Effect of substrate and cutting diameter on the propagation of *Arrabidaea chica* (Humb. & Bonpl.) B. Verl. (Bignoniaceae)

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RESUMO: Efeito de substratos e diâmetros de estacas na propagação de *Arrabidaea chica* (Humb. & Bonpl.) B. Verl. (Bignoniaceae). *Arrabidaea chica* (Humb. & Bonpl.) B. Verl. é uma liana nativa da região amazônica encontrada principalmente nas florestas secundárias ou como planta medicinal (tratamento de inflamação uterina,ovariana, intestinal e de colo, bem como cólicas intestinais, disenterias sangrentas, conjuntivites, infecções vaginais, leucemia, anemias e diabete) cultivada nos jardins domésticos. Nos estados brasileiros do Amazonas e Pará esta planta é conhecida pelos nomes populares crajiru, carajuru, carajiru e pariri, entre outros. O objetivo deste trabalho foi verificar a influência de dois substratos e quatro diâmetros de estacas no desenvolvimento de mudas de crajiru. O experimento foi conduzido num delineamento inteiramente casualizado, em esquema fatorial 2 X 4, com 5 repetições (10 estacas por repetição), dois ambientes/substratos para o enraizamento (1 – substrato sólido, 2 – água) e quatro diâmetros de estacas, em cm (1,1; 0,6; 0,3 e 0,2), a partir da base, sendo as mesmas classificadas nas seguintes categorias: lenhosas, semi-lenhosas, herbáceas e apicais. As estacas tinham aproximadamente 20 cm de comprimento. Apenas as estacas apicais tinham folhas, com uma média de quatro por estaca. O substrato sólido (1) foi preparado com 3 partes de areia: 1 de argila: 1 de húmus. Cada estaca ficou em um saco de polietileno preto com capacidade para 1 kg. Para as estacas em água (2), as de cada repetição foram colocadas em garrafas de polietileno-tereftalato (PET) de 2 L, contendo aproximadamente 500 mL de água, renovados a cada três dias para evitar a proliferação de larvas de insetos. Desde o dia da implantação em julho/2003 as mudas permaneceram em ambiente coberto com telha plástica transparente, recebendo irrigação diária. Decorridos 90 dias foram avaliadas as seguintes variáveis: % de pegamento, comprimento médio dos rebrotos (cm), comprimento médio das raízes (cm) e matéria seca das folhas e raízes (g plant^{-1}). As médias foram analisadas a 5% de probabilidade. Verificou-se que somente para a variável comprimento das raízes, não houve interação significativa. O percentual de pegamento foi superior no substrato sólido nas estacas de diâmetro 0,6 cm. Nas outras variáveis também o substrato sólido foi superior. No geral, o melhor desempenho foi para as estacas de 1,1 cm, no substrato sólido.

Palavras-chave: crajiru, carajiru, pariri, substratos, propagação vegetativa

ABSTRACT: *Arrabidaea chica* (H.B.K.) Verlot is a perennial vine which is native to the Amazon region being found mainly in secondary forests or as a cultivated, medicinal plant (treatment of uterine, ovarian, intestinal and colon inflammation, as well as intestinal cramps, bloody dysenteries, conjunctivitis, vaginal infections, leukemia, anemia and diabetes) in household gardens. In the Brazilian States of Amazonas and Pará it is known by the common names crajiru, carajuru, carajiru and pariri among other names. The objective of this study was to evaluate the effect of two different growth media (substrates) and stem cutting diameter on the development of *Arrabidaea chica* (H.B.K.) Verlot (Bignoniaceae) plants. The experiment was entirely randomized in a 2 X 4 factorial scheme with 5 repetitions (10 stem cuttings per repetition), 2 environments for root development (1 – solid substrate, 2 – water) and 4 basal stem diameters: 1.1, 0.6, 0.3 and 0.2 cm which were classified as woody, partially woody, herbaceous, and apical, respectively. The stem cuttings were *ca*. 20 cm in length with only apical cuttings presenting leaves. The solid substrate

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was prepared from sand, argillaceous soil and humus in the proportion 3:1:1. Each cutting was kept in a black polyethylene bag with 1 kg capacity. For the experiments in liquid environment, cuttings of each repetition were placed in clear, polyethylene terephthalate (PET) bottles of capacity 2 L (with tops cut off), containing approximately 500 mL of water, which was renewed every three days to avoid the proliferation of insect larvae. From the start of the experiment in July, 2003 stem cuttings/developing plants were maintained in areas having clear plastic protective roofing and were irrigated daily. After 90 days, the following variables were evaluated: established plants (%), average aerial (shoot) and root growth (both in cm), and average dried leaf and root masses (both in g plant^{-1}). Averages were analyzed at 5% probability. There was no significant interaction only in the average root growth per plant. In the solid substrate (1), the percentage of established plants was superior in stem cuttings of basal diameter 0.6 cm and for other variables development in general was better in the solid substrate. The greatest development was observed for stem cuttings of basal diameter 1.1 cm, in the solid substrate.

