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Concentrations of indolebutyric acid on air-layering of guava cv. Paluma

Gabriela da Silva Tamwing*, Sebastião Elviro de Araújo Neto, Isabela de Almeida Rodrigues, Rosely Ferreira de Oliveira, Bruno Jhosef de Souza, Bárbara Barbosa Mota

Federal University of Acre, Rio Branco, Brazil
*Corresponding author, e-mail: gaby_tamwing@hotmail.com

Abstract

Nowadays, the predominant technique for the commercial propagation of guava seedlings is through cuttings, using herbaceous cuttings that need a specialized infrastructure with intermittent misting, clean water, exhausters, water filters, and fans. As an alternative to plant propagation by cuttings, this study aimed to evaluate the influence of concentrations of indolebutyric acid (IBA) on the rooting of branches of the guava cv. Paluma by air-layering. The experimental design was in randomized blocks, with four replications and 10 air layers per plot. The treatments consisted of six concentrations of IBA powder mixed with industrial talcum: 0, 1,000, 2,000, 3,000, 4,000, and 5,000 mg.kg^{-1}. Four adult guava parents that were in the off-season period were used. For the preparation of the air layers, the stems were girdled with a 4.0 cm width, using a steel blade, by removing the bark until exposing the cambium region, followed by IBA application and wrapping of the branches with a plastic bag containing moist organic substrate. The following variables were evaluated 120 days after air-layering: percentage of rooted and callused air layers, longest root length, and root dry matter. The analysis of variance indicated no significant differences between the IBA concentrations for all variables, but the rooting percentages were high (68.6 to 92.2%) regardless of the application of the exogenous auxin.

Keywords: vegetative propagation, *Psidium guajava,* growth regulators

Introduction

Guava production is expanding in Brazil due to the growing demand for *in natura* fruits and agro-industry products, such as juices, jams, and sweets. This valorization promoted advances in the production and marketing systems of this crop (Quintal et al., 2017), placing the country among the leading red guava producers in the world (FAO, 2018).

Guava propagation can be performed by seeds, air-layering, grafting, root and stem cuttings, and tissue culture (Pereira et al., 2017). The use of seeds is employed in the production of rootstocks and in breeding programs to obtain new cultivars (Coser et al., 2014; Moura et al., 2015). However, sexual propagation for commercial orchards is disadvantageous, given the unevenness of the plants in the field and the late fructification of the crop (Oliveira et al., 2012).

Nowadays, propagation via herbaceous cuttings is the most used technique in Brazil (Pereira et al., 2017). However, herbaceous cuttings or mini-cuttings require environments with high relative humidity (above 80%) in order to maintain the turgidity of soft tissues throughout the rooting period (Milhem et al., 2014).

Air-layering is a multiplication method that promotes good responses in species that present difficult propagation by cuttings and low germination rates (Brito et al., 2014; Hossel et al., 2016) since the seedlings are linked to and formed in the parent plant itself.

The advantages of this method, compared to propagation through cuttings, consist in not depending on specialized equipment and infrastructure, such as plant nurseries and acclimatization systems (Brito et al., 2014), besides promoting high rooting rates, simplicity of execution, and independence from the many conditioners required for rooting success.

On the other hand, this technique presents

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limitations due to its slow and challenging execution, resulting in low seedling yield. Air-layering has been studied in the propagation of several fruit species, such as umbu (*Spondias tuberosa)* (Dutra et al., 2012), black plum ((*Syzygium cumini* (L.) Skeels) (Silva et al., 2019), jaboticaba (*Plinia cauliflora*) (Sasso et al., 2010; Cassol et al., 2015), and achiote (*Bixa orellana)* (Mantovani et al., 2010).

The success of air-layering is influenced by several factors, among them, the diameter of the branches selected and the width of girdling (Sasso et al., 2010), the exogenous application of indolebutyric acid (IBA) (Barbosa Filho et al., 2016; Campos et al., 2015), the substrates used (Naithani et al., 2018), and the time of the year and type of wrapping (Cassol et al., 2015).

Therefore, this study aimed to evaluate the influence of IBA concentrations on the rooting of branches of the guava cv. Paluma by air-layering.

Material and Methods

The experiment was performed in the Seridó Ecological Site, located in Rio Branco, Acre, in the geographic coordinates 99° 53' 16'' S latitude, 67° 49' 11'' W longitude, and elevation of 170 m. The region presents a hot and wet climate of the Am-type, according to the classification by Köppen, with mean annual temperatures around 24.4 °C, air relative humidity of 84%, and annual rainfall varying from 1,700 to 2,400 mm (INMET, 2019). Table 1 exhibits the data on the climatic conditions of the region during the experimental period.

Table 1. Data of total rainfall, maximum, minimum, and mean temperatures, and air relative humidity during the experimental period, provided by the National Institute of Meteorology (INMET). Rio Branco, AC, 2018-2019.

Month	Rainfall	Tmax.	Tmin.	Tmed.	R.H.
	(mm)		(°C)		(%)
December	278.2	31.11	23.44	26.13	87.99
January	322.5	31.34	23.04	26.06	92.44
February	443.5	31.10	23.27	25.99	90.96
March	371.5	31.94	23.37	26.40	89.67

Rainfall – Total rainfall; Tmax. – Maximum temperature; Tmin. – Mean temperature; Tmed. – Mean temperature; R.H. – Relative humidity.

