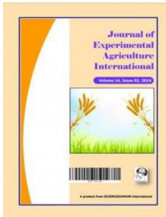

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Effect of Indolebutyric Acid Immersion Period on the Rhizogenic Process of Guava Cuttings (*Psidium guajava* L.) Cultivar Século XXI

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In the rhizogenic process, the immersion time of the base of the cuttings to be propagated in plant regulators depends on the concentration of the solutions, the cultivar to be used and the type of cutting required. Therefore, this research work has as objective to investigate which immersion time, in solution with indolebutyric acid promotes a greater rooting in herbaceous cuttings of guava cultivar Século XXI. The experiment was distributed in the completely randomized design, being defined as treatments the immersion times (5, 10, 15 and 20 seconds) of the base of the cuttings in

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the solution of indolebutyric acid - IBA at the concentration of 2000 mg L^{-1}, with three replicates and 10 cuttings per plot. In relation the variable dry mass of the aerial part, this presents a favorable response to the different immersion times in indolebutyric acid. Diverging of the variables cuttings rooted, live without root, number of roots, root length, callus, sprout, leaf retention and mortality which were not influenced by the different immersion times of the base of the cuttings in the plant regulator. Concluding that the different times of immersion of the base of the cuttings do not influence in the rhizogenic process of herbaceous cuttings of guava cultivar Século XXI. For the variable dry mass of aerial part, the immersion time of 5 seconds in the concentration of 2000 mg L^{-1} in AIB, present the better results when compared to the other concentrations.

Keywords: Propagation; cuttings; immersion times; plant regulators.

1. INTRODUCTION

The guava (*Psidium guajava* L.) is a native fruitful of tropical America [1], but is cultivated in Brazil, from Acre to Rio Grande do Sul, even though it is still of form extractive in many regions. Composing the picture of the 50 best-known edible fruits in the world, besides having commercial importance in more than 50 countries [2], due to its organoleptic qualities, affordable price and possibility of production throughout the year.

The cultivar Século XXI is a relatively new guava on the market, which can be used for industrialization and fresh consumption, as well as presenting an early cycle, large fruits, thick rosy-reddish pulp and few and small seeds, promising to be an excellent choice of guava, for its quality and productivity [3,4].

The most diverse guava cultivars may have their perpetuation through sexual propagation, however, currently in function of the to market needs, this is not a commercially used practice, due to the high heterogeneity of the plants, which damages the standardization of the fruits and causes hindrances to the management. Being used so alternative methods, such as asexual reproduction. Nowadays, the most frequently used asexual mechanism for this crop is the cutting method, per enable the commercial production of good quality seedlings in a short period of time and promotes uniformity in the crop [5]. Having as principle the regeneration that is when segments removed from a mother plant are able to regenerate giving rise to a new plant, thanks to cellular totipotency [6,7].

For the success of vegetative propagation several factors must be considered, whether they are intrinsic, related to the plant itself or the extrinsic, related to the environmental conditions, such as size, age and type of cuttings [4,8], presence of leaves, luminosity [4], type of auxin concentration [3], times of immersion of the base of the cuttings in the inductor of rooting [9], among others.

Aiming to favor the rhizogenic process, the use of indolebutyric acid in vegetative propagation has become a constant, bringing into its composition characteristics beneficial to the process [6], promoting the acceleration of the rooting process of the cuttings and consequent increase of the rooting percentage [10]. However, in spite of the increasing use of IBA exogenously, more specific studies must still be carried out with the aim of characterizing the time interval of immersion of the base of the cuttings in inductors considered optimal to stimulate the rhizogenesis [10], in the most diverse plant tissues.

Lattuada [9] reported that the time of immersion of the hormonal solution at the base of the cuttings depends on the concentration of the solutions used. Diluted solutions with low concentrations require contact with the base of the cuttings for hours, while solutions at high concentrations, the contact with the base of the cuttings should be in seconds.

Being thus, considering the importance of the immersion time of the base of the cuttings, in the regulators, for the success of the vegetative propagation in the commercial production, it was aimed to find out which immersion time, in solution with indolebutyric acid promotes a better response to the rhizogenesis process of herbaceous cuttings of guava ‘Século XXI’.