Key words: crajiru, carajiru, pariri, substrates, vegetative propagation

INTRODUCTION

Arrabidaea chica (H.B.K.) Verlot. is a perennial vine which is native to the Amazon region, mainly secondary forests, and is also cultivated as a medicinal plant in domestic gardens. In the Brazilian states Amazonas and Pará, it is known by the common names “carajuru”, “puca panga”, “crajiru”, “carajiru”, “pariri”, “chica”, “cipó-cruz”, “cipó-pau”, among others. Young plants have cylindrical and hairless stems, whereas older ones have tetragonal, striated and lenticellate stems presenting small and wrinkled protuberances. Their leaves are petiolate and composed of three leaflets that are oblong-lanceolate, hairless, leathery, reticulate-veined, and present distinctly or similarly colored blades. Red-lilac campanulate flowers are arranged in terminal, pyramid-shaped and loose panicles of 18-20 cm length. The fruit is an elongated, linear, hairless, rust-brown capsule which is sharp on both sides and has a salient median vein on the valves. Seeds are ovoid (Sandwith & Hunt, 1974; Pio Corrêa, 1984; Vasquez, 1992).

A. chica leaves are traditionally used for several purposes. “Carajura” (“crajura” or “chica vermelha”) is the name of a body stain that is made by using a leaf water extract precipitate obtained from this species by indians of Meta and Orinoco Rivers (Chapman et al., 1927). The main medicinal uses include treatment of uterine, ovarian, intestinal and colon inflammation, as well as intestinal cramps, bloody dysenteries, conjunctivitis, vaginal infections, leukemia, anemia and diabetes, besides several skin ailments of different etiologies such as eczemas and ringworms. They are also used for asepsis and healing of open wounds (Duke & Vasquez, 1994; Ribeiro et al., 1999; Mors et al., 2000; Revilla, 2002). The Brazilian Federal Government has registered a large number of cosmetic products. *A. chica* adstringent, emollient and valuable red pigment properties have been highly exploited for their commercial value.

The red color of *A. chica* leaves has been related to the presence of the 3-desoxyanthocyanidin named carajurin (6,7-dihydroxy-5,4’-dimethoxy-flavylium). This leaf color is a distinguishing characteristic of “crajiru” within the genus *Arrabidaea*. Several structurally similar 3-desoxyanthocyanidins (flavylium derivatives) and flavones have also been isolated from leaf extracts (Takemura et al., 1995; Zorn et al., 2001). Cyanidin-3-glucoside and cyanidin-3-rutinoside have been found in *A. chica* flowers (Scogin, 1980). Besides, anisic acid, assimilable iron, cyanocobalamine (Albuquerque, 1989), quinones, pseudoindicans, triterpenes, coumarins, alkaloids, tannins, saponins, bixine and genipin (Gottlieb, 1981; Bernal & Correa, 1989; Schultes & Raffauf, 1990) have been reported as *A. chica* constituents.

In domestic gardens and backyards in Amazonas State, one “crajiru” variety predominates. It has narrower leaves and tends to grow vertically, whereas other varieties have larger leaflets and strongly tends to grow horizontally. Based on these differences, “crajiru” varieties or types have been distinguished in this region. The most common garden variety is referred to as type I and reference plants are kept under constant cultivation in the main campus of National Institute of Amazonian Research (INPA). This first type, as well as types II and III, is kept under constant cultivation in Brazilian Agricultural Research Corporation (Embrapa) – Western Amazonia, Manaus, Amazonas State (AM). A fourth “crajiru” type, which has broader leaves than all other above-mentioned types, has been identified based on a specimen at the Herbarium of Biological Sciences Institute, Federal University of Amazonas, Manaus, AM. There may be five or more “crajiru” types (Borras, M.R.L., personal communication), and further systematic studies are needed to clearly differentiate these types.

