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Use of babassu decomposed stem substrate on the vegetative propagation of *Euphorbia splendens*

Uso de substrato do caule decomposto de babaçu na propagação vegetativa de *Euphorbia splendens*

Uso de substrato de tallo decompuesto de babasú em la propagación vegetative de *Euphorbia splendens*

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Abstract

The present study aimed to evaluate the use of the babassu decomposed stem under different proportions in substrate composition for the vegetative propagation of *Euphorbia splendens*. The experiment was conducted in a greenhouse and we used a completely randomized design with six treatments and four repetitions. Six types of substrates were formulated using a mixture of babassu decomposed stem (BDS) and soil (SL) in the proportions of 100% SL, 20:80 % BDS:SL, 40:60 %, BDS:SL, 60:40 % BDS:SL, 80:20 % BDS:SL and 100 % BDS. The seedlings were evaluated at 45 days after cutting by measuring the diameter of the longest shoot, number of leaves, number of shoots, root length, root volume, largest shoot length, fresh weight of the aerial part, root fresh weight, dry weight of the aerial part, and root dry weight. The treatments that presented normality and homoscedasticity were submitted to simple linear regression analysis. The proportion of the substrate of 20: 80% BDS: SL has a greater length of the largest shoot about the substrate 80:20% BDS: SL. The diameter of the largest sprout, the number of leaves, and the root length decreased due to the increase in the proportion of babassu decomposed stem in the substrates. The production of seedlings using cuttings of *Euphorbia splendens* is facilitated by the fact that it is a species with easy rooting, therefore, it is not necessary to use substrates with proportions of babassu decomposed stem and soil for its vegetative propagation.

Keywords: *Attalea speciosa* Mart.; Alternative substrate; Seedling production.

Resumo

O presente estudo teve como objetivo avaliar a utilização do caule decomposto do babaçu em diferentes proporções na composição do substrato para a propagação vegetativa de Euphorbia splendens. O experimento foi conduzido em casa de vegetação e utilizou-se o delineamento inteiramente casualizado com seis tratamentos e quatro repetições. Seis tipos de substratos

foram formulados utilizando uma mistura de caule decomposto de babaçu (BDS) e solo (SL) nas proporções de 100% SL, 20:80% BDS: SL, 40:60%, BDS: SL, 60:40% BDS: SL, 80:20% BDS: SL e 100% BDS. As mudas foram avaliadas 45 dias após o corte medindo-se o diâmetro do caule mais longo, número de folhas, número de brotos, comprimento da raiz, volume da raiz, maior comprimento do caule, massa fresca da parte aérea, massa fresca da raiz, massa seca da parte aérea e massa seca da raiz. Os tratamentos que apresentaram normalidade e homocedasticidade foram submetidos à análise de regressão linear simples. A proporção do substrato de 20: 80% BDS: SL tem um comprimento maior do maior rebento sobre o substrato 80: 20% BDS: SL. O diâmetro da maior brotação, o número de folhas e o comprimento da raiz diminuíram devido ao aumento da proporção do caule decomposto do babaçu nos substratos. A produção de mudas a partir de estacas de Euphorbia splendens é facilitada pelo fato de se tratar de uma espécie de fácil enraizamento, portanto, não é necessário o uso de substratos com proporções de caule decomposto de babaçu e solo para sua propagação vegetativa.

Palavras-chave: *Attalea speciosa* Mart.; Substrato alternativo; Produção de mudas.

Resumen

El estudio tuvo como objetivo evaluar el uso del tallo descompuesto de babasú en diferentes proporciones en la composición del sustrato para la propagación vegetativa de Euphorbia splendens. El experimento se realizó en invernadero y se utilizó un diseño completamente al azar con seis tratamientos y cuatro repeticiones. Se formularon seis tipos de sustratos utilizando una mezcla de tallo de babasú descompuesto (BDS) y suelo (SL) en las proporciones de 100% SL, 20: 80% BDS: SL, 40: 60%, BDS: SL, 60: 40% BDS: SL, 80: 20% BDS: SL y 100% BDS. Las plántulas se evaluaron 45 días después del corte midiendo el diámetro del tallo más largo, número de hojas, número de brotes, longitud de la raíz, volumen de la raíz, longitud más larga del tallo, peso de brotes frescos, peso de brotes frescos, peso de brotes secos y peso de brotes secos. Los tratamientos que presentaron normalidad y homocedasticidad fueron sometidos a análisis de regresión lineal simple. La proporción de sustrato de 20: 80% BDS: SL tiene una mayor longitud del brote más grande sobre el sustrato 80: 20% BDS: SL. El diámetro del brote más grande, el número de hojas y el largo de la raíz disminuyeron debido al aumento en la proporción del tallo descompuesto de babasú en los sustratos. La producción de plántulas a partir de esquejes de Euphorbia splendens se ve facilitada por el hecho de que es una especie de fácil enraizamiento, por lo que no es

