

## Research Paper

# Development, rooting and nodulation of mororó (*Bauhinia cheilantha*) cuttings harvested in different seasons

*Desarrollo, enraizamiento y nodulación de esquejes de mororó (Bauhinia cheilantha) cortados en diferentes estaciones.*

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## Abstract

To increase the establishment options of the tropical forage legume tree, mororó (*Bauhinia cheilantha*), a native of the Caatinga vegetation in Northeast Brazil, a vegetative propagation study was carried out. In 2 experiments the performance of cuttings taken from 2 different locations on the mother plant (apical and basal branches) was evaluated on 4 different substrates: washed sand (SA); soil (S); soil in a moist chamber (S+MC); and vermiculite (V), in which cuttings were ‘planted’. The variables analyzed were: bud emergence; presence of expanded leaves; length and width of expanded leaves; and development of roots. For the first experiment, cuttings were taken in the dry season (December), for the second experiment in the rainy season (June). Cutting season had the major effect on all variables, particularly emerging buds (37–90% in the dry vs. 1–34% in the rainy season) and expanded leaves (23–60% in the dry vs. 1–13% in the rainy season). The best results were obtained in substrates S+MC and SA, the latter applying particularly for root development. It seems cuttings can be taken from any part of the mother plant but should be taken in the dry season, when an adequate supply of nutrients exists in the branches. Further studies are warranted to determine how to increase the success of root development on cuttings.

**Keywords:** Caatinga, cutting season, forage trees, tropical legumes, vegetative propagation.

## Resumen

Para aumentar las opciones de establecimiento del mororó (*Bauhinia cheilantha*), un árbol forrajero nativo de la vegetación de Caatinga en el noreste de Brasil, se realizó un estudio de propagación vegetativa con esquejes de ramas apicales y basales que fueron plantados en 4 sustratos diferentes: arena lavada (SA); suelo (S); suelo colocado en una cámara húmeda (S+MC); y vermiculita (V). En 2 experimentos, uno en época seca (diciembre) y el otro en época lluviosa (junio), se analizaron las variables: brotes emergentes; presencia de hojas expandidas; largo y ancho de las hojas expandidas; y desarrollo de raíces. La época tuvo el mayor efecto en todas las variables, particularmente el desarrollo de brotes (37–90% en la época seca vs. 1–34% en la época lluviosa) y hojas expandidas (23–60% en la primera vs. 1–13% en la segunda). Los mejores resultados se obtuvieron con el uso de S+MC y SA; especialmente en el desarrollo de raíces en el medio SA. No se observaron diferencias entre esquejes de ramas apicales y basales, pero sí entre épocas de colecta,

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siendo la época seca más adecuada para la toma de esquejes, probablemente debido a mayor disponibilidad de nutrientes en las ramas. Se requieren estudios para determinar cómo aumentar el desarrollo de raíces en los esquejes.

**Palabras clave:** Árboles forrajeros, Caatinga, época de colecta, leguminosas tropicales, propagación vegetativa.

## Introduction

The Brazilian Northeast Caatinga Biome covers an extensive area, characterized by a semi-arid climate, with stochastic rainfall events, 300–1,000 mm/year concentrated in 3–5 months during the year (January–May varying by subregion). The region experiences high evaporation rates ([Silva et al. 2012](#)). Its main vegetation is trees and shrubs, with specific adaptations to their harsh habitats, such as loss of leaves in the dry period, small leaves, thorns and other xerophytic adaptations ([Silva et al. 2017](#)). As in other tropical and subtropical arid and semi-arid ecosystems, also in the Caatinga Leguminosae make up an important part of the native vegetation ([Muir et al. 2019](#)).