2. MATERIALS AND METHODS

The herbaceous cuttings of guava (*Psidium guajava* L.) cv. Século XXI were collected from parent plants located in the external area of the Fruit Crop Nursery of the Department of

Phytotechnie and Environmental Sciences, at the Center of Agricultural Sciences of the Federal University of Paraíba - Areia, PB, located in the geographical coordinates 6º51'47 " and 7º02'04" South latitude and 35º34 ' 13 "and 35 ° 48'28" west longitude of the Greenwich meridian, which were with five years old and were originating from asexual propagation and were in full vegetative activity at the time of collection. The herbaceous cuttings were removed from the apical part of the branches, with eight pairs of leaves, which were wrapped in moistened paper and packed in plastic bags, forming a humid chamber, to reduce the possibility of dehydration of the tissues, then were transported to the nebulization chamber, located in the internal area of the Fruit Crop Nursery of the Department of Phytotechnie and Environmental Sciences, at the Center of Agricultural Sciences of the Federal University of Paraíba. The experiment was carried out from December 2014 to March 2015.

The experimental design was a completely randomized design, presenting as treatment four immersion times (5, 10, 15 and 20 seconds) of the cuttings base in the 2000 mg L^{-1} solution of indolebutyric acid (IBA) with three replicates and 10 cuttings per plot.

The hydroalcoholic solution of IBA was prepared by dissolving the IBA in 10 mL of alcohol, after fully dissolved, the volume was completed to 100 mL with distilled water, obtaining then the concentration of 2000 mg L^{-1} of IBA [3].

The preparation of the cuttings were performed in the nebulization chamber, staying these with a straight cut at the apex and a bevel at the base, with ± 10 cm of length, being maintained a pair of leaves, and the limbs reduced to half the length. After finishing of the preparation of the cuttings, they were grouped by plot and had 1.0 cm of the base placed in the hormonal solution, according to the treatments mentioned. Being then staked in tubes filled with a composition of 50% carbonized rice husk and 50% organic compound, which were kept under intermittent misting system with mean opening and closing time of 30 seconds and 10 minutes respectively, which could vary according to the daily climate; and with shading coverage (50%). For the control of fungal diseases, the cuttings were treated with applications of Aliette® fungicide, always that necessary.

After 70 days of the experiment installation the following variables were analyzed: rooted cuttings (%), live rootless cuttings (%), live cuttings (%), number of roots (nº), length of roots (cm), cuttings with callus (%), cuttings with sprout (%), cuttings with leaf retention (%), mortality (%), dry mass of the aerial part (g) and dry mass of roots (g).

The variables: rooted cuttings (%), live rootless cuttings (%), cuttings with callus (%), cuttings with sprout (%), cuttings with leaf retention (%) and dry mass of the aerial part (g) were correlated only with the percentage of cuttings that remained alive until the end of the experiment. The variables: number of roots (nº), length of roots (cm) and dry mass of roots (g) were correlated only with the percentage of cuttings that rooted and ending the percentage of dead cuttings took into account all dead cuttings at the end of the experiment.

For the statistical analysis initially was carried out the transformation of the data for the square root function (y + 0.5) when obtained by percentage and, logarithmically (log + 1) when obtained by counting. Then, carried out the analysis of variance and regression, using the F test to verify the treatment effect and the adjustments of the models, assuming an error of up to 10% probability. The software SAS 9.4 [11] was used.

3. RESULTS AND DISCUSSION

The rooted cuttings, although not influenced by the factor under study, exhibit an average value of 63.61% (Fig. 1A). Superior value than found by other authors, such as [3] that by working with herbaceous cuttings of cv. Século XXI treated with IBA for 10 seconds, obtained a rooting by part of the cuttings of 35% when using the concentration of 2000 mg L^{-1} of AIB.

This high rooting percentage obtained by cuttings treated with IBA, is due to many factors such as the leaf maintenance during the experiment, mother plants with continuous management, presence of intermittent misting, among others, which favor the expressiveness of the plant material to the stimuli performed.