necesario utilizar sustratos con proporciones de tallo descompuesto de babasú y suelo para su propagación vegetativa.

Palabras clave: *Attalea speciosa* Mart.; Sustrato alternativo; Producción de plântulas.

1. Introduction

The substrate selection is especially important to produce healthy and vigorous seedlings. However, obtaining this organic compost depends on the cost and availability in the locality (Santos et al., 2015) combined with the physical and chemical characteristics that promote moisture retention, so water and nutrients are available to meet plant needs (Oliveira Neto et al., 2018). Therefore, the use of alternative substrates from industrial or agro-industrial waste can be a solution to make both activities more sustainable (Costa et al., 2013).

The decomposed stem of the babassu palm (*Attalea speciosa* Mart.) stands out among the organic materials that have the potential for substrate composition. The babassu palm tree is a species native to the North and Northeast regions of Brazil (Oliveira Neto et al., 2018). Oliveira et al. (2017) considered the decomposed stem of the babassu palm as a substrate for potential use, it can be used entirely or partially with the addition of P sources in agricultural substrates.

Several native plants from the Caatinga biome are used in folk medicine because they have therapeutic effects widely recognized by the empirical knowledge from regions of the Caatinga biome (Gomes et al., 2008). Among these native species, the *Euphorbiaceae* family stands out in economic activity due to its use in food and medicine from popular knowledge (Trindade and Lameira, 2015).

The christ thorn (*Euphorbia splendens*), also popularly known in Brazil as the crown of thorns, Christ plant, Well Married, and Two Brothers (Vasconcellos & Amorim, 2003), is a shrub of the Euphorbia family, constituted by a climbing stem and prickly, tortuous and prostrate branches so this plant has reduced architecture (bush) with leaves of matte green color, small usually arranged at the stem apex, however, the christ thorn does not have leaves in winter, unlike its flowers which are present in all seasons. The flowers are in pairs and supported by two bracts (Biachini et al., 1994).

There is great economic viability to produce *Euphorbia splendens* seedlings using low-cost and easily accessible substrates. Therefore, the present study aimed to evaluate the use of the babassu decomposed stem under different proportions in substrate composition for the vegetative propagation of *Euphorbia splendens.*

2. Methodology

The experiment was carried out in a greenhouse with 70% luminosity control, from September to November of 2019, at the Agricultural and Environmental Sciences Center (CCAA) of the Federal University of Maranhão (UFMA) (03º44'17" S and 43º20'29" W and altitude of 107 m) located in the Chapadinha municipality, Maranhão state, Brazil.

The climate in the study site, according to the Thornthwaite (1948) climate classification, is characterized as C_2s_2A 'a' (sub-humid, megathermal, with a great water deficit in the summer), annual rainfall of 1613 mm and mean annual air temperature of 28 ° C (PASSOS et al., 2016). The soil was Ferralsol classified according to World Reference Base (WRB) – FAO (IUSS, 2015).

The experimental design used was completely randomized (DCR), with six treatments and four repetitions, totaling 48 plots and two seedlings in each plot. The treatments were substrates were formulated using a mixture of babassu decomposed stem (BDS) and soil (SL) in the proportions of 100% SL, 20:80 % BDS:SL, 40:60 %, BDS:SL, 60:40 % BDS:SL, 80:20 % BDS:SL and 100 % BDS.