Among the leguminous forage tree species in the Caatinga, *Bauhinia cheilantha* (Bong.) Steud. (mororó) is highly palatable to cattle ([Ydoyaga-Santana et al. 2011](#)) and is considered potentially important for introduction into pastures ([Lira Júnior et al. 2013](#)). However, legume introduction into pastures and rangelands can be hampered by several factors such as lack of commercial seed sources, impermeable seeds, seedlings displaying low vigor resulting in slow establishment, low seed yields, pod dehiscence and low persistence under continuous stocking ([Muir 2019](#)). Mororó seed, for example, suffers from integument impermeability ([Gutiérrez et al. 2011](#)).

Nevertheless, propagation by cuttings presents an alternative establishment method which can be employed throughout the year, thus circumventing the problems associated with using seeds, and gives uniform stands. Vegetative propagation has distinct advantages for expediting breeding programs, e.g. for distribution of sterile materials and for planting in non-arable locations ([Shelton 2019](#)).

Vegetative propagation by cuttings can be influenced by several factors, including the plant's self-inherent characteristics, environmental conditions and the period of the year when cuttings are collected ([Ahkami et al. 2013](#)). For each cutting type (apical or basal), optimal size for rooting should be considered, as reserves of nutrients in the cutting and the number of buds on the cutting are important determinants of success ([Pizzatto et al. 2011](#)).

The objective of this study was to evaluate the effects of different harvest periods, cutting types and substrates on the initial establishment of *B. cheilantha* cuttings.

## Materials and Methods

Two experiments were conducted at the Department of Animal Science of Federal Rural University of Pernambuco, Dois Irmãos, Pernambuco, Brazil: Experiment 1 with cuttings harvested in the dry season (December 2003) and Experiment 2 with cuttings harvested in the rainy season (June 2004).

The experimental treatments were combinations of 2 types of cuttings (apical and basal) and 4 substrates [washed sand (SA), soil (S), soil in a moist chamber (S+MC) and vermiculite (V)], under a completely randomized design with 4 replicates. Whereas SA is a substrate free of salts, silt and clay, V is an industrial mineral substrate with its particular advantage being lightness, cleanness and high water-holding capacity. The soil used came from the Experimental Station of the Agronomic Institute of Pernambuco (IPA) in São Bento do Una municipality, Pernambuco, Brazil, is classified as a Regolithic Neosol with a loamy-sandy texture ([Santos et al. 2013](#)) and is considered of medium fertility.

The cuttings were harvested in a mororó forest at the same IPA Experimental Station where the soil originated from, in the dry season (December 2003; accumulated rainfall from August to December 2003: 89 mm) for Experiment 1, and in the rainy season (June 2004; accumulated rainfall from January to June 2004: 763 mm) for Experiment 2.

Apical cuttings were harvested from branches located in the upper part of the plant, and basal cuttings from the lower part. All cuttings, 15–20 cm long, with a horizontal section at the base, no leaves plus similar diameters (mean 7.5 mm) and 8–10 buds, were taken from a single adult plant. After collection, the cuttings were transported in coolers to the experimental site at Dois Irmãos.

Eight PET bottles with a capacity of approximately 1.5 kg were filled with the respective substrate to form each experimental unit. Each bottle had newspaper at the bottom with a hose to drain excess water and was irrigated daily to keep the substrate moist.

The cuttings of the treatments SA, S and V were kept in a standard greenhouse whereas the moist chamber for treatment S+MC consisted of a white 12 L plastic container, closed with a transparent acetate box. Plastic cups with 50 mL of water were kept inside to ensure the environment remained saturated, as well as the PET bottles with the plants from that treatment.

The following variables were measured: emergence of buds; presence of expanded leaves; and length and width of expanded leaves. After 120 days, rooting percentages of the cuttings and presence of nodules were determined.

Statistical analyses were performed separately for each experiment (season of year) using the SAS statistical software with means compared by Tukey test at  $P < 0.05$  (SAS 2012).

## Results

### Experiment 1

For cuttings collected in the dry period, there was no significant effect ( $P > 0.05$ ) of cutting type, i.e. apical or basal, nor any interaction between cutting type and substrate, so data were pooled for both cutting types (Table 1).

