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Production of fig seedlings in alternative substrates in the Upper-Middle Gurgueia region

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Abstract

TGiven the importance of determining which substrate source attends to the need of each fruit species and at the same reducing production costs, this work aimed to evaluate the quality of fig seedlings, cultivar 'Roxo de Valinhos', in alternative substrates in the Upper-Middle Gurgueia region, Piauí state. The treatments consisted of Sand (SND), Decomposed Moriche Palm Stem (DMT); Goat+Sheep Manure (GSM), Ravine Soil (TBA), and Commercial Substrate (COM). A Randomized Block Design (RBD) was adopted, with 4 replications and 5 experimental units. The analyzed variables were: Sprouting rate index (SRI), branch length (BRL), branch diameter (BRD), number of leaves in the branch (NLB), chlorophyll A (CLA), chlorophyll B (CLB), shoot fresh matter (SFM), root fresh matter (RFM), shoot dry matter, (SDM) root dry matter (RDM), rooted cuttings (ENR), root length (RL) and volume of the root system (VRS). A significant effect of the substrates was verified for all variables, except chlorophyll A, chlorophyll B, number of branches, and branch diameter. Due to the chemical characteristics of the goat+sheep manure, it provided the necessary conditions for the growth and development of the shoot part and root system, revealing to be superior to the remaining substrates. Therefore, it may be concluded that the goat+sheep manure provides all the essential nutrients for the quality production of fig seedlings, cultivar 'Roxo de Valinhos', allowing the rooting of 100% of the cuttings.

Keywords: *Ficus carica* L., rooting, cuttings, macronutrients

Introduction

The fig plant (*Ficus carica* L.) is currently cultivated in several regions of the world (Mawa et al., 2013). Brazil occupies the ninth position in the ranking of producing countries, with 25.8 thousand tons of produced fruits, and a harvested area of approximately 2.6 thousand hectares (FAOSTAST, 2017).

In Brazilian orchards, the cultivar 'Roxo de Valinhos' is the only commercially-grown variety due to its characteristics of high yield, vigor, economic value, rusticity and adaptation to the intensive pruning system (Silva et al., 2010).

Rooting is one of the primary forms of propagation of the fig tree (*Ficus carica* L.) through the use of cuttings from the basal or middle portion of the branches, place in which there is more availability of carbohydrates, reflecting in the rooting success (Sousa et al., 2013).

Propagation through cuttings allows the use of selected genotypes and also the obtention of more productive and uniform orchards, besides forming genetically identical seedlings to the matrix plant, resulting in homogenous production with fruits of higher quality standard (Peralta et al., 2017).

However, for seedling production, besides determining the propagation method the choice of the substrate if also of utter importance,

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given its function in the development of the root system and, consequently, of the shoot part. Therefore, the substrate must allow water retention, avoiding desiccation in the base of the cutting, and possess porous space for the providing of oxygen, besides possessing a good adherence to the cutting and being free of phytotoxic substances (Yamamoto et al., 2013).

Among the several types, the use of alternative substrates from abundant materials in the very region is a low-cost option (Aragão et al., 2011). These inputs may be of vegetal or animal origin, obtained from the composting process, and are rich in nutrients and mineralized organic matter (Cavalcante et al., 2016). Furthermore, they are characterized by their easy acquisition and non-toxicity to the plants, being easily able to replace the conventional substrates (Sirin et al., 2010).

For being an important agricultural frontier, the Upper-Middle Gurgueia region stands out in the farming sector, favoring the availability of inputs (manures), facilitating their acquisition and decreasing their cost. Furthermore, the region possesses several areas with the formation of Moriche palm (buritizeiro) groves, allowing access to the decomposed trunk of the plant, an important source of organic matter (Silva, 2012).

Therefore, given the importance of determining which substrate source attends to the needs for the growth and development of each fruit species, reducing the production costs, this work aimed to evaluate the quality of fig seedlings, cultivar 'Roxo de Valinhos', in alternative substrates in the Upper-Middle Gurgueia region, Piauí state.

Material and Methods

The experiment was conducted on the Campus Professora Cinobelina Elvas of the Federal University of Piauí (CPCE-UFPI), in the municipality of Bom Jesus, Piauí state, located in the Upper-Middle Gurgueia Microregion, at 287 meters of elevation and geographical coordinates 09°04'59.9" of South latitude and 44°19'36.8" of West longitude, in a plant nursery covered with a 50% shading screen, in the period from December 19, 2018 to February 8, 2019.

A complete block design (DBC) with five treatments, four replications, and five experimental units was adopted, totaling 100 cuttings. The treatments consisted of the substrates: sand (SND), decomposed Moriche palm trunk (DMT), goat+sheep manure (GSM), ravine sand (TBA) and commercial substrate (COM) containing pine bark, coconut fiber, fibrous peat, vermiculite, NPK, and micronutrients.