We performed the physical (Table 1) and chemical (Table 2) analyzes of the substrates before installing the experiment when the substrates had soil in their composition, we performed the granulometric analysis: 384 g coarse sand kg^{-1}, 336 g fine sand kg^{-1}, 112 g silt kg^{-1}, 168 g of total clay kg^{-1}, 38 g of natural clay kg^{-1}, sandy loam texture class, and soil flocculation degree of 77 g / 100 g.

Table 1. Density (D), particle density (PD), and porosity (P) of the substrates based on babassu decomposed stem (BDS).

Substrates	Density (g cm^{-3})		Porosity (%)
	D	PD	
100% SL	0.56	0.85	34.43
20:80 % BDS:SL	1.28	2.64	51.53
40:60 % BDS:SL	1.18	2.57	54.01
60:40 % BDS:SL	0.98	2.24	56.22
80:20 % BDS:SL	0.73	1.88	60.91
100 % BDS	0.33	0.97	65.95

Legend: SL – Soil and BDS - babassu decomposed stem. Source: Authors.

Table 2. Values of the potential of hydrogen (pH), electric conductivity (EC) and total contents of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sulfur (S) of substrates based on babassu decomposed stem (BDS).

Substrates	pH	EC	N	P	K	Ca	Mg	S
		ds m^{-1}	g kg^{-1}	mg kg^{-1}			cmolc kg^{-1}	
100% SL	4.92	2.78	3.08	553	2.89	22.50	3.40	29.4
20:80 % DBS:SL	4.88	0.61	1.23	14	0.67	1.60	1.00	3.8
40:60 % DBS:SL	5.11	1.36	1.46	13	1.82	3.20	1.70	7.6
60:40 % DBS:SL	4.83	1.79	2.02	13	2.35	4.40	2.80	10.8
80:20 % DBS:SL	5.16	3.00	3.47	27	6.17	10.90	4.60	24.6
100 % DBS	5.32	4.34	5.88	33	3.63	20.60	15.20	41.5

Legend: BDS:SL= SL -Soil and BDS – babasu deomposed stem. Source: Authors

For the production of *Euphorbia splendens* seedlings, we collected cuttings from the stock plant around five centimeters in length, casually allocated in polyethylene bags with dimensions of 12 x 20 cm. The seedlings were watered daily.

At 45 days after cutting, The variables evaluated were: a) number of shoots (NB) and number of leaves (NF) - was evaluated by counting live cuttings that had sprouting, b) largest

shoot length (CMB) - measured using a ruler graduated in cm, c) diameter of the longest shoot (DB) - obtained by the digital caliper in mm, d) root length (CR) - measured using a ruler graduated in cm, e) root volume (VR) - performed by measuring the displacement of the water column in a graduated cylinder, in cm^3, f) fresh weight of the aerial part (MFPA) and root fresh weight (MFSR) - weighed on an electronic scale (accuracy= ± 0.01 g) in g, dry weight of the aerial part (MSPA) and root dry weight (MSSR) - the material was dried in a forced-air circulation oven (65°C) until constant weight during 72 hours.

Data were submitted to the Shapiro-Wilk test ($p > 0.05$) and f test ($p < 0.05$) to verify the normality and homoscedasticity of variances, respectively. Then, the means that demonstrated significance were compared by the Tukey test at 5% probability. The treatments that presented normality and homoscedasticity were submitted to simple linear regression analysis.

3. Results and discussion

There was a significant effect by the F test ($p < 0.05$) for the fresh weight of the aerial part, root volume, the diameter of the longest shoot, number of leaves, largest shoot length and root length of *Euphorbia splendens* seedlings (Table 3).

Table 3. Analysis of variance of the number of leaves (NF), number of shoots (NB), largest shoot length (CMB), diameter of the longest shoot (DMB), root length (CR), root volume (VR), root fresh weight (MFR), fresh weight of the aerial part (MFPA), root dry weight (MSR), and dry weight of the aerial part (MSPA) of *Euphorbia splendens* seedlings as a function of substrates based on babassu decomposed stem.

