Influence of indolebutyric acid in the rooting of *Campomanesia aurea* semihardwood cuttings[(1)]

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ABSTRACT

Campomanesia aurea (O. Berg) is a species native to southern Brazil, naturally occurring from the state of São Paulo to Rio Grande do Sul, and presenting a great ornamental potential. The objective was to verify the rooting of semihardwood cuttings of *Campomanesia aurea* using indolebutyric acid (IBA) doses. The cuttings were collected in the municipality of Barão do Triunfo, Rio Grande do Sul State, in December 2014. The cutting base was immersed in concentrations of zero (control), 2,000, 4,000, 6,000 and 8,000 mg L^{-1} of IBA, subsequently established in a carbonized rice husk substrate and placed in a protected environment with an intermittent misting system. At 111 days after installation, dead and rooted cuttings, leaf retention, callus formation, root volume, root and shoot dry matter were evaluated. The experimental design was completely randomized with four replications with 20 cuttings. Data were submitted to analysis of variance and regression. No statistical differences were found for any of the evaluations. An average rooting was observed in 28% of cuttings and callus formation was observed in 48% of cuttings. Root average volume per cutting was 0.15 mL, root dry mass was 0.01 g, and shoot dry mass was 0.28 g. There was a negative correlation between leaf retention and mortality of cuttings. It is concluded that the production of *C. aurea* by cutting is viable, and that there was no positive response to the application of IBA with the conditions under which the experiment was developed.

Keywords: native ornamental species, vegetative propagation, auxin.

RESUMO

Influência de ácido indolbutírico no enraizamento de estacas semilenhosas de *Campomanesia aurea*

Campomanesia aurea (O. Berg) é uma espécie nativa do sul do Brasil, de ocorrência natural desde o estado de São Paulo até o Rio Grande do Sul, apresentando amplo potencial ornamental. O objetivo do trabalho foi verificar o enraizamento de estacas semilenhosas de *Campomanesia aurea* com a utilização de doses de ácido indolbutírico (AIB). As estacas foram coletadas no município de Barão do Triunfo, RS, em dezembro de 2014. A base das estacas foi imersa nas concentrações de zero (controle), 2.000, 4.000, 6.000 e 8.000 mg L^{-1} de AIB, posteriormente estabelecidas em substrato casca de arroz carbonizada e colocadas em ambiente protegido com sistema de nebulização intermitente. Aos 111 dias após a instalação foram avaliadas estacas mortas, enraizadas, retenção de folhas, calogenese, volume de raiz, massa seca de raiz e parte aérea. O delineamento experimental utilizado foi o inteiramente casualizado, com quatro repetições de 20 estacas. Os dados foram submetidos à análise da variância e regressão. Não foram verificadas diferenças estatísticas para nenhuma das avaliações. Foi observado enraizamento médio de 28% e formação de calo em 48% das estacas. O volume médio de raiz por estaca enraizada foi de 0,15 mL, a massa seca radicular de 0,01 g e a massa seca de parte aérea de 0,28 g. Houve correlação negativa entre a retenção de folhas e mortalidade de estacas. Conclui-se que a propagação de *C. aurea* por estaquia é viável, e que não houve resposta positiva à aplicação de AIB nas condições em que foi desenvolvido o experimento.

Palavras-chave: espécie ornamental nativa, propagação vegetativa, auxina.

1. INTRODUCTION

Campomanesia aurea O. Berg is a fruit species native to southern Brazil. It belongs to the Myrtaceae family, which has a high potential for garden landscaping because of its morphological characteristics (STUMPF, 2009). It is commonly known as "guabiroba-do-campo", "goiabinha-do-mato", "araçazeiro-do-campo" or "guabiroba-araçá" (LORENZI, 2006) and occurs in Rio Grande do Sul State, in the Campanha de Cima da Serra, Depressão Central and Serra do Sudeste (SOBRAL, 2003).