The experimental design consisted of six IBA powder concentrations mixed with industrial talcum (0, 1,000, 2,000, 3,000, 4,000, and 5,000 mg.kg^{-1}) in randomized blocks, with four replications and ten air layers each. Four adult parents of the guava cultivar Paluma that were in the off-season period were used, one for each block, to prepare 60 air layers per plant. IBA was applied in the vascular cambium region, which was possible after girdling the stems.

For the preparation of the air layers, the girdling of the stems was performed with a 4.0 cm width, using a steel blade, by removing all the bark until exposing the vascular cambium region, after which the IBA was applied (Figure 1a).

Figure 1. Application of IBA in the girdled branches (a) and air layers covered with plastic bags, filled with substrate, and identified (b).

After applying the concentrations of the phytoregulator, the branches were covered with two layers of a black plastic bag (20 x 25 cm), which was filled with an organic substrate and tied with a string in the extremities (Figure 1b). The substrate was prepared by mixing soil, organic compost, and ground Ouricuri palm stem (*Syagrus coronata*), being previously moistened with water to facilitate the formation of a spherical shape, with an air layer diameter from 10 to 12 cm.

The air layers were removed from the parent plant after 120 days, when the following variables were evaluated: percentage of rooted air layers, percentage of callused air layers, number of roots, longest root length (cm), and root dry matter (g air layer^{-1}).

The data were subjected to analysis of variance by the F-test to verify significant statistical differences between the treatments, at 5% of probability.

Results and Discussion

Under the experimental conditions, the guava cv. Paluma reached a high rate of adventitious rooting in the branches, by air-layering, even without the application of IBA (72.5%), reaching up to 92.22% when applying 4,000 mg.kg^{-1} of IBA. However, no significant statistical difference was verified by the F-test (p>0.05) (Table 2).

These results are explained by the fact that, in air-layering, the branches remained connected to the parent plant during the whole process, thus draining water, nutrients, and rooting-promoting substances, with endogenous auxin among these. When evaluating the propagation by air-layering in Myrtaceae, Hossel et al. (2016) also observed no IBA effect on the 62.6% rooting rate in rose apple, and Cassol et al. (2015) verified no effect of IBA on the 20.0% adventitious rooting rate in jaboticaba. These authors attribute this phenomenon to the high C/N ratio and other rooting cofactors present in the plant during air-layering.

Table 2. Mean percentages of rooted air layers (RA), callused air layers (CA), longest root length (LRL), root dry matter (RDM), and number of main roots per cuttings (RC) at 120 days after girdling and application of indolebutyric acid (AIB).

Concentrations of IBA	RA	CA	LRL	RDM	RC
(mg.kg^{-1})	(%)		(cm)	(g.air layer^{1})	(un)
0	72.5^{ns}	27.5^{ns}	13.57^{ns}	4.6176^{ns}	2.72^{ns}
1,000	84.17	15.83	13.04	4.4826	3.64
2,000	76.67	23.33	12.52	3.3579	3.71
3,000	68.61	26.11	12.40	4.5451	3.20
4,000	92.22	7.78	12.81	6.6336	5.24
5,000	68.89	28.61	10.93	1.9201	3.14
General mean	77.18	21.53	12.55	4.2595	3.61
$F_{treatment}$	1.680	1.232	0.824	1.876	2.223
F_{block}	1.486	2.136	0.106	0.583	0.190
C.V. (%)	18.74	65.29	15.64	53.51	32.58

^{ns} = Not significant; C.V.= coefficient of variation

Besides the high root emission rate, the roots occurred in higher number and length, which is essential for the production of commercial seedlings since a well-developed root system provides better nutrient and water absorption, reflecting positively on plant establishment in orchards (Carvalho Junior, 2009).

The period with high temperatures and rainfall (Table 1), which intensified plant metabolism and the synthesis of rooting cofactors, also contributed to the high rooting percentage verified in this study (Hossel et al., 2016), besides not coinciding with the flowering and fructification periods of the plant, increasing the C/N ratio and reducing the presence of rooting inhibitory substances (Fachinello et al., 2013).

Furthermore, using black plastic bags to cover the air layers can maintain the internal heat higher than in the outside, stimulating the adventitious rooting through stimuli to cell division (Cassol et al., 2013).

It was observed that the formation of calluses was a precursor stage to the adventitious rooting of the air layers. According to Fachinello et al. (2013), the callus is the result of the healing of wounds made in the xylem and phloem tissues, and although it is not an indicator of root formation, it demonstrates that there was a response to the stimulus.

On the other hand, Singh & Ansari (2014), studying air-layering in different tropical species, verified that the formation of calluses is independent to rooting, thus constituting phenomena that compete for carbohydrates. In some cases, as verified by Bisi et al. (2016) in fig propagation, the presence of calluses can even inhibit root emission.

In studies performed in India, Parmar et al. (2019) observed that the application of 8,000 ppm of IBA combined with the use of a substrate composed of sphagnum moss, coconut husk, and vermicompost significantly increased the rooting rates, with a maximum percentage of 83.33%, 11.15 cm length, and 0.83 g of root dry matter in guava air layers. Naithani et al. (2018), in turn, verified higher rooting rates in guava air layers prepared on July 15 (74.44%) by applying 4,500 ppm of IBA (82.22%) and using sphagnum moss as a covering substrate (68.33%). In the northern hemisphere, this period corresponds to the same meteorological conditions of the month of December in the southern hemisphere (Brazil).

Conclusions

By considering the protocol of this study and the meteorological conditions during the experiment, the guava cv. Paluma can be multiplied by air-layering without using indolebutyric acid, reaching an average rooting rate of 72.5%.

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