TRAT	NF	NB	CMB	DMB	CR	VR
0:100%	17.63 a	4.13	2.08 ab	3.59 a	11.89 a	0.33 a
20:80%	22.50 a	4.75	2.74 a	3.54 a	14.76 a	0.65 a
40:60%	19.38 6a	5.00	1.06 ab	3.14 a	11.53 a	0.30 a
60:40%	9.00 a	2.75	1.50 ab	2.46 a	8.44 a	0.20 a
80:20%	9.63 a	3.13	0.33 b	2.38 a	2.29 a	0.15 a
100:0%	6.00 a	4.00	0.25 ab	0.75 a	0.00 a	0.00 a
Shapiro-Wilk	0.1798	0.7840	0.0614	0.6474	0,2314	0.0121
F Test	0.0042*	0.1207^{ns}	0.0016*	0.0256*	0.0061*	0.0273*

TRAT	MFR	MFPA	MSR	MSPA
0:100%	0.16	0.92 a	0.04	0.11
20:80%	0.33	1.29 a	0.08	0.13
40:60%	0.17	0.54 a	0.04	0.10
60:40%	0.09	0.39 a	0.03	0.11
80:20%	0.12	0.10 a	0.02	0.10
100:0%	0.00	0.09 a	0.00	0.26
Shapiro-Wilk	0.0202	0.0003	0.0143	0.1142
F Test	0.0527 ^{ns}	0.0077*	0.0613 ^{ns}	0.7171 ^{ns}

BDS: SL = babaçu decomposed stem: soil; soil; averages followed by the same letter in the column do not differ by the Tukey test at 5%; NS = not significant; * = significant at 5% by the F test. Source: Authors.

The substrate in the proportion of 20:80% BDS: SL presented the highest CMB compared to the substrate in the proportion of 80:20% BDS: SL. Similar results were found by Silva et al. (2019) when evaluating increasing proportions of BDS as a substrate in the production of tamarind seedlings. These authors observed that the treatment with a mixture of 20% BDS and 80% soil, possibly provides a greater water retention capacity, associated with the ideal aeration for a given crop, favoring the availability of nutrients.

Garreto et al. (2020) also observed that the volume and dry mass of the root of Polyscias spp. the seedlings did not differ in substrates with decomposed babassu stem.

DMB, NF, CMB, NB and CR were the variables that showed normality and homoscedasticity (Table 3). For these variables, we adjusted the linear models under the proportions of the decomposed babassu stem in the substrates. There was a significant effect on the linear regressions of DMB, NF and RC (Table 4).

Table 4. Análysis of variance of simple linear regressions.

MSPA				
	SQ	*MQ*	*F*	*p-value*
Regression	0.005598	0.005598	1.781472	0.252874
Residuo	0.01257	0.003142		
Total	0.018168			
DMB				
	SQ	*MQ*	*F*	*p-value*
Regression	4.810321	4.810321	23.63034	0.008273
Residuo	0.814262	0.203565		
Total	5.624583			
NF				
	SQ	*MQ*	*F*	*p-value*
Regression	163.9395	163.9395	11.21342	0.028605
Residuo	58.47976	14.61994		
Total	222.4193			
NB				
	SQ	*MQ*	*F*	*p-value*
Regression	0.858036	0.858036	1.129813	0.347727
Residuo	3.037798	0.759449		
Total	3.895833			