The species is perennial, with woody and well-branched stems, reaching up to 1 m tall. The leaves are permanent, and the flowering is intense with a pleasant aroma. Flowering takes place from October to January as solitary flowers located in the axils of leaves and at the base of the branches. Fruiting occurs from December to February. The fruits are edible globular berries, with colors ranging from green to yellow according to the ripening stage (LORENZI, 2006; STUMPF et al., 2009; STUMPF, 2009).

The species is not yet commercially used, and there is no research in the literature on its propagation. However, pharmacological studies are being developed evaluating the antimicrobial activity of the essential oil (PACHECO et al., 2014) and describing the species physiognomy (MARCHIORI and SANTOS, 2010).

The use of this species as an ornamental plant may benefit the flower sector, since the discovery of new

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materials associated with its easy propagation may be a distinguishing factor for local producers, resulting in an increase in income for families and in the sustainable exploitation of resources available. Thus, the use of native species in this sector is a way to enhance local potentialities and contribute to the maintenance of biodiversity by the propagation and spread of the species.

The spread of *C. aurea* occur naturally by seeds (LORENZI, 2006). However, the vegetative propagation is often used for the production of ornamental plants because it is a simple, inexpensive, and easy to perform technique, and because it reduces the cultivation time of some species, ensuring a uniformity of the varietal characteristics and optimizing the available propagules, increasing the possibility of seedling formation.

Vegetative propagation also includes some drawbacks such as the transmission of diseases, the need for maintenance of parent plants, a high volume of transport and storage material, and the difficulty to achieve uniform semihardwood cuttings by small farmers (PETRY, 2008). Furthermore, the possibility of using vegetative propagation depends mainly on the capacity of formation of adventitious roots of each species and/or cultivar, the quality of the formed root system and the further development in the production area.

The use of plant growth regulators may assist in the formation of adventitious roots and may enable the propagation of some species. One of the synthetic auxins most commonly used as a rooting promoter is indolebutyric acid (IBA), widely used for a large number of species (FACHINELLO et al., 2005).

Thus, the objective of this study was to verify the rooting of semihardwood cuttings of *Campomanesia aurea* using of indolebutyric acid (IBA) doses.

2. MATERIALS AND METHODS

The experiment was conducted in a protected environment located at the Faculty of Agronomy of the Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, Rio Grande do Sul State (RS). An intermittent misting irrigation system was used, keeping the relative humidity of the environment higher than 80%.

In December 2014, the collection of propagation material of *C. aurea* was made in an *in situ* population located in the municipality of Barão do Triunfo, RS, at 30°18'136" S and 51º50'282" W. The county is located in the Pampa Biome, featuring a relief ranging from undulated to strongly undulated, with an average altitude of 300 m, precipitation and average annual temperature of 1,350 mm and 17°C, respectively. The climate ranges from humid temperate (Cf) to humid subtropical (Cfa), according to the Köppen classification, with two well-defined seasons (PREFEITURA MUNICIPAL DE BARÃO DO TRIUNFO, 2013).

At the time of collection, branches from the species were collected, subsequently placed in plastic bags and wrapped in moist paper to prevent the dehydration of the cuttings during transport.

Only the apices of the branches were used in the preparation of cuttings. They were standardized at 7 cm in length from leaf insertion on the stem and four apical leaves were kept. The cuttings were kept in containers with water until the time of the final base cutting and immersion in different IBA concentrations in order to reduce the effect of a possible oxidation.

In the basal end of each semihardwood cutting, a beveled cut was made and then immersed in IBA solution for five seconds at concentrations of zero (control), 2,000, 4,000, 6,000 and 8,000 mg L^{-1}. The cuttings were immediately transferred to multicellular expanded polystyrene trays with a cell volume of 15 cm^3 filled with carbonized rice husk substrate. The cuttings were inserted about 1 cm deep and kept in a misting irrigation system, with an intermittent system controlled by a 15-second timer every 5 minutes during the experiment. The use of carbonized rice husk substrate was due to its suitable physical properties such as total high porosity and low water retention capacity (KAMPF, 2005).

At 111 days after the beginning of the experiment, evaluations of the mortality of cuttings, leaf retention, number of rooted cuttings (RC), callus formation (CAL), root volume (RV), root dry matter (RDM) and shoot dry matter (SDM) were made by cutting.