Table 1. Chemical analyses of the substrates: decomposed Moriche palm trunk (DMT), goat+sheep manure (GSM), ravine soil (TBA), and commercial substrate (COM)

Characteristics	Unit	DMT	GSM	TBA	COM
pH H_2O		6.8	7.1	5.5	5.3
P resin	mg dm^{-3}	100	394	8.44	82.10
$H^{+}+Al^{3+}$	$cmol_c$ dm^{-3}	0.75	1.13	1.29	5.4
Al^{3+}		0.00	0.00	0.00	0.30
Ca^{2+}		3.60	18.6	2.22	10.0
Mg^{2+}		1.91	11.61	0.66	6.80
K^{+}		4.33	2.40	0.23	1.19
SB		9.84	32.59	3.1	16.90
CEC		10.59	33.72	4.4	20.99
V	%	92.9	96.6	70.5	80.7
m		0.00	0.00	0.00	1.4
O.M.	g/kg	122.0	129.7	9.3	8.25

P and K - Mehlich 1 extractor; Ca, Mg, and Al – KCl extractor - 1 mol/L; H + Al – Calcium Acetate extractor at pH 7.0; Organic Matter (OM) - Walkley-Black method. Source: Center of Soil Analyses of the Federal University of Piauí (UFPI), Campus Professora Cinobelina Elvas - Bom Jesus, PI

Herbaceous cuttings were employed in the experiment, extracted from the medial portion of the fig branches, cultivar 'Roxo de Valinhos', with 1 year and 7 months of age, from the didactic orchard of the CPCE-UFPI. The cuttings contained 5 non-sprouted buds, with a diameter varying from 9 to 11 mm and absence of leaves. To facilitate the rooting and avoid the accumulation of water and proliferation of diseases, a bevel cut was made in the base of the branch, as well as a straight cut in the apex (Chalfun et al., 2012).

The cuttings were planted individually in polyethylene bags with capacity for 0,5 L, previously filled with the substrates corresponding to the respective treatments, and allocated in a suspended stand.

The planting was performed so that two buds were completely covered by the substrate to increase the contact with the surface and ensure rooting.

An automatic misting irrigation system was used, programed for 8 watering moments of 0,47 l/min per day, in a moist chamber structure made of transparent plastic to avoid the dehydration of the cuttings and favor the rooting. The moist chamber was removed 35 days after planting (DAP), after the setting of the cuttings, aiming to reduce fungal infestation, with the irrigation being conducted only with the nebulizers, without the plastic.

At 5 Days After Planting (DAP), when the sprouting started, the sprouting rate index (SRI) was obtained by the daily count of sprouts in the fig cuttings until the stabilization, which occurred at 11 DAP.

At the end of the experiment, at 51 DAP, one branch per cutting (the most developed) was selected for the measurement of the following variables: branch length (BRL), measured with the aid of a millimeter rule from the base to the apex of the branch, with the results expressed in centimeters (cm); branch diameter (BRD), measured with the aid of a digital pachymeter at the base of the branch, with the results expressed in millimeters (mm); number of leaves of the branch (NLB), obtained by the visual count of the fully-opened leaves; and chlorophyll A (CLA) and B (CLB), measured with a chlorophyll meter (clorofiLOG) by choosing a single fully-developed branch leaf for the evaluation.

The shoot part and the root system were separated, washed, and sent to the Laboratory of Plant Propagation of the CPCE-UFPI for the analysis of the following characteristics: root length (RL), measuring the length of the larger root with a millimeter rule; volume of the root system (VRS), measured in a 100 mL graduated cylinder with a known volume of water, in which the root was inserted and the displaced water volume was registered, converting the values to cubic centimeters (cm^3); rooted cuttings (ENR), determined by the total number of cuttings of each treatment with formation of the root system; shoot fresh matter (SFM) and fresh root matter (RFM), obtained by the weighing of the fresh vegetal material in an analytical balance, with the results expressed in grams (g); shoot dry matter (SDM) and root dry matter (RDM), for which the material remained in a forced circulation oven at 65°C until obtaining constant weight. The results were obtained by the weighing of the material in an analytical balance, with the results expressed in grams (g).

The data were subjected to analysis of variance and the treatments were compared by Tukey’s test at 5% probability, using the R software (R CORE TEAM, 2019).

Results and Discussion

The analysis of variance (ANOVA) did not point out a significant effect of the substrates only for the variables chlorophyll a (CLA), chlorophyll b (CLB), number of branches (NRA), and branch diameter (BRD), as it may be observed in Table 2.

The sprouting rate index (SRI) was higher in the fig cuttings planted in the goat+sheep manure (GSM), with mean of 0.8, what might be justified by the greater amount of organic matter present in this substrate (Table 1), resulting in the best water holding capacity (Da Costa et al., 2017), which is important in the setting stage of the cuttings, since it avoids the difference of hydric potential between the environment and the cuttings, and compensates the water need for the processes of transpiration and growth of new sprouts (Nava et al., 2014). The organic matter, besides retaining moisture, provides nutrients to the seedlings and influences the total porosity, aeration, and density of the substrate (Araújo & Sobrinho, 2011).

The fig seedlings produced in the goat+sheep manure (GSM) presented higher values in the number of leaves (NLB), branch length (BRL), shoot fresh matter (SFM) and shoot dry matter (SDM) in relation to the remaining substrates. These results may be explained by the greater amount of calcium (Ca^{2+}) and magnesium (Mg^{2+}) contained in this substrate (Table 1), since calcium is responsible for the emission of new leaves, and magnesium, as the central atom of chlorophyll, ensures the initial photosynthetic activity (Andrade et al., 2013).