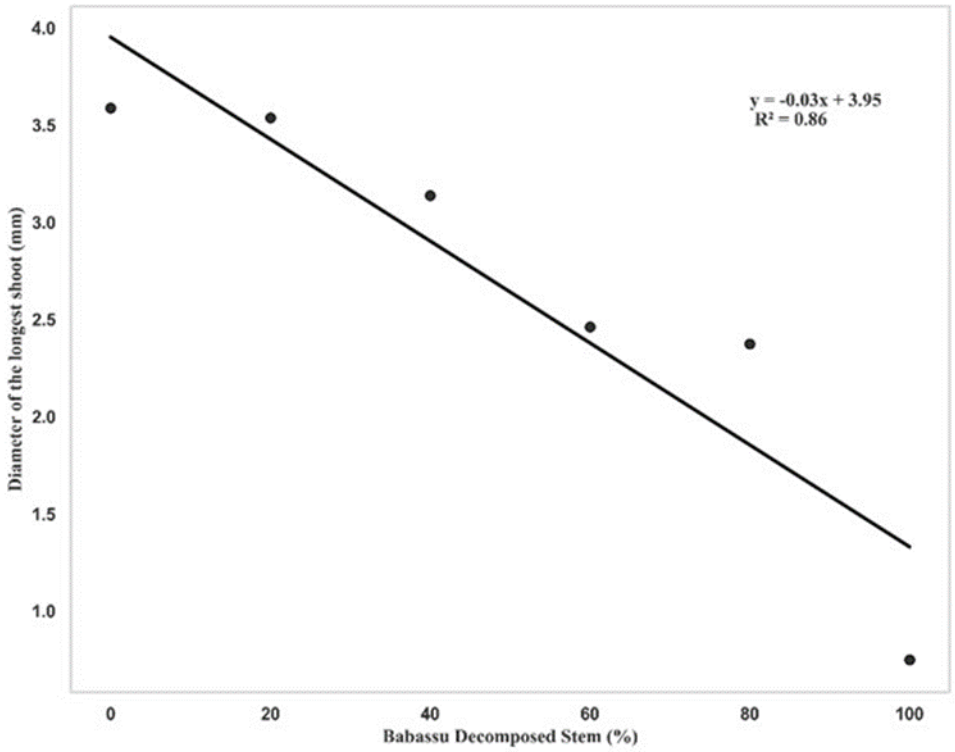
		CR		
	SQ	*MQ*	*F*	*p-value*
Regression	142.7143	142.7143	20.95318	0.010203
Residue	27.24443	6.811107		
Total	169.9588			

Source: Authors

The diameter of the largest shoot of *Euphorbia splendens* seedlings decreased by 0.03 mm with an increase of 1% in the proportion of BDS (Figure 1). According to the model adjusted with high precision (R^2 = 0.86), we observed that DMB of *Euphorbia splendens* seedlings had 3.95 mm without using the studied substrates.

These results differ from those found by Oliveira Neto et al. (2018), the authors observed the better root and shoot developments of pomegranate (*Punica granatum* L.) cuttings, using substrates with a mixture of babassu decomposed stem and soil

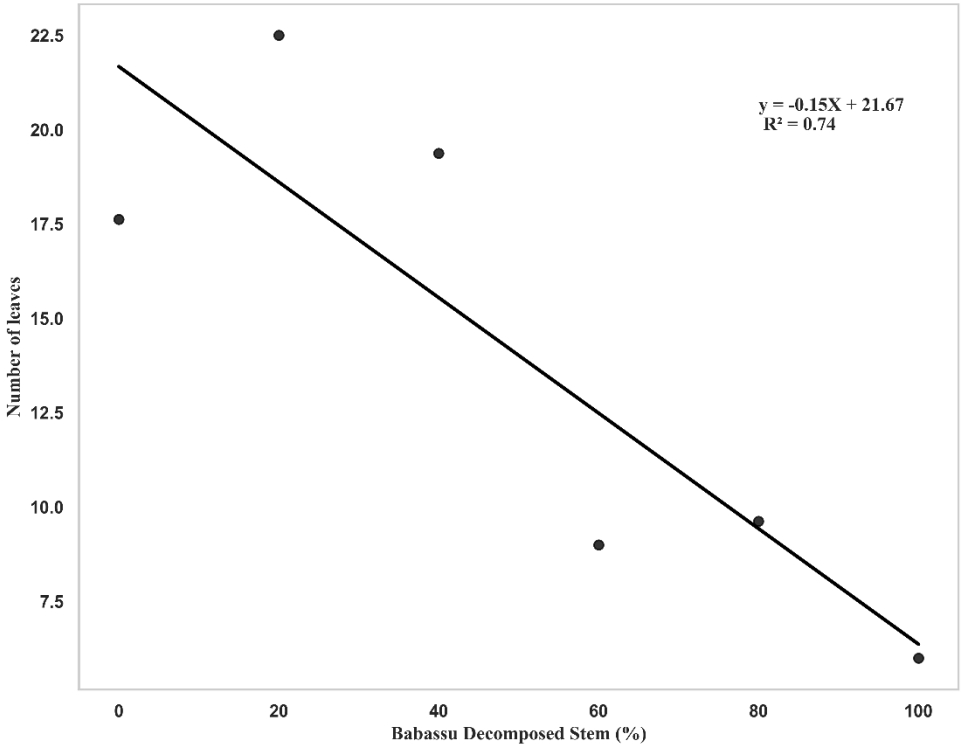
Figure 1. The diameter of the longest shoot (mm) under the percentage of Babassu decomposed stem (%) in the sustrates.