Substrate type had a significant effect ( $P < 0.05$ ) on percentage of cuttings which produced buds, expanded leaves and roots plus length and width of expanded leaves. The substrate S+MC promoted the highest percentage of buds (89.7% of cuttings), while S had the lowest number of cuttings which produced buds (37.3%) and fully expanded leaves (22.9%). Rooting of cuttings was significantly higher in V (19.1%) than in both substrates involving soil, where very low percentages of cuttings produced roots (2.4 and 0.8%). Both V and SA produced longer and wider leaves on cuttings than did straight soil.

Some nodules were found on roots in the S+MC after 120 days of culture.

While no statistical comparison between sampling periods was done, higher values were found for bud, expanded leaves and rooting percentages for cuttings obtained during the dry season, without any apparent difference for leaf width or length (Table 1).

### Experiment 2

For cuttings taken in the rainy season, no significant effect was observed ( $P > 0.05$ ) for cutting type, nor was there any interaction between cutting type and substrate, so data were pooled for the 2 cutting types. Substrate type had a significant effect ( $P < 0.05$ ) on the percentage of cuttings which produced buds and expanded leaves plus length and width of expanded leaves (Table 1).

Percentage of cuttings producing buds was higher for those grown in S+MC and SA than for those grown in S.

Substrate had no significant effect ( $P > 0.05$ ) on percentage of rainy season cuttings producing roots, the only substrate producing any rooting being S+MC (0.8%).

## Discussion

This study has shown that season when cuttings were taken had the greatest overall effect on production of buds, expanded leaves and roots on cuttings of mororó. It is possible that the difference between seasons is linked to amounts of substances stored in the cuttings, as during the rainy season the tendency is for more intense growth, with translocation/consumption of these substances in the branches.

While cuttings taken during the dry season generally produced buds and expanded leaves at an acceptable level, those taken in the rainy season produced at a much lower level, barely better than a third of that in the dry. While root development was also affected by time when cuttings were taken, only SA and V substrates produced acceptable levels of root development and then only for cuttings taken in the dry season.

**Table 1.** Percentages of mororó (*Bauhinia cheilantha*) cuttings harvested during the dry and rainy seasons which produced buds, expanded leaves and roots in different substrates plus dimensions of leaves produced.

| Substrate                   | Dry Season (Experiment 1) |                     |                  |                 |             | Rainy Season (Experiment 2) |                     |                  |                 |             |
|-----------------------------|---------------------------|---------------------|------------------|-----------------|-------------|-----------------------------|---------------------|------------------|-----------------|-------------|
|                             | Buds (%)                  | Expanded leaves (%) | Leaf length (cm) | Leaf width (cm) | Rooting (%) | Buds (%)                    | Expanded leaves (%) | Leaf length (cm) | Leaf width (cm) | Rooting (%) |
| Washed sand (SA)            | 62.4b <sup>1</sup>        | 47.6a               | 2.7ab            | 3.0ab           | 16.4ab      | 27.2ab                      | 12.6a               | 1.7a             | 2.3a            | 0.0a        |
| Soil + Moist Chamber (S+MC) | 89.7a                     | 62.3a               | 1.9bc            | 2.1bc           | 2.4bc       | 34.0a                       | 13.4a               | 1.2ab            | 1.3ab           | 0.8a        |
| Soil (S)                    | 37.3c                     | 22.9b               | 1.7c             | 1.9c            | 0.8c        | 0.5c                        | 0.5b                | 0.1c             | 0.1c            | 0.0a        |
| Vermiculite (V)             | 56.1b                     | 46.8a               | 2.9a             | 3.3a            | 19.1a       | 13.0b                       | 5.0ab               | 0.7bc            | 0.8bc           | 0.0a        |
| Mean                        | 61.4                      | 44.9                | 2.3              | 2.6             | 9.7         | 18.7                        | 7.9                 | 0.9              | 1.1             | 0.2         |
| CV (%)                      | 10.0                      | 14.5                | 10.4             | 10.4            | 57.1        | 30.4                        | 36.4                | 17.4             | 43.6            | 20.5        |

<sup>1</sup>Means within columns followed by the same letter are not significantly different at  $P < 0.05$  by Tukey test.

