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# Initial Growth of *Amburana cearensis* in Decomposed Buriti Stem Substrate and Nitrogen Doses

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**Abstract**

One of the difficulties of producing native species seedlings is slow growth. The objective of this study was to evaluate the initial development of *Amburana cearensis* (Allem.) A. C. Smith in relation to the concentration decomposed buriti stem substratum and nitrogen doses. A completely randomized design was used in a factorial arrangement of 3 × 5 (proportions of decomposed buriti stem × nitrogen doses), with six replicates. The treatments were formulated substrates comprised of decomposed buriti stem manually mixed with soil (Dystrophic Yellow Latosol) in three proportions (0, 25 and 50%) and five nitrogen doses (0, 100, 200, 300 and 400 mg $dm^{-3}$) applied in treatments. There was no significant interaction between the DRM and ND factors. However, there was an isolated effect for the following variables: Plant height (PH), stem diameter (SD), leaf number (LN), leaf area (LA), dry mass of the aerial part (DMA) and root length (RL). The best concentrations of the substrate for the variables PH, LA and DMA were 25% and 50%, whereas for SD, LN and RL, the best result was 50%. ND and other variables had good responses under recommended doses ranging from a minimum of 264.82 mg $dm^{-3}$, observed in DMA, and a maximum of 400 mg $dm^{-3}$, observed in RL. Both factors positively the quality of umburana seedlings.

**Keywords:** nitrogen fertilization, native species, isolated factors, vigor

## 1. Introduction

The Caatinga is a prevalent Brazilian biome representing more than 10% of the country (844.453 $km^2$) and is the main biome of the northeast region. A great diversity of fauna and flora can be found in the Caatinga, as it is considered the most biodiverse semi-arid biome in the world (Almeida et al., 2015).

Amid the rich flora is the *Amburana cearensis* (Allem.) A.C. Smith, commonly known as "cumaru", "umburana" and/or "cherry tree". It is a native species frequently found in the Caatinga, known for its quality wood, seeds, roots and bark, which are commonly used in perfumes (preservative), food (candy) and pharmaceuticals (anti-inflammatories). The species is scientifically proven to be an effective resource and of popular usage (Canuto, 2008; Almeida et al., 2014; Pimentel & Guerra, 2015).

Given the importance of *A. cearensis*, extractive exploitation and environmental degradation have significantly reduced the population of this species (Campos et al., 2013). Thus, planting seeds in the Caatinga is a viable method to increase the population of this species. However, semi-arid soils are nutrient poor and it is difficult to produce quality seedlings.

The use of substrates is a viable alternative for seedling production, since substrates create positive effects regarding the vigour, sanity and nutritional value of the seedlings (Sousa et al., 2013). A material that demonstrates potential for composition of substrates in seedling production and is easy to access in the southern region of Piauí is the decomposed Buriti stem (*Mauritia vinifera* Mart.), commonly known as wood-of-buriti. Decomposed Buriti stem has been successfully tested for native fruiting species as chestnut-of-gurgueia (Calvacante et al., 2011) and species of economic value, such as passion fruit (Silva, 2012) and heliconia (Beckmam-Cavalcante et al., 2011).

Mineral fertilizers can be used in production since the amount of nutrients present in the substrates may not be sufficient for the plant. One of the difficulties faced in when producing native forest species seedlings is slow growth (Ferraz & Engel, 2011). Thus, correct fertilization can improve seed development and maximize survival chances. Among the critical nutrients, nitrogen is one of the most abundant elements in plants and it is an essential constituent of amino acids, proteins, nitrogenous bases, nucleic acids, hormones, chlorophyll, and other molecules necessary for the development and growth of plants (Silva et al., 2014).

Inadequate nutrition and other factors, such as competition with weeds, pest attacks and disease can stress the seedlings and cause damage in the establishment of cultivation. However, there are few studies about the response of umburana in agricultural or agroforestry management in the Caatinga biome. Thus, it is important to develop research that could progress cultivation efforts for the plant (Pimentel & Guerra, 2015).

The aim of this study was to evaluate the initial development of *A. cearensis* (Allem.) A. C. Smith seedlings in relation to the concentration of decomposed buriti stem substratum and doses of nitrogen.

## 2. Materials and Methods

The experiment was developed in a greenhouse at the Professor Cinobelina Elvas (CPCE) campus, Federal University of Piauí (UFPI), in the city of Bom Jesus located in the state of Piauí, 09°04′28″S and 44°21′31″W, with an average altitude of 277 m and a mean temperature of 26.5 °C, although a common mean temperature of 40 °C (Viana et al. 2002) was recorded between October and November 2015.