Source: Authors.

The number of leaves decreased as the proportion of BDS increased (Figure 2). We observed that increasing 1% of the proportion of BDS in the substrate decreased 0.15 the number of leaves of *Euphorbia splendens* seedlings. *Euphorbia splendens* seedlings without using the studied substrates showed around 22 leaves.

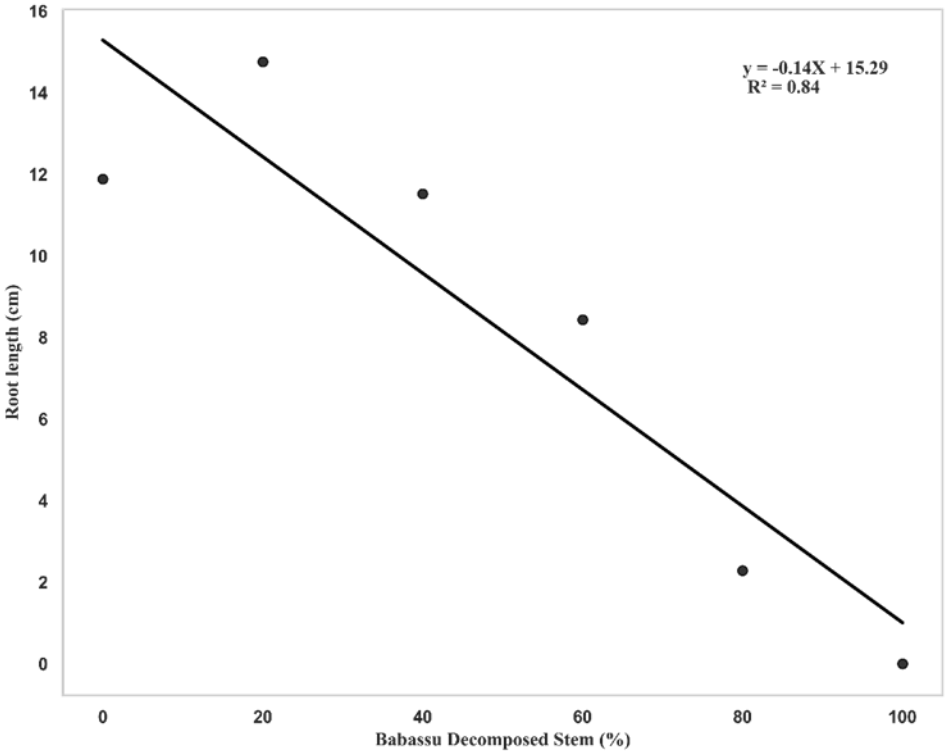
Figure 2. The number of leaves under the percentage of Babassu decomposed stem (%) in the substrates.



Source: Authors.

Root length in seedling production is an important variable for the establishment of seedlings on the substrate. However, the root length of *Euphorbia splendens* seedlings showed a decrease due to the increase in the proportions of the babassu decomposed stem. For each addition of 1% BDS to the substrate, the root length decreased by 0.14 cm. *Euphorbia splendens* seedlings not submitted to the proportions of the studied substrates may have a root length of 15.29 cm. These results occurred because this ornamental species presents rusticity in propagation; in other words, rapid sprouting after rooting (Rossa et al., 2019).

Figura 3. Root length (cm) under the percentage of Babassu decomposed stem (%) in the substrates.



Source: Authors.

4. Final Considerations

The proportion of the substrate of 20: 80% BDS: SL has a greater length of the largest shoot about the substrate 80:20% BDS: SL.

The diameter of the largest sprout, the number of leaves, and the root length decreased due to the increase in the proportion of babassu decomposed stem in the substrates.

The production of seedlings using cuttings of *Euphorbia splendens* is facilitated by the fact that it is a species with easy rooting, therefore, it is not necessary to use substrates with proportions of babassu decomposed stem and soil for its vegetative propagation.

New studies on the propagation of *Euphorbia splendens* seedlings by cuttings should be carried out.

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