The presence of leaves in the cuttings is important for root formation, since the phenolic compounds produced in the shoot part interact with the auxins, inducing the initiation of the root system (Vignolo et al., 2014). Therefore, even with the absence of leaves at the beginning of propagation, the later development of such structures was essential for the growth of vigorous roots.

Table 2. Mean values of the shoot and root part variables of fig seedlings, cultivar 'Roxo de Valinhos', produced in sand (SND), decomposed Moriche palm trunk (DMT), goat+sheep manure (GSM), ravine soil (TBA), and commercial (COM) substrates in the Upper-Middle Gurgueia region.

Substrates	SRI	NLB (u)	NRA (u)	BRL (cm)	BRD (mm)	SFM (g)	SDM (g)
SND	0.45 b	10.17 ab	1.7 a	4.48 b	6.15 a	5.52 b	0.41b
DMT	0.58 ab	9.31 b	2.06 a	3.75 b	5.09 a	5.13 b	0.75 b
GSM	0.8 a	16.74 a	2.01 a	13.35 a	5.99 a	17.29 a	2.04 a
TBA	0.59 ab	9.56 b	1.77 a	3.43 b	5.84 a	2.94 b	0.46 b
COM	0.55 ab	10.44 ab	1.88 a	4.75 b	5.87 a	4.48 b	0.62 b
CV (%)	19.58	26.73	25.38	28.19	10.5	51.23	37.36
Substrates	**CLA**	**CLB**	**RL (cm)**	**VRS (cm^3)**	**RFM (g)**	**RDM (g)**	**ENR (%)**
SND	16.76 a	4.53 a	10.82 abc	1.93 b	1.5 b	0.09 b	75 ab
DMT	16.07 a	4.19 a	11.76 ab	2.33 b	2.06 b	0.16 b	65 b
GSM	19.39 a	5.36 a	14.56 a	4.95 a	7.13 a	0.46 a	100 a
TBA	17.71 a	5.05 a	7.71 c	1.61 b	0.74 b	0.14 b	85 ab
COM	14.03 a	3.96 a	10.65 bc	3.06 ab	2.76 b	0.17 b	70 ab
CV (%)	15.24	25.55	15.36	34.6	47.69	60.05	18.92

Lowercase letters: comparison between substrates. Same letters in the same column are not significantly different by Tukey's test at 5% probability.

There was a similar behavior to the shoot part for all variables referring to the root system, in which the goat+sheep substrate revealed to be satisfactory also for the development of roots, and provided the rooting of 100% of the fig cuttings (Table 2). According to the chemical analysis (Table 1), the manure possesses a greater amount of macronutrients (phosphorus, calcium, and magnesium) compared to the remaining substrates used in the present work, justifying the results, since they are essential elements in the induction and formation of roots, acting in the processes of division, elongation, and multiplication of cells, synthesis of nucleic acids and proteins, among other functions (Cunha et al 2009).

The low performance of the remaining substrates, besides being associated with the lower availability of nutrients to the fig seedlings, might have occurred due to their physical characteristics. The use of soil in an isolated manner reduces the drainage capacity of the water excess or increases compaction with the frequent watering, thus decreasing oxygenation and the capacity of emission and growth of radicles (Nava et al., 2014).

Sand (SND), considered a chemically inert subtract, presents high drainage and, consequently, lower water holding. However, when associated with other substrates, it acts as conditioning, improving the physical structure of the substrate (Nava et al., 2014).

The decomposed Moriche palm trunk (DMT), abundantly available material in the Southwest region of the Piauí state is rich in organic matter and, in addition to other substrates, it provides lower density, higher total porosity, aeration and water retention (Sousa et al., 2013). However, the use of 100% of DMT caused moisture excess (Albano et al., 2014), what possibly explains the low performance in the rooting of fig cuttings (65%) and the lower number of leaves (9.31). The great water holding capacity induces the lack of oxygenation for root development (Zorzeto et al., 2014) and also propitiates the appearing of diseases in the plants (Navroski et al., 2015).

Regarding the commercial substrate (COM), the superiority of the goat+sheep manure in the amount of nutrients, higher cation exchange capacity, sum of bases, and pH, demonstrates the potential of the use of this substrate in the nutrition of fig seedlings and becomes an alternative for cost reduction in seedling production, since it is abundantly available in the Northeastern region of Brazil, besides being an income source for of goat and sheep raisers.

Studies with other species, such as papaya and sunflower have demonstrated that the addition of goat and sheep manure to other substrates promotes a greater development of the seedlings, providing a favorable environment both physically and chemically (Araújo et al., 2010; Pereira et al., 2014). However, works with the use of these manures are yet scarce, with more studies being necessary to clarify their role in seedling nutrition.

Conclusion

The goat+sheep manure provides the necessary nutrients for the growth and development of fig seedlings, cultivar 'Roxo de Valinhos', allowing the rooting of 100% of the cuttings and higher seedling quality.

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