In relation the live rootless cuttings (Fig. 1B), it can be said that the observed value (28.05%) is indicative of the maintenance of live cuttings, even when they do not emit root. Not being able to discard the possibility of a future emission, seen the days that the stakes remained in the greenhouse, sometimes they are not enough for the expression of the vegetal tissue [5]; or even that the tissues that present callus can, in the future, issue root, even though these processes are seen as independent.

In the Fig. 1C the percentage of cuttings with callus, was also not suffered influence of the immersion times. Callus formation depends basically on two factors, one being the regulators and their concentrations and the other is the type of formation process, which can be direct or indirect. When dependent on the regulators it is necessary that there is adequate hormonal balance between the promoter and inhibitory substances in the plant. The interaction between auxins and cytokinins is a primary relationship in propagation, because, the high auxin/cytokinin ratio favors rooting, the high cytokinin/auxin ratio favors sprouts formation, and the high level of both favors the development of callus [12].

The direct formation comprises the formation of the roots from the proximities of the vascular system, common in species of easy rooting. In the indirect formation there is a cicatricial reaction with the formation of a layer of suberin at the base of the cutting, giving rise to callus which is constituted by proliferative and dedifferentiated masses of parenchymatic cells, typically disorganized, and in different degrees of lignification. Thus, the parenchyma cells present in the callus that preserve meristematic function can be reactivated with this function and / or resume the function giving rise to the new root beginnings that evolve to a connection with the vascular system, typical in species of difficult rooting [13,8,14]. However, some authors consider that callus and root formation are independent processes, and that the simultaneous occurrence is due to the dependence of endogenous conditions of the cuttings and the environment being similar [8,15,14,16,17].

The percentage of cuttings with sprouting also did not present significant difference when analyzed the use of IBA in the different immersion times (Fig. 1D), as well as the percentage of live cuttings (Fig. 1E).

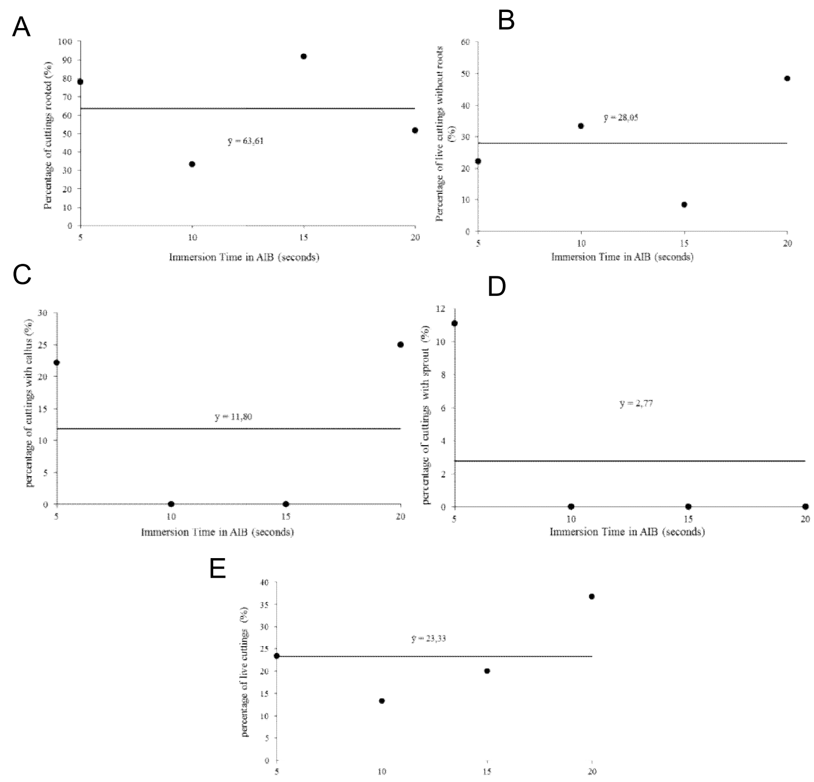

Fig. 1. Percentage of cuttings rooted (A) percentage of live cuttings without roots (B) percentage of cuttings with callus (C) percentage of cuttings with sprout (D) and percentage of live cuttings (E) cuttings of guava cv. Século XXI treated with IBA (indolebutyric acid) at 70 days after application of the treatments, Areia-PB.