Leaf retention was assessed by counting the number of leaves that remained in cuttings after the experiment period. Then, its percentage was calculated in relation to the initial number of leaves.

The root volume and root dry matter were calculated per rooted cutting, and the shoot dry matter was calculated by each survivor cutting. The dry matter was obtained by placing the material in an oven at 65°C until constant weight.

The experimental design was completely randomized, with five IBA concentrations and four repetitions with 20 cuttings, totaling 400 cuttings. Rooting data and root volume did not meet the assumptions of equal variances and normality, respectively, even after the transformations. They were then analyzed by the non-parametric Kruskal-Wallis test. The other evaluations were submitted to analysis of parametric variance (ANOVA) and regression using the *software* Sigmaplot 11.0.

3. RESULTS AND DISCUSSION

For all evaluations, no statistical differences were observed (Table 1). An average rooting was observed in 28% of cuttings and callus formation was observed in 48% of cuttings. The root average volume per cutting was 0.15 cm^3, root dry mass was 0.01 g, and shoot dry mass was 0.28 g.

Table 1. Rooted cutting (RC), callus formation (CAL), root volume (RV), root dry matter (RDM) and shoot dry matter (SDM) of semihardwood cutting of *Campomanesia aurea* in of different doses indolbutiric acid (IBA).

IBA Doses mg $^{L-1}$	RC %	CAL %	RV mL	RDM g	SDM g
0	30.00	52.50	0.13	0.01	0.30
2000	36.25	45.00	0.18	0.01	0.28
4000	21.25	50.00	0.16	0.01	0.22
6000	23.75	51.25	0.16	0.01	0.28
8000	28.75	41.25	0.12	0.01	0.31
Valor p	0.256	0.758	0.817	0.18	0.25
Média	28.00	48.00	0.15	0.01	0.28
CV (%)	-	27.18	-	33.02	17.56

Rooting in native Myrtaceae has a different behavior according to species analyzed and characteristics of the material used in the preparation of the cuttings. In two experiments evaluating the feasibility of the propagation of “guabirobeira” (*Campomanesia xanthocarpa* Berg.) with semihardwood and herbaceous cuttings with different doses of ethanol and IBA, root formation was not verified in any of the cases (SCUTTI and ZANETTE, 2000). This is different from that observed in this study.

For *Campomanesia adamantium* (Cambess.) O. Berg, different collect dates, types of cuttings, concentration and grow regulators were tested for propagation by cutting. The authors found different responses of hormonal induction according to time of collect of cuttings. The best rooting result (57%) was obtained without the use of an exogenous auxin with hardwood cuttings collected in May. This result was attributed to the increased availability of nutrients in more lignified cuttings, and endogenous and climatic factors (MARTINS et al., 2015). The use of semihardwood cuttings of *C. aurea* may also have influenced the results obtained in this study, so that works with different sampling times may result in results that are more satisfactory.

In pineapple guava (*Acca sellowiana* (O. Berg) Burret), there was no root formation, regardless of time of year and type of cutting used (FRANZON et al., 2004). In herbaceous cuttings of guava (*Psidium guajava* L.), it was found that the IBA dose of 2,000 mg L^{-1} was the most effective for rooting (28.5%) (YAMAMOTO et al., 2010). This was similar to the results obtained in this work, in which the same dose, although without presenting a statistical difference, obtained the highest rooting (36.25%).

For “jabuticabeira” (*Plinia cauliflora* (DC.) Kausel), using herbaceous apical cuttings, there was a maximum of 10% rooting with IBA doses of 2,000 and 4,000 mg L^{-1} (SASSO, CITADIN and DANNER, 2010). Unlike the Myrtaceae mentioned above, there was no statistical significant effect of the application of IBA on the formation and development of roots for *C. aurea*. This was verified by dry matter and root volume.