In Amazonas State and great part of the Amazon region, the different “crajiru” types have common characteristics: red-brownish dry leaves, absent flowering, and non-available seeds. Thus, propagation structures are required, and stem cuttings are the most frequently recommended since this plant produces abundant shoot over the year.

The propagation of medicinal species through cuttings is a common practice. Biasi & De Bona (2000) found that 15-20cm-high *Baccharis trimera* (carqueja) apical and sprout cuttings could efficiently propagate in carbonized rice husks without the need of applying the plant growth regulator indolebutyric acid. Sousa et al. (2005) reported that basal cuttings and earth substrate containing plant matter were effective in the propagation of *Ocimum gratissimum* (basil). In this species, Ehlert et al. (2004) obtained the best results when medium-sized stem cuttings were used. *A. chica* pyroligneous extract applied to sand, commercial substrate and soil contributed to increase height and accumulation of both shoot and root dry matter. Charcoal substrate was the least effective for this plant (Souza et al., 2006).

Studies on the chemistry and pharmacology of the three "crajiru" types cultivated in Embrapa-AM indicated qualitative differences in the composition and pharmacology among their extracts (Borras, M.R.L., personal communication). The present work is part of a federal and state project aimed at potentiating the local production of high-quality "crajiru" in industrial scale. Thus, this study evaluated the effect of substrate and water, and stem cutting diameter on *A. chica* propagation during root and plant development, in Manaus-AM, Brazil.

MATERIAL AND METHOD

The experiments were carried out in a greenhouse from Department of Natural Products, INPA. Stem cuttings were obtained from type I plants previously introduced and cultivated in this department. Statistical design was completely randomized in a 2 x 4 factorial arrangement, i.e. 2 environments (1 – substrate, 2 – water) for root growth and 4 different stem cutting diameters (1.1, 0.6, 0.3 and 0.2 cm), with 5 replicates (10 cuttings each). Based on stem characteristics in the adult plants, these diameters were classified as woody, semi-woody, herbaceous, and apical. Cuttings were approximately 20 cm long and only apical ones had leaves. Substrate was prepared using sand, clay and humus at 3:1:1 proportion. Each stem cutting was placed in a black polyethylene 1kg-bag. For water, cuttings were placed in transparent polyethylene terephthalate (PET) 2L-bottles which were cut at 5 cm below the top and filled with approximately 500 mL water. Every 3 days, water was changed to avoid the proliferation of insect larvae. From the beginning of the experiment in July 2003, stem cuttings kept covered with transparent plastic tiles and were daily irrigated. After 90 days, the following variables were evaluated: set plants (%), mean shoot and root length (cm), and mean leaf and root dry matter (g/plant). Means were analyzed at 5 % probability (Gomes, 1970).

RESULT AND DISCUSSION

Significant interaction between developmental environments and stem cutting diameters was not observed only for root length (Figure 3). In general, set percentage was higher in the substrate, relative to water, and 0.6cm-diameter stem cuttings had the highest percentage (100%) in the substrate, whereas in the water, even the greatest-diameter cuttings (1.1 cm) did not reach this survival rate (Figure 1).

The substrate was the best environment for stem cutting development. Cuttings of smaller diameters had 68.3% set rate in the substrate but 50% in the water. Stem cuttings of smaller diameters have less energy reserves and more tender tissues (Metcalfe & Chalk, 1985; Cutter, 1986). For new shoot growth, both environments led to increasingly linear responses, but the results in the substrate were much higher than in the water (Figure 2), peaking 34.6 cm for the greatest diameter. The three smallest diameter cuttings kept in the water had mean shoot growth much inferior to that resultant from the smallest-diameter cuttings kept in the substrate (7.95 cm). The substrate composed of sand, clay and humus was capable of providing roots with sufficient nutrients for a new plant formation, resulting in shoot formation quickening. On the other hand, there was no satisfactory response in the water, even for the largest-diameter stem cuttings evaluated after 90 days.

Similarly, Marini (1983) reported that pear (*Pirus communis*) stem cutting diameter had a direct influence on root set. Apical cuttings needed a minimum diameter of 3.5 mm, whereas basal stem cuttings needed 5mm diameter to ensure 50% root set. As regards the cutting position in the stem or branch, semi-woody cuttings taken from the stem apex had a greater rooting percentage than those obtained from basal portions.

To corroborate this information, in the present study, root growth of stem cuttings in the water was practically non-significant, whereas in the substrate it was increasingly linear (Figure 3).