In the foliar retention it was not possible to verify a significant difference when related the use of IBA to the immersion times of guava herbaceous cuttings ‘Século XXI’, being show an average value of cuttings that kept the leaves until the end of the research, of 76.11% (Fig. 2A).

In the staking, the leaves had their limbs reduced for a decrease in perspiration and maintenance of leaf reserves, which reflected in the percentage of rooted cuttings. Because known itself that the retention of leaves in the propagation process is important because it helps in the production and transport of auxin, allowing the carbohydrate supply through photosynthesis, favoring the division and stretching [18,5].

The importance of the presence of leaves in the cuttings, in the rooting of most plants, is recognized by several authors. Lattuada et al. [19] observed that the treatments without leaves resulted in the death of the cuttings, compromising the homogeneity and normality of the data. These same responses were reported in the experiments of [19,20] because they verified that the cuttings without leaves did not present roots formation. For the mortality variable (Fig. 2B) no significant difference was found when the immersion time factor was analyzed.

It was verified that for both the number of roots and the length of the roots the data were not significant, revealing an average value of 1.13 and 7.91 cm, respectively (Figs. 2C and 2D). [5] working with herbaceous 'Paluma' cuttings and different inducers in the time of 5 seconds of immersion of the base, obtained values very close (2.66 and 8.03, respectively) to those found in this experiment, with no significant response to root length as well. Corroborating with the data of [3] that working with herbaceous ‘Século XXI’ cuttings treated with IBA for 10 seconds, linked in talc and alcohol, verified that for both the number of roots for cuttings and root length, there was no significant interaction between the IBA concentrations and the application forms.

The low number of roots in the cuttings can be related to two factors, the time of reduced permanence in greenhouse or the difficulty of the cultivar in responding to the treatments used. But in spite of the low number of roots emitted by the cuttings, a relevant result of factors related to the aerial part such as the dry mass of aerial part could be observed, which was also due, fur satisfactory length of the roots emitted. Demonstrating the importance of the roots emitted quickly by the cuttings in the accumulation of mass. Importance confirmed by [21], who reported that the emission of roots in greater number and length is fundamental when the objective is the production of seedlings in commercial scale. In addition, the well-formed root system increases the area of soil to be exploited, favoring the absorption of nutrients and water, which provides a better development of the seedlings when taken to the field [3,22].

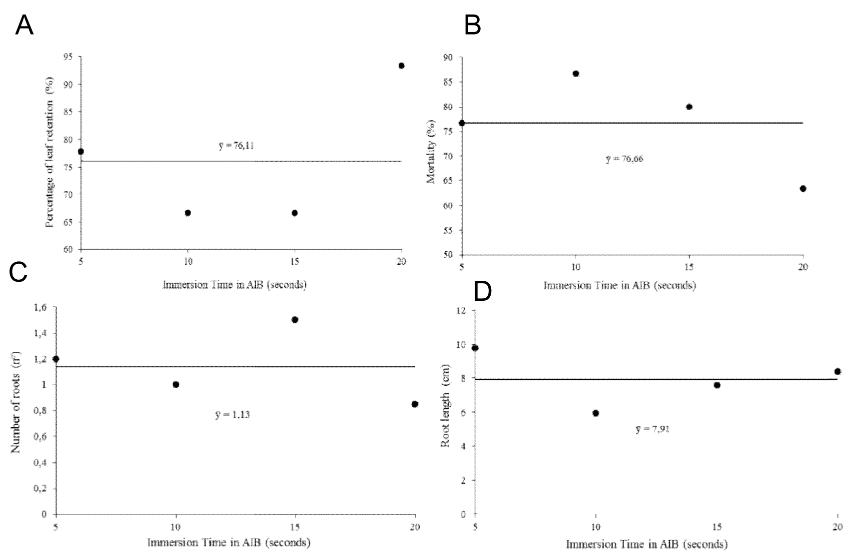

Fig. 2. Percentage of leaf retention (A), mortality (B), number of roots (C) and root length (D) cuttings of guava cv. Século XXI treated with IBA (indolebutyric acid) at 70 days after application of the treatments, Areia-PB.

