ruler. To determine the diameter of the lap, a digital caliper was used at the height of the lap of the plant (Figure 1).

Figure 1: Regions of yellow passion fruit seedlings (*Passiflora edulis*),cultivated under different types of substrate.

To determine the fresh mass of shoot and root, both were performed on precision analytical scale. In determining the dry mass of shoot and root the same after weighing were referred to forced circulation greenhouses at 65°C for 72 hours.

The data were submitted to variance analysis through the Tukey test at 5% probability, being processed by the ASSISTAT software®, to obtain this test, and jmp® was used, to perform multivariate tests with color map correlation analysis and principal component analysis, aiming at better data discrimination and clarity.

Result ad Discussion

Through statistical analysis, the variable number of leaves per plant (NF) showed no significant difference according to the treatments (Table 1). The length of shoot (Figure 2A) differed significantly between treatments, and can highlight those that received bio plant commercial substrate and soil + M mixture, obtaining values above 10 cm, being considered the highest growth averages of shoots, compared to the other treatments evaluated in the study. Organic matter is a compound that provides soil, Carbon, Nitrogen and Sulfur, resulting in greater water retention capacity and aeration of the soil, making there are better conditions for plant growth [13].

Figure 2: Cair part omprimento (CPA), neck diameter (DC) and root length (CR) of yellow passion fruit seedlings (*Passiflora edulis*), grown under different types of substrate.

Means followed by the same letter do not differ statistically from each other.

Regarding the length of the shoot, the treatment containing only bovine manurein its composition presented the lowest values for this variable.

The significant difference was served in the variable stem diameter (CD) (Figure 2B), entre the treatments. The Bioplant treatments and the mixture of Soil + Micorriza obtained the best means for this variable, and not overcome by any other treatment, presenting diameter above2.5 mm. Maiorano [14], studying substrates in the production of blacksmith seedlings reports that plants colonized by *G. etunicatum* had the highest means in diameter in substrates without fertilizer.

Smiderle., *et al.* [15] report that the length of the shoot, associated with the diameter of the cervix, is one of the most important morphological characters to estimate the growth of seedlings after definitive planting in the field.

N the variable root length (CR) (Figure 2C), the treatment containing the Bioplant substrate, presented the highest mean among the treatments, because, the same, provided the highest values (16 cm), this commercial substrate presents in its composition: sphagnum peat, coconut fiber, rice husk, pine bark and vermiculite [16]. Reis., *et al.* (2014), analyzed the root length and obtained satisfactory results, since in the present study the highest values were found in the Bioplant substrate. According to Lima *et al.* [17], substrate aeration is one of the most important factors involved in root growth.

Palace., *et al.* [18], report that the substrate que contains the formulation sand + soil + manure, promotes better development of seedlings in general, considering positive effects on the length of the roots. However, these data do not coincide with those found in this experiment, because the bovine manure substrate presented the lowest development in this regard, obtaining an average of 3.2 cm.

In relation to the fresh mass of the root, treatment containing commercial substrate was shown to present positive growth values of seedlings. When analyzing the fresh mass of the shoot, it was observed that the treatment containing Solo + Micorriza had a higher effect than withercial. The substrates containing Dark Soil only and the commercial (Bioplant) presented the same values statistically, and the treatment containing bovine manure obtained the lowest mean for this variable presenting the smaller root system (Figure 1).

Mendonça., *et al*. [19] compared different substrates and containers in the formation of papaya seedlings found that the commercial substrate together with the polyethylene bag container showed results favorable to the fresh and dry matter of the root. Paulus., *et al.* (2011), evaluating substrates in the production of mint seedlings, found that the production of fresh mass of the shoot and roots of the commercial substrate was higher than the other treatments.

Nunes., *et al.* [20], evaluating the development of peach root stocks, observed that inoculation with *Glomus etunicatum* provided the highest indexes of fresh biomass of the tissues of the aerial part than in all other substrates, resembling the results found in the present study.

When analyzing the dry mass of the root (MSR) and the dry wings of the shoot (MSPA), the soil + M treatments and the commercial substrate, obtained higher volume of mass, while the treatments containing chicken and bovine manure, presented seedlings with lower volume. In a work carried out with papaya seedlings, Saraiva., *et al.* (2011) showed that the positive effect of phosphorus increases the dry matter of papaya roots, which should be reflected in greater nutrient absorption capacity, thanks to greater root development. Smiderle., *et al.* [21] found the same results in chili seedlings cultivated with commercial substrate. These effects are predictable, since this commercial substrate presents as lower density characteristics and good water retention, according to field capacity, besides being balanced in its chemical compositions [22].

David., *et al.* [23] reported that higher doses of phosphorus provided conditions for the plant to absorb a greater amount of other nutrients, reflecting positively, at greater height and dry matter production of yellow passion fruit.

Maiorano [14], studying substrates in the production of blackheads lemon seedlings noted that the dry matter of the aerial part of plants colonized by *G. etunicatum* was significantly higher in all substrates used.

The variables number of leaves per plant, shoot growth, stem diameter, root growth, fresh and dry mass of seedlings have great importance as indicative of quality, as they reflect on growth as a function of the amount of nutrients absorbed from the substrate. The main functions of the substrate are the support and nutrition of the plant [24].

The substrate can be of any material or mixture of materials containing desirable characteristics for the development of the seedling. It should present adequate levels of fertility, homogeneity, good absorption capacity of water and nutrients, ease of handling and mainly be free of pathogens [25]. In addition, for normal plant growth, all nutrients must be present in the substrate in adequate quantities to meet plant requirements [26].