A completely randomized design was used in a factorial arrangement of 3 × 5 (proportions of decomposed buriti stem x nitrogen doses), with six replicates. The treatments were formulated substrates comprised of decomposed buriti stem manually mixed with soil (Dystrophic Yellow Latosol) in three proportions (0, 25 and 50%) and five nitrogen doses (0, 100, 200, 300 and 400 mg dm$^{-3}$) applied in treatments. The source of nitrogen was urea. The decomposed buriti stem was obtained from the Agrovila Formosa settlement, in Redenção do Gurguéia city located in the state of Piauí. The chemical composition of the soil is shown in Table 1.

Table 1. Chemical characterization of Dystrophic Yellow Latosol in a 0-0.20m layer

| pH | P | K | S | H+Al | Al | Ca | Mg | K | SB | T | m | V | OM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $H_2O$ | ---- mg dm$^{-3}$ ---- | | | ---------------- cmol$_c$ dm$^{-3}$ ------------------ | | | | | | | ------- % ------ | | g/Kg |
| 5.4 | 14.19 | 192.5 | - | 4.95 | 0.00 | 2.24 | 0.86 | 0.49 | 3.59 | 8.54 | 0.00 | 42.1 | 20.9 |

*Note*. pH in water; P = phosphorus; S = sulfur; H + Al + = hydrogen + aluminum; Al = aluminum; Ca = calcium; Mg = magnesium; K = potassium; SB = Sum of exchangeable bases; T = effective CEC; m = Aluminum Saturation Index; V = Base Saturation Index; and OM = Organic Matter.

The substrates were packed in plastic bags (12.5 cm long × 3 cm in diameter) where umburana seeds obtained from existing adult plants in Redenção of Gurguéia city were sown manually. After five days of the establishing seedling emergence, the nitrogen doses (0, 100, 200, 300 and 400 mg dm$^{-3}$) were applied to each substrate in treatments divided into two applications with intervals of 10 days. After sowing and throughout the experimental period, irrigation was performed twice a day; in the morning and at the end of the afternoon.

The development of the seedlings was evaluated 30 days after the first application of nitrogen, using the following variables: plant height (PH) measured using a graduated ruler; stem diameter (SD): measured with digital caliper; number of leaves (LN): by counting the total number of leaves/sapling; leaf area (LA): measured with the equipment LI-3100 leaf area meter (LI-COR, Inc. Lincoln, NE, USA); root length (RL): measured using a digital caliper. The dry mass of the aerial part (DMA) and roots (DRM) were determined: the parts were weighed in a semi-analytical scale after that they were dried in an oven at 65 °C until they reached a consistent weight.

The results were submitted to normality analysis by the Shapiro-Wilk test and variance by the F test ($p < 0.05$) with the aid of the "R" statistical program, version 3.1.3. When the data were significant, the mean values of variables for the qualitative treatments (substrate of decomposed buriti stem) were compared by the Turkey test at 5 % probability, whereas the mean values of the variables for the quantitative treatments (nitrogen doses) were adjusted in regression equations using Sigmaplot 11.0 software.

## 3. Results and Discussion

There was no significant interaction among the factors, decomposed buriti stem and doses of nitrogen for the analyzed variables. However, the isolated effect of these factors was significant for all the analyzed variables, with the only exception of the dry root mass (DRM) (Table 2). Sousa et al. (2013) studied another native species (*Enterolobium contortsiliquum*) and it also demonstrated individual effects of the sources of N and the proportions of decomposed buriti stem for the diameter of the stem and dry mass of the aerial part.

Table 2. Analysis of variance and average values for plant height (PH), stem diameter (SD), leaf number (LN), leaf area (LA), dry mass of aerial part (DMA), root length (RL) and dry root mass (DRM) of umburana plants in function of the decomposed buriti stem (DBS) and nitrogen doses (ND)

| Source of variation | PH (cm) | SD (mm) | LN (unit.) | LA ($cm^2$) | DMA (mg) | RL (cm) | DRM (mg) |
|---|---|---|---|---|---|---|---|
| DBS | 8.50* | 0.071* | 1.47** | 8976.3** | 115473* | 11.39* | $954.5^{ns}$ |
| T1 | 28.33 b | 2.936 b | 8.06 b | 179.26 b | 1030.16 b | 17.56 b | 374.70 |
| T2 | 29.24 a | 2.97 ab | 8.31 ab | 205.14 a | 1133.07 a | 18.46 ab | 384.62 |
| T3 | 29.26 a | 3.03 a | 8.50 a | 212.08 a | 1141.65 a | 18.73 a | 384.32 |
| ND | 5.99* | 0.065** | 1.46** | 5843.4** | 69235* | 8.32* | $806.1^{ns}$ |
| DBS*ND | $0.38^{ns}$ | $0.005^{ns}$ | $0.02^{ns}$ | $222.6^{ns}$ | $5854^{ns}$ | $1.38^{ns}$ | $211.6^{ns}$ |
| Residue | 2.39 | 0.016 | 0.26 | 464.1 | 26501 | 3.33 | 5169.3 |
| CV (%) | 5.35 | 4.31 | 6.2 | 10.83 | 14.78 | 10.01 | 18.86 |