However, other species belonging to the same family present rooting results that are more satisfactory. For “malaleuca” (*Melaleuca alternifolia* Cheel), rooting up to 62.5% was observed in apical branches of semihardwood cuttings. There were no statistical differences regardless of the IBA dose tested for rooting and death of cuttings (SILVA et al*.,* 2012). In “camu-camu” (*Myrciaria dubia* (Kunth) McVaugh), a 58% rooting of hardwood cuttings was found, favored by the application of 200 mg L^{-1} of IBA (DELGADO and YUYAMA, 2010). In Surinam cherry (*Eugenia uniflora* L.), there was a 44% higher rooting for cuttings from young plants, regardless of IBA doses applied, and low callus formation (LATTUADA et al., 2011).

The results reported for several species from the Myrtaceae family demonstrate the discussion of the literature regarding rooting potential varying according to species, cultivar, environment and internal conditions of the plant used to obtain propagules (HARTMANN et al., 2002).

Callus formation in the base of cuttings is indicative of the beginning of the healing and regeneration process, and is characterized as an irregular mass of parenchymal cells in various stages of lignification. The callus and root formation are independent processes, and their simultaneous occurrence is due to the requirement for similar endophytic and environmental conditions (HARTMANN et al*.,* 2002; FACHINELLO et al., 2005). Thus, in some species, callus formation is a precursor to the formation of adventitious roots, while in others it may be a physical barrier to its development (FACHINELLO et al., 2005).

In this study, both growth of roots, with and without callus formation, and development of a great amount of callus were observed without visual evidence of root formation. As already reported in the literature, two rooting patterns are known. The first is the direct formation of roots from the differentiation of cells near the vascular system; the second occurs when the formation of adventitious roots takes place after the formation of the callus, i.e., indirectly.

There may also be the formation of adventitious roots from different tissues in the same cutting (HARTMANN, 2002; XAVIER et al., 2013).

The quality of the root system is directly related to the survival of cutting when planted in the field due to a greater ability to absorb water and nutrients (SANTORO et al., 2010). For *C. aurea*, the characteristics of the root system (dry matter and root volume) were not changed by the different concentrations of IBA used. This was also observed for the species "malaleuca" (*Melaleuca alternifolia*) (SILVA et al., 2012).

In guava (*P. guajava*), the highest dose of IBA tested (2,000 mg L^{-1}) provided the highest number of roots per cutting and the highest root dry matter (YAMAMOTO et al., 2010). ZIETEMANN and ROBERTO (2007) found similar results for the same species, in which 1,500 and 2,000 mg L^{-1} IBA doses provided greater rooting, number of roots, length and root dry mass. This was not observed in this study for *C. aurea*, in which the increase in IBA concentration did not improve the root system of the cuttings.

Leaf retention had a quadratic behavior. Higher values for *C. aurea* cuttings not treated with IBA were observed. They kept 87.5% of their leaves. However, at concentrations of 4,000 and 6,000 mg L^{-1} of IBA, they kept the lowest number of leaves, 67.8 and 67.5%, respectively (Figure 1).

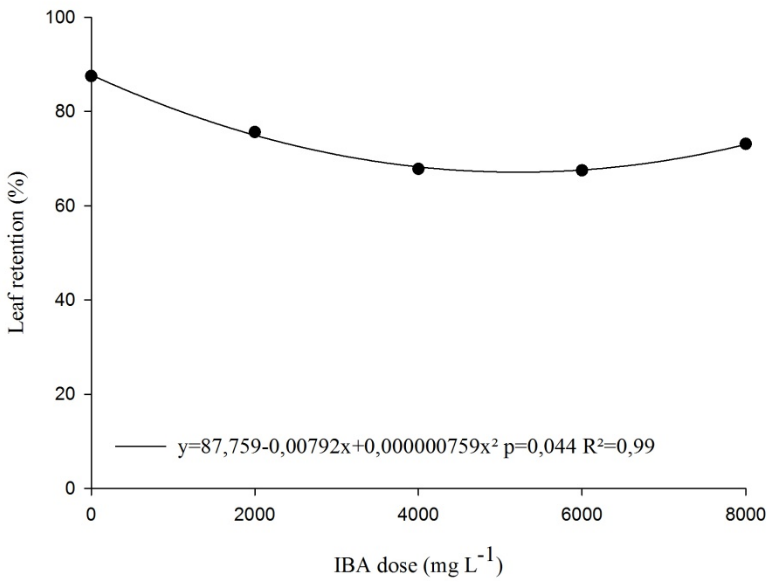

Figure 1. Leaf retention of semihardwood cuttings *Campomanesia aurea* in different doses indolbutiric acid, (IBA).