Treatments	NF	MFR (g)	MFPA (g)	MSR (g)	MSPA (g)
Bioplant	7,5 ns	1,2a	2.0 from	0,24a	0,36a
Chicken Dung	6,3 ns	0,1c	0,6bc	0,03c	0,09bc
Bovine Manure	4,0 ns	0,2c	0,6c	0,09c	0,05c
Dark Soil	7,0 ns	0,5bc	1,4abc	0,11bc	0,24abc
Only Micorriza	8,1 ns	0,6b	2,2a	0.21 from	0,24abc

Table 1: Number of leaves (NF), fresh root mass (MFR), fresh shoot mass (MFPA), dry root mass (MSR) and dry shoot mass (MSPA) of yellow passion fruit seedlings *(Passiflora edulis),* cultivated under different types of substrate.

Means followed by the same letter do not differ statistically from each other.

ns: Not Significant.

The seedlings obtained in the bioplant and Soil + Micorriza substrates obtained better means in all variables when compared to the others. According to Lima., *et al.* [17], as passion fruit orchards, in its entirety, are established with seedlings obtained from seeds, the high heterozygosis existing in this species determines a high variability, resulting in DE uniformity between plants in orchards.

Through Pearson correlation analysis (Figures 3A and 3B), there were positive correlation levels, close to 1, where the variable growth of shoots presented a positive correlation index of 0.9233, considered of high magnitude in relationship with the diameter of the lap of the passion fruit seedlings, where, this result corroborates the studies by Smiderle., *et al.* [27].

Figure 3: Pearson Correlation Index (A) and color map (B), variables number of leaves (NF), shoot growth (CPA1), neck diameter (DC) fresh root mass (MFR), fresh shoot mass (MFPA), dry root mass (MSR) and shoot dry mass (MSPA) of yellow maraquezeiro seedlings (Passiflora edulis), grown under different substrate types.

Principal component analysis (Figure 4) depicts the effect of two-component formation, where the first component (CP1) corresponded to 86.9% response of variables compared to the second component (CP2) which resulted in 8.89%. Give me an answer. In this statistical analysis, two groups were formed, which report the direction of the variables in the Bioplant treatments and the compound composed by Soil + Mycorrhiza, which obtained seedlings of commercial quality. As for the second group, there was the formation of the other treatments, thus showing that there are significant differences between the results obtained and that the substrate containing formulation Solo + Mycorrhiza (*Glomus etunicatum*) was similar to the commercial Bioplant among the results obtained in this experiment, resulting in vigorous and well-developed seedlings [28-30].

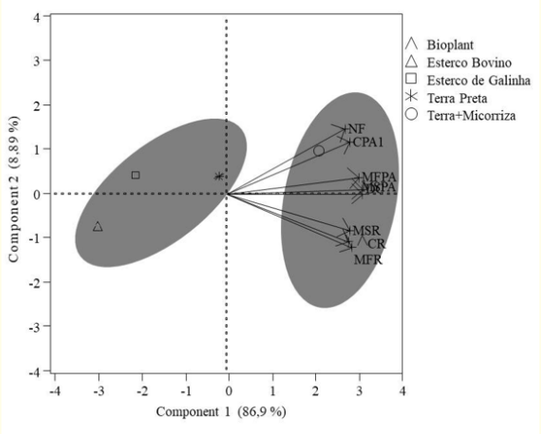

Figure 4: Analysis of main components, variables number of leaves (NF), shoot growth (CPA1), neck diameter (DC) fresh root mass (MFR), fresh shoot mass (MFPA), dry root mass (MSR) and shoot dry mass (MSPA) of yellow marawhosezeiro seedlings (Passiflora edulis), grown under different substrate types.

Conclusion

The yellow passion fruit (*Passiflora edulis*) within the genus *Passiflora* is one of the species of greatest economic interest in all Brazilian regions. The great obstacle to the best development of fruit growing is the availability of selected seedlings. The objective of this work is to develop alternatives to improve seedling production, in reducing production costs, characterizing the effect of organic and commercial substrates associated with mycorrhizal fungus *Glomus etunicatum*, on the growth of maracujozeir seedlings in the Empress-MA region. The work was developed at the Center for Technological Diffusion (CDT), an area of INFRAERO de Imperatriz-MA. The experimental design used was fully updated with five treatments and six replications, being distributed as: T1: Bioplant 100%; T2: Dark soil, rice straw and chicken manure in the proportion of 2:2:1; T3: Dark soil, rice straw and bovine manure in the ratio of 1:1:1; T4: Dark Soil 100%; T5: Dark soil 100% and 5 g of mycorrhizal fungi. The variables analyzed were: number of leaves, shoot growth, stem diameter, fresh and dry root mass and shoots. The treatment corresponding to Solo + M icorriza (*Glomus etunicatum*), was treated to treatment with commercial substrate (Bioplant). Bioplant and Soil + Micorriza substrates obtained better results regarding stem diameter, root growth, fresh biomass and dry biomass compared with other substrates. Treatment with bovine manure substrate showed lower vegetative growth.

- In the parameters number of leaves per plant, shoot growth, stem diameter, root growth, fresh biomass and biomass secto bioplant and soil + Micorriza substrates obtained better results when compared to other substrates;
- The treatment containing bovine manure in its composition presented lower means of development in all variables analyzed;
- The formulation containing Solo + Micorriza (*Glomus etunicatum*) obtained seedlings of greater vigor and well developed compared to the commercial substrate (Bioplant), reducing production costs and improving the cost-benefit ratio in the production of seedlings of yellow passion fruit (*Passiflora edulis*).

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