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Rooting inducers and organic substrates in the propagation of 'Paluma' guava by cutting

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To produce seedlings with quality is one of the factors that mostly contribute to increase the production chain of a fruit crop. The use of organic substrates in the production of seedlings becomes a way to reduce costs by using raw material available regionally. Then, the aim of this study was to evaluate the influence of rooting inducers and the contribution of organic substrates to improve the rooting of herbaceous cuttings of 'Paluma' guava. The experiment was completely randomized arranged in a 5×2 factorial design with 4 replications and 10 cuttings per plot. The factors comprised five substrates (S1-100% OC; S2-25% CRH + 75% OC; S3-50% CRH + 50% OC; S4-75% CRH + 25% OC; S5-100% CRH), where CRH: carbonized rice husk and OC: organic compost, and 2 rooting inducers (Radimaxi 20® and Indolbutyric Acid - IBA), with the concentration of 2000 mg L⁻¹. With regard to the analyzed variables, rooting, mortality, length of roots, and dry weight of shoots and roots did not fit with any regression model. However, the live rootless cuttings, callus, sprouting, leaf retention, and number of roots showed interaction between the inducers and the used substrates. The maximum rooting percentage obtained was 20%, independently of the type of inducer or used substrate; the use of Radimaxi 20® provides greater percentage of cuttings with callus and live rootless cuttings; the carbonized rice husk in composition S2 (25% CRH + 75% OC) is indicated to compose the rooting substrate of 'Paluma' guava cuttings; despite the satisfactory results obtained in this work, more studies are needed to clarify the rhizogenic process of guava in diversified conditions.

Key words: Indolbutyric acid, vegetative propagation. Radimaxi 20®.

INTRODUCTION

The cultivation of guava (Psidium guajava L.) has great economic importance in the area of fruit processing industry, with the ‘Paluma’ cultivar as the most widely used, with 70% of production for the industrial processing
showed that in the first stage of induction and formation of roots, the nutrients calcium, iron, copper, boron, zinc, and manganese are important to trigger the process, since they take part of the cell wall formation, lignification, and cell elongation, being these processes essential for root growth.

Considering these evidences and the importance of cuttings propagation in the commercial production of guava, this work aimed to verify the influence of rooting inducers and the contribution of organic substrates to improve the rooting of herbaceous cuttings of ‘Paluma’ guava.

MATERIALS AND METHODS

Cuttings of guava cv. ‘Paluma’ were collected from a five-year-old mother plants in the summer. The plants were from the Macaquinhos grange, located in the municipality of Remigio, Paraíba State. The herbaceous cuttings were taken from the apical part of the side branches, with four pairs of leaves, being involved in moistened paper and packed in plastic bags, forming a moist chamber, and afterwards, transported to the Fruit Crop Nursery of the Department of Phytotechnology and Environmental Sciences, at the Centre for Agricultural Sciences of the Federal University of Paraíba.

The experimental design was completely randomized in a 5×2 factorial design, with five substrate compositions (S1-100% OC; S2-25% CRH + 75% OC; S3-50% CRH + 50% OC; S4-75% CRH + 25% OC; S5-100% CRH), where CRH: carbonized rice husk and OC: organic compost, and 2 rooting inducers (Radimaxi 20® and Indolbutyric Acid - IBA) used in the concentration of 2000 mg L⁻¹, with four replications and 10 cuttings per plot.

The preparation of the cuttings was performed in the nebulization chamber, getting these with 10 cm long making a straight cut at the apex and beveled at the base, and a couple of leaves at the apex, with the limbs reduced to half of the leaf length.

After prepared, the cuttings had 2 cm of their bases immersed for 5 s in hydroalcoholic solution of IBA and Radimaxi 20®, according to the previously defined treatments. Growth inducers were weighed and dissolved separately in 10 mL of ethanol and the volume was completed to 90 mL of distilled water to give a concentration of 2000 mg L⁻¹ for both.

The cuttings were planted in plastic tubes filled with different proportions of substrates and maintained under intermittent nebulization system, and a shading coverage (50%) with temperature ranging from 39 to 20°C. For the control of fungal diseases, the cuttings were treated with Aliette® fungicide sprays. After 70 days of experiment installation (Yamamoto et al., 2010), the following variables were analyzed: Cuttings with callus (%), live rootless cuttings (%), number of roots, leaf retention (%), Length of roots (cm), Dead cuttings (%), rooted cuttings (%), cuttings with sprout (%), dry weight of shoots (g) and dry weight of roots (g).

The data were transformed by the square root function (y + 0.5) when obtained by counting and by logarithmic function (log + 1) for the quantitative ones. It was performed analysis of variance and regression using the F test (p ≤ 0.10) to verify the isolated effects and the interaction between the factors. The SAS/STAT Software 9.3 (2011) was used.

RESULTS AND DISCUSSION

The variables live rootless cuttings, number of roots, cuttings with callus and leaf retention showed interaction

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1 Tereza Malvezzi: Managing partner of Fertsana agricultural specialties LTDA, responsible for the marketing of the Radimaxi 20® (Personal information, 2016).

(Pereira, 2008). However, to meet the production expectations, it is necessary plantlets with high standard of quality as result of appropriate technologies to obtain propagation