The turning point occurred with doses higher than 5,200 mg L^{-1} of IBA. However, this increased leaf retention did not reflect in greater rooting or in improvements in the quality of the root system formed in rooted cuttings. Auxin has the capacity to slow leaf abscission (TAIZ and ZEIGER, 2004). Thus, the application of high concentrations of IBA (8,000 mg L^{-1}) in *C. aurea* cuttings may have increased endogenous auxin levels, favoring leaf retention.

The importance of leaves to the survival and rooting of cuttings is due to the maintenance of the photosynthetic process and the production of auxins and cofactors in apical buds and new leaves transported to the base of cuttings, favoring rooting (HARTMANN et al., 2002; FACHINELLO et al., 2005).

It was observed that only the cuttings that kept at least one of the leaves survived, formed callus or rooted. This was also observed for "jabuticaba" (SASSO et al., 2010), guava (SANTORO et al., 2010) and pineapple guava (FRANZON et al., 2004).

In the evaluation of five clones of *Eucalyptus grandis* x *E. urophylla* hybrids, it was observed that the maintenance of the lower leaves in mini-cuttings favored rooting in contrast with upper leaves, possibly due to a higher photosynthetic rate. Mini-cuttings without leaves or only with upper leaves had the lowest rooting rates (SOUZA et al., 2013).

In Surinam cherry (*E. uniflora*), there was a linear decrease in leaf retention of cuttings collected from young plants with the increase of IBA doses (LATTUADA et al., 2011). This is a result different from that observed for *C. aurea*, in which, even with the application of high IBA concentrations, cuttings had a high leaf retention.

For guava (*P. guajava*), there was not an influence of IBA concentration on leaf retention (ZIETEMANN and ROBERTO, 2007; YAMAMOTO et al., 2010). However, when considering only the influence of presence of leaves, it was found that the conservation of leaves is essential to the survival of the cuttings. However, the conservation of a pair of full or cut in half leaves did not differ regarding the percentage of rooted cuttings, number of roots, length and survival of cuttings, differing only in root fresh and dry matter, which was higher in cuttings with full leaves (SANTORO et al., 2010). Similar results were observed in this study, where the presence of leaves was effective to the survival and rooting of cuttings, showing a negative correlation (-0.71) between leaf retention and cutting mortality (Figure 2).

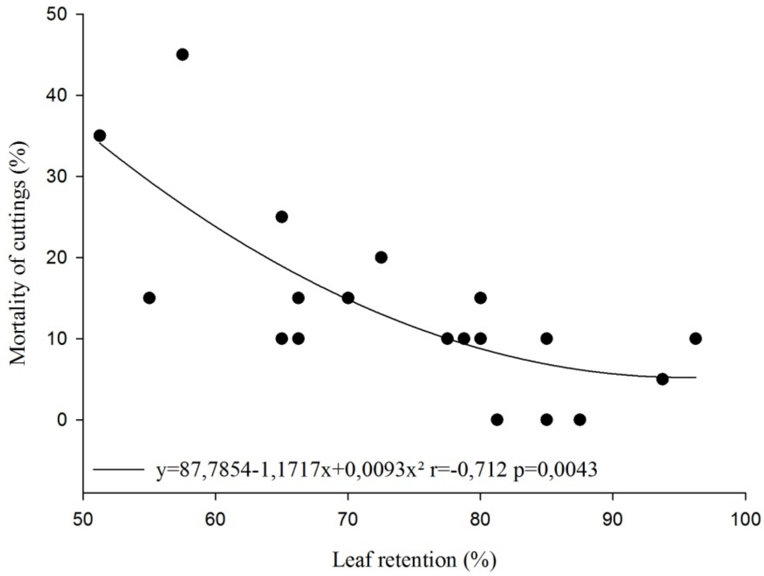

Figure 2. Correlation between the leaf retention and mortality *Campomanesia aurea* cuttings.