The role of leaves in the rooting of semi-woody cuttings is related to photosynthesis, and the supply of carbohydrates, auxins and rooting cofactors, which are transported to the base of the cuttings (Lima et al. 2011). In this way, Bowerman et al. (2013) suggested that, providing good soil characteristics, e.g. adequate aeration and drainage, and a relatively consistent but moderate amount of moisture should ensure faster and better quality root development. Despite producing the highest levels of both buds and expanded leaves, cuttings grown in S+MC had poor root development, which suggests that factors other than adequate leaf development determined the level of root development in this study.

The fact that cuttings grown in sand had the second highest budding (>50%) and expanded leaf percentages (47%) (Table 1) plus satisfactory root production (16%) for cuttings taken in the dry season, was opportune as sand has many advantages as a substrate, since it is low-cost, easily available and has positive drainage characteristics (Almeida et al. 2008).

The effects of season when cuttings were taken on success rate agreed with the findings of Santos and Diodato (2017) who worked with algaroba [*Prosopis juliflora* (Sw.) DC.]. They reported that the dry season was the ideal time to collect cuttings in Petrolina, Pernambuco's semi-arid area, independent of cutting type (basal or apical).

The emergence of expanded leaves was lower than the development of buds for all substrates, which may help explain the poor development of roots, since leaves are necessary for the survival of cuttings, as they provide the carbohydrates produced by photosynthesis, plus auxins and other substances for root development and growth (Ahkami et al. 2013).

The substrate which promoted the highest percentage of buds was S+MC; this is probably associated with a greater water availability for the cuttings, a fundamental factor, especially in the initial growth phase.

Although 90% of dry season cuttings cultivated in S+MC produced buds and 60% produced expanded leaves, continued development would likely be compromised by the low degree of root formation (2.4%). While the cuttings presented lots of buds, probably due to the presence of nutrient reserves in the cuttings, these reserves seemed insufficient to promote root development. The failure of cuttings to develop roots may be associated with nutritional deficiency in plants at the collection site, but this is speculation as we have no supporting evidence. It was reassuring that V and SA substrates allowed development of roots (16–19%) on dry season cuttings, as no hormones were applied to stimulate root development. It appears that substrate had an over-riding influence on root development

as cuttings in both substrates including soils produced virtually no roots. Rooting of cuttings is dependent on many factors, both internal and external, e.g. the mother plant's nutritional and phytosanitary condition, genetic potential, hormonal balance, collecting period, temperature and humidity (environmental conditions), etc. (Gratieri-Sossella et al. 2008; Pizzatto et al. 2011). Natural climate factors, such as temperature and photoperiod, may also explain the year effects that we observed. In our study all cuttings were obtained from the same mother plant so most of the above factors can be ruled out in explaining why differences in rooting success between substrates were obtained in the dry season. More studies seem warranted to determine if the substrate plays an important role in rooting success. There seems little merit in repeating the seasonal comparisons as other studies, e.g. Santos and Diodato (2017), have previously found that dry season cuttings provide the optimal outcomes.

Although Song et al. (2010) reported that plants of the genus *Bauhinia* are probably non-nodulating, some nodules were found on roots in the S+MC substrate. Sprent et al. (2017) indicate that there are many non-nodulated caesalpinoid legumes in the New World tropics, for example *Bauhinia* and *Caesalpinia*.

The ability to grow uniform mororó cuttings could be of importance in cultivation of this species, which is well adapted to semi-arid conditions and is highly palatable to animals. Further studies are needed to determine appropriate substrates plus additives, e.g. hormones, which might stimulate root development, to expedite the successful adoption of this species by farmers.

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