*Note*. ** Significant at 1% probability level, * Significant at 5% probability level, ns: not significant. CV - coefficient of variation. T1 = decomposed buriti stem (0%) + soil (100%); T2 = decomposed buriti stem (25%) + soil (75%); T3 = decomposed buriti stem (50%) + soil (50%).

The effect of the isolated factor CDB for the variables PH, LA and DMA was evaluated. It was observed that the best responses were obtained at concentrations of 25 (T2) and 50% (T3) of the substrate (Table 2). Sousa et al. (2013) obtained a higher PH of tamboril (*E. contortsiliquum*) in the proportion of 59:41 (decomposed buriti stem: soil), which are results close to the present study. Albano et al. (2014) also observed positive effects of DRM, especially for the variables LA and DMA. The LA and DMA variables are directly related, so both had better responses in the same substrate concentrations. The CDB is a rich substratum in nutrients (N, P, K, Ca and Mg) and organic matter, and thus demonstrates a good responsive capacity of umburana in the addition to the nutrients observed, resulting in the best solution for these variables (Sousa et al., 2013; Silva júnior et al., 2014).

For all variables that presented significant effect of the isolated nitrogen dose (PH, SD, LN, LA, DMA and RL), averages were adjusted to the quadratic polynomial regression model (Figure 1). PH had a maximum growth of 29.40 cm in the dose of 314.99 mg $dm^{-3}$, which represents an approximate increment of 4.89% when compared to the control (28.03 cm) (Figure 1A). For LA, the dose of maxim growth was 275.33 mg $dm^{-3}$, which provided a maximum value of 216.16 $cm^2$, representing an increase of 26.25% when compared with the control (170.68 $cm^2$) (Figure 1). For DMA, the best dose observed was 264.82 mg $dm^{-3}$, promoting a maximum value of 1155.66 mg, consequently providing an increment of 15.41% when was compared with the control (1001.38 mg) (Figure 1).

Nitrogen (N) induces an increase in the nutrient content in native species. In the absence of nitrogen fertilization, there is a superior demand of N and Ca from the aerial part in relation to the root (Carnevali et al., 2016). According to these same authors, research about mineral nutrition in native arboreal species states that fertilization has a positive effect, mainly in relation to N and phosphorus.

The isolated effect of CDB obtained better responses in T3 for the variables SD, LN and RL providing increments of 3.20%, 5.46% and 6.66%, respectively, when compared to the control (Table 2). Sousa et al. (2013) also observed this increase in the growth variables and diameter of the stem, which validates the results of this study. This improvement was attributed to DRM quality.

The increase in RL can be attributed to the physical characteristics of the substrate, such as aeration space (35%), humid density (625 kg $m^{-3}$), water retention capacity (57%) and volume of pores (93%) and aeration space in particular favors the development of the root system, because substrates with larger aeration spaces have a greater root volume than those with smaller spaces (Silva Júnior et al., 2014).