The mortality of *C. aurea* cuttings increased with the increase in the concentration of IBA used, reaching 21.25% in the treatment with 8,000 mg L^{-1} (Figure 3). Possibly, a phytotoxic effect occurred due to the high concentration of IBA applied to the base of the cuttings during the experiment time. The application of exogenous auxin causes a stimulatory effect on the formation of roots until a maximum value, from which it presents an inhibitory effect (FACHINELLO, 2005)

In pineapple guava (*A. sellowiana*) and guava (*P. guajava*), different concentrations of IBA did not influence the survival of cuttings (FRANZON et al., 2004; ZIETEMANN and ROBERT, 2007). The survival of cuttings and the rooting capacity is related to intrinsic factors of the species such as hormonal balance, time of collection, type of cutting and genetic potential of the species (FRANZON, 2004; FACHINELLO, 2005).

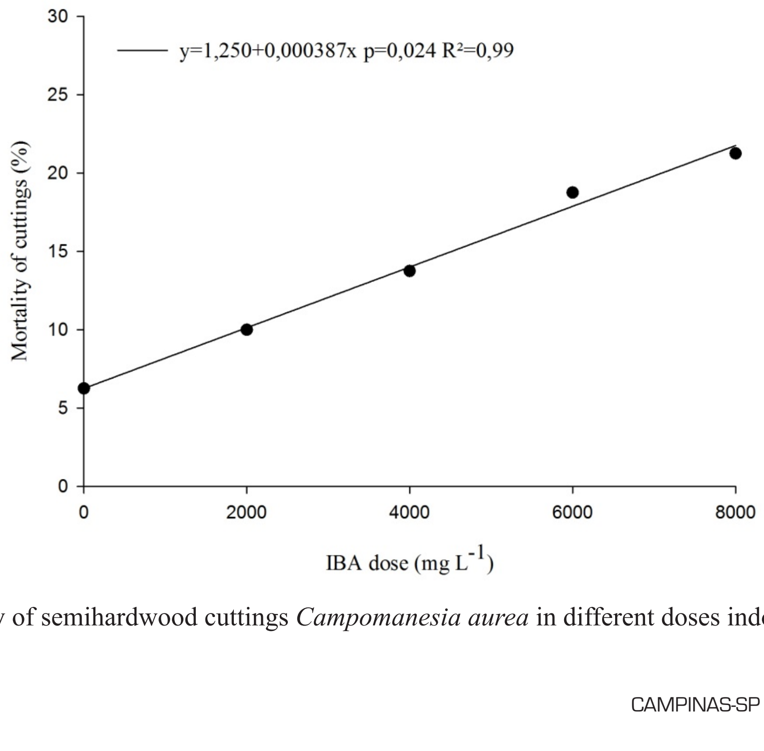

Figure 3. Mortality of semihardwood cuttings *Campomanesia aurea* in different doses indolbutiric acid, (IBA).

The rooting results (28%) obtained in this experiment, although low for a commercial production, may be considered satisfactory for cuttings brought directly from the field without any phytosanitary or nutritional treatment of parent plants. Other works considering different collect times and different adjustments in the study's conduction method may improve the results achieved to date. The conduction of matrix plant in a controlled environment (greenhouse), subjected to frequent pruning seeking the rejuvenation of cuttings, as well as the implementation of mini-gardens to collect cuttings, may also improve the results obtained in this work.

The conduction of matrix plants in a greenhouse and the use of herbaceous cuttings is an established procedure, for example, for eucalyptus, in which, depending on the clone, the rooting increases using mini-cuttings increased by 40% compared to conventional cuttings (ALFENAS et al., 2004).

4. CONCLUSIONS

The propagation of *Campomanesia aurea* by cutting is viable because cuttings collected in the field showed on average 28% of rooting.

The conditions under which this experiment was developed had no positive response to the rooting of cuttings with application of IBA.

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