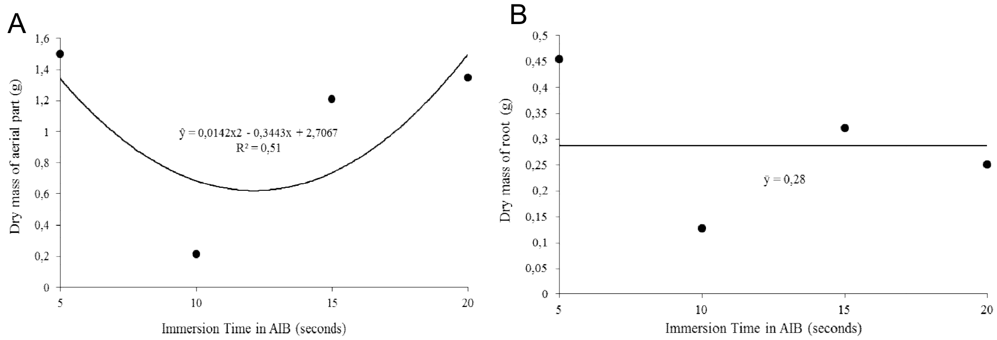

Fig. 3. Dry mass of aerial part (A) and dry mass of root (B) cuttings of guava cv. Século XXI treated with IBA (indolebutyric acid) at 70 days after application of the treatments, Areia-PB.

The dry mass of the aerial part presented a quadratic model with the time of 5 seconds being the holder of the highest value obtained (1.49 g) (Fig. 3A). Possibly this favorable response to the immersion time factor was due to the maintenance of the leaves on the cuttings, as well as the presence of roots, which promoted an accumulation of nutrients and water in the leaves and stem, which remained until the end of the test.

The root dry mass did not present a significant difference (Fig. 3B). Even with a considerable value in rooting, the cuttings did not present a satisfactory root mass value, which can be justified by the short time in which the roots were emitted, giving them no time to develop and accumulate more mass.

In general, it can be stated that the non-consistent expression of several hormones in the rooting of cuttings of species of the Myrtaceae family may be correlated to the most diverse factors, being they the cultivar, the age of the tissue, the type of cuttings, the conditions of cultivation, times of collection, polarity, presence of leaves, temperature, light, humidity, substrate, conditioning, concentration of hormones, oxidation of phenolic compounds and the time of immersion used in the process of rooting of the material. Being necessary more studies to clarify these divergences of responses.

4. CONCLUSION

The rapid immersion times, used at the base of the cuttings, do not influence the rhizogenic process of herbaceous cuttings of guava 'Século XXI'.

For the variable dry mass of aerial part, the immersion time of 5 seconds in the concentration of 2000 mg L^{-1} in AIB, present the better results when compared to the other concentrations.

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COMPETINGINTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kumari S, Arumugam N, Singh R, Srivastav M, Banoth S, Mithra A.C, Arun MB, Goswami A.K, Khan A.J. Diversity analysis of guava (*Psidium guajava*) germplasm collection. Indian Journal of Agricultural Sciences. 2018;88(3):489–97.
2. Roberto BS. Guava residue: metabolism in rats and applicability in cereal bars. Master. Federal University of Santa Maria, Santa Maria; 2012.
3. Yamamoto LY, Borges RS, Sorace M, Rachid BF, Ruas JMF, Sato O, Assis AM, Roberto SR. Cutting rooting of *Psidium guajava* L. 'Século XXI' guava treated with indolebutyric acid with talc and alcohol as a vehicle. Rev. Cien. Rural. 2010;40(5): 1037-1042.
4. Costa JCF. Rooting of cuttings of guava (*Psidium guajava* L.) cultivar século XXI