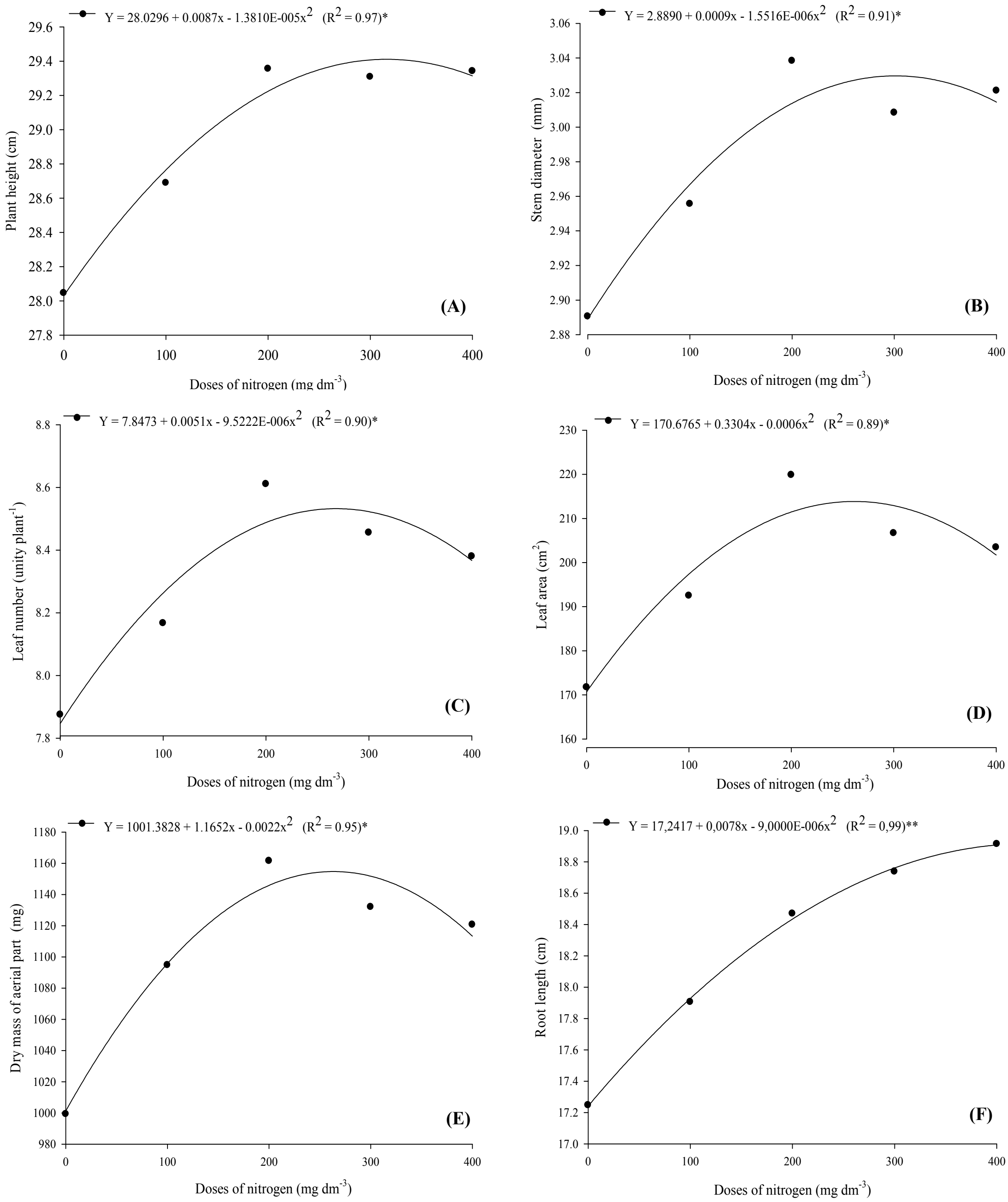


Figure 1. Plant height (A), stem diameter (B), leaf number (C), leaf area (D), dry mass of aerial part (E) and root length (F) of umburana plants in relation to nitrogen doses

*Note*. ** and * statistical significance at 1% and 5% by F test, respectively.

The isolated factor ND for SD obtained maxim answer in the 290.02 mg $dm^{-3}$ dose, promoting an increase of 4.53% compared to the control (2.89 mm) after raising its value to 3.02 mm (Figure 1B). The best dose was 267.80 mg $dm^{-3}$ for LN, providing a maximum LN of approximately 8.53 representing an increment of 8.70% when compared to the control (7.85) (Figure 1C). For RL, the dose of greater effect was of 400 mg $dm^{-3}$, which elevated its value to 18.93, representing an approximate increment of 9.79% when compared to the control (17.24 cm) (Figure 1F).

N is directly related to some plant mechanisms, such as: photosynthesis, respiration, root development, absorption of nutrients, cellular differentiation and growth. N is found in the chloroplasts of the leaves as constituent of the chlorophyll molecules and participates in the synthesis of compounds such as: vitamins, alkaloids, hormones, coenzymes, and others. Therefore, if the plant has an adequate supply of N, it will present good agronomic and physiological characteristics (Costa et al., 2012).

## 4. Conclusion

The seedlings of *A. cearensis* (Allem.) A.C. Smith respond positively to the isolated factors decomposed Buriti stem and nitrogen doses. The best substrate concentration is T3 (50%) and the best nitrogen doses varied from 264.82 mg $dm^{-3}$, observed in the aerial part dry mass at 400 mg $dm^{-3}$, at root length.

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