The mean dry matter of leaves and roots produced per stem cutting over 90 days are shown in Figures 4 and 5. In general, stem cuttings in the substrate produced larger leaf number than those in the water. Even the largest-diameter stem cuttings kept in the water produced lower leaf dry matter per cutting than those of smallest diameter kept in the substrate. Thus, stem cuttings did not have sufficient energy and nutrient reserves for new leaf formation and, consequently, leaf dry matter production.

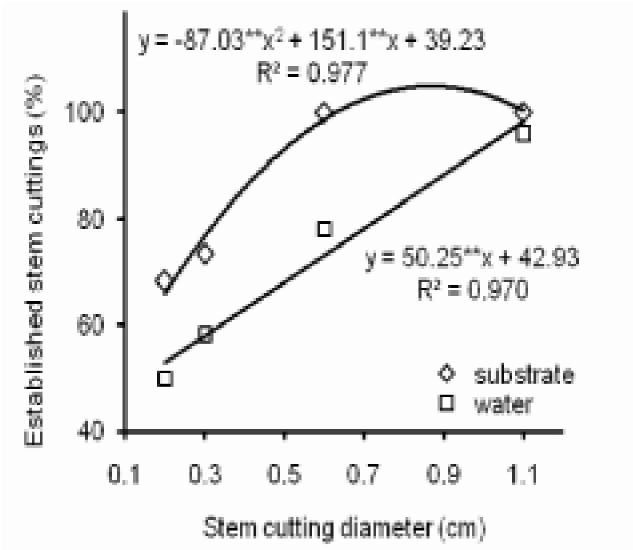

FIGURE 1. Set percentage of *Arrabidaea chica* stem cuttings under two rooting environments and four stem diameters. INPA, Manaus–AM, Brazil, 2004. **1% significance level.

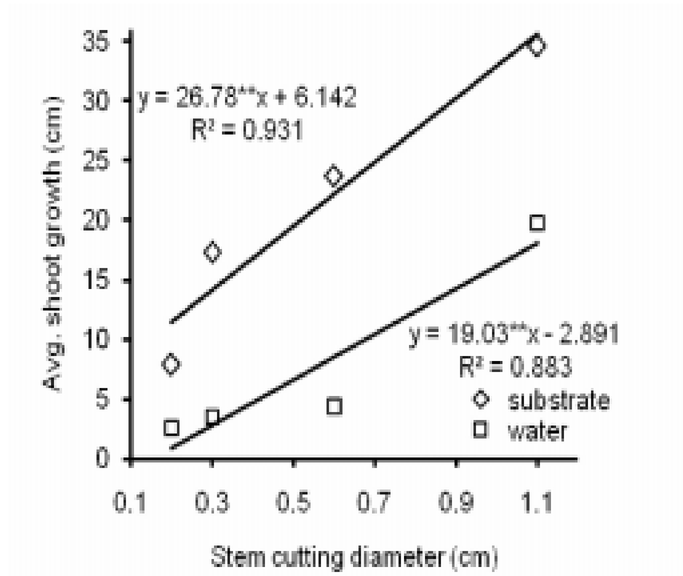

FIGURE 2. Mean shoot growth of *Arrabidaea chica* stem cuttings under two rooting environments and four stem diameters. INPA, Manaus–AM, Brazil, 2004.

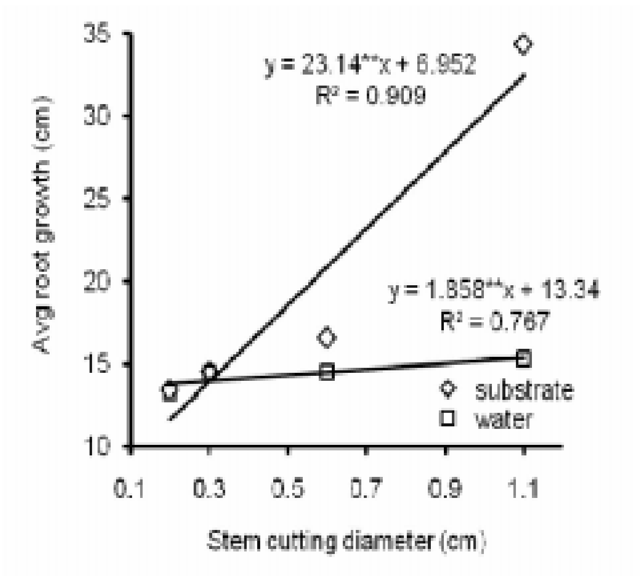

FIGURE 3. Mean root length of *Arrabidaea chica* stem cuttings under two rooting environments and four stem diameters. INPA, Manaus–AM, Brazil, 2004.

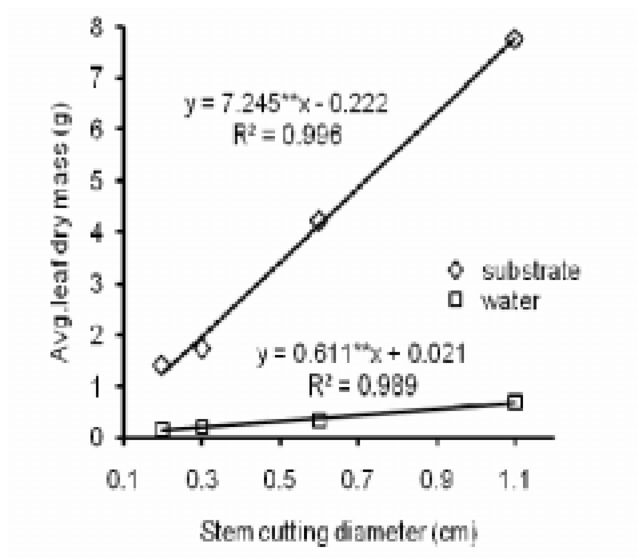

FIGURE 4. Mean leaf dry matter of *Arrabidaea chica* stem cuttings under two rooting environments and four stem diameters. INPA, Manaus-AM, Brazil, 2004.

As regards root growth, considering root dry matter, two definite phases were identified in response to both environments and stem cutting diameter (Figure 5). In the substrate, mean root growth per stem cutting was higher only for 0.6 cm or greater diameters. On the other hand, smaller diameters led to more efficient development in the water. Since water did not provide nutrients for the stem cuttings, energy and metabolic reserves were directed to the roots instead of leaves.

Wang & Boogher (1988) reported that *Schefflera arboricola* and *Hedera helix* basal stem cuttings developed higher shoots and larger root number than apical stem cuttings under similar conditions, which corroborates *A. chica* behavior in the present study, especially in the substrate. It must be emphasized that, in other plant species, stem cuttings present different leaf and root regeneration mechanisms. Thus, Correia (1998) described that apical stem cuttings produced the highest mean leaf and root dry matter, as well as the largest root number, per stem cutting in Brazilian goldenrod or arnica

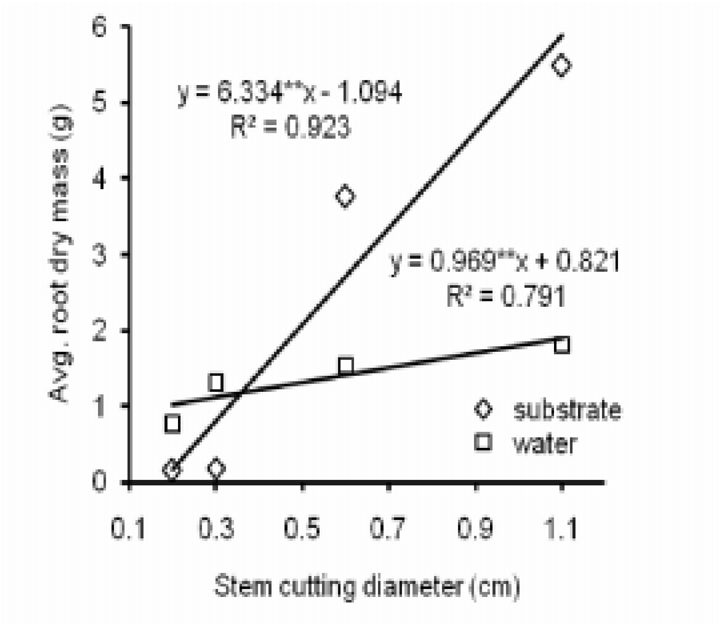

FIGURE 5. Mean root dry matter of *Arrabidaea chica* stem cuttings under two rooting environments and four stem diameters. INPA, Manaus-AM, Brazil, 2004.

(*Solidago chilensis*). Also, Ehlert et al. (2004) obtained the best results using medium-sized stem cuttings in clove basil (*Ocimum gratissimum*).

In the present work, *A. chica* stem cuttings grown in substrate presented higher shoots and leaf dry matter than those grown in water; besides, the best results were obtained with larger-diameter stem cuttings.

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