and paluma. Master in Agronomy, Federal University of Paraíba, Areia; 2015.
5. Costa JCF, Mendonça RMN, Fernandes LF, Silva GC, Silva SM, Pereira WE, Cavalcanti LF, Figueiredo LF. Rooting inducers and organic substrates in the propagation of 'Paluma' guava by cutting. Afr. J. Agric. Res. 2017;12(5):371-376.
6. Paulus D, Valmorbida R, Toffoli E, Paulus E. Vegetative propagation of *Aloysia triphylla* (L'Hér.) Britton according to the concentration of IBA and the length of the cuttings. Rev. Bras. Plantas Med. 2014;16(1):25-31.
7. Santana AA. Rooting of 'Chinese' guava cuttings with the use of indolebutyric acid under nebulization chamber. Graduation in Agronomy. University of Brasilia. Brasilia; 2014.
8. Hartmann HT, Kester DE, Davies Jr FT, Genever L. Plant propagation: principles and pratices. 8ª ed: New Jersey: Prentice Hall; 2011.
9. Lattuada DAS. Advances in the vegetative propagation of *Eugenia uniflora* and *Plinia peruviana*. Master, Federal University of the Rio Grande do Sul. Rio Grande do Sul; 2010.
10. Pizzatto M, Wagner Jr A, Luckmann D, Pirola K, Cassol DA, Mazaro SM. Influence of the use of AIB collection season and stake size on the vegetative propagation of hibiscus by cutting. Rev. Ceres. 2011;58(4):487-492.
11. Sas. User's Guide. Statistical Analysis Systems Institute Cary NC USA; 2013.
12. Santos M. Produção de mudas por semente e estaquia em annonáceae. Graduation in Forest engineering. Federal University of Santa Catarina. Santa Catarina; 2016.
13. Santos JP. Potential of rooting of woody cuttings of forest species of ciliary forest. Master in Forestry Engineering. Federal University of Lavras. Lavras; 2009.
14. Goulart PB, Xavier A, Iarema L, Otoni WC. Morphoanatomy of adventitious rhizogenesis in minicuttings of *Eucalyptus grandis* x *Eucalyptus urophylla*. Rev. Ci. Fl. 2014;24(3):521-532.
15. Bischoff AM, Vendramim DW, Gomes EN, Zuffellato Ribas KC, Engel ML, Maggioni RA. Rooting of black sage cuttings according to different indolebutyric acid concentrations and number of leaves. Rev. Ciências Agroveterinárias. 2017;16(1):41-47.
16. Cassol DA, Wagner Jr A, Pirola K, Dotto M, Citadin I. Packing, seasoning and indolbutiric acid in the propagation of jabuticabeira by aporporquia. Rev. Bras. Frutic. 2015;37(1):267-272.
17. Mendonça CI. Multiplication of the nematode *Meloidogyne paranaensis* and rooting speed of stem cuttings in seven species of medicinal plants. Master in Agronomy, University of Brasilia, Brasília. 2016.
18. Vignolo GK, Picolotto L, Gonçalves MA, Pereira IS, Antunes LEC. Presence of leaves in the rooting of mulberry cuttings. Rev. Cien. Rural. 2014;44(3):467-472.
19. Santoro PH, Mikami AY, Souza SGH, Roberto SR. Influence of leaves and lesions on the base of herbaceous cuttings in guava rooting of the selection 8501-9. Rev. Semina. 2010;31(2):289-294.
20. Sasso SAZ, Citadin I, Danner MA. Propagação de jabuticabeira por estaquia. Revista Brasileira de Fruticultura. 2010;32(2):577-583.
21. Paulus D, Valmorbida R, Paulus E. Indolebutyric acid on rosemary vegetative propagation. Hortic Bras. 2016;34:520-528.
22. Carvalho Jr WGO, Melo MTP, Martins ER. Length of cuttings in the development of rosemary seedlings. Rev. Cien. Rural. 2009;39(7):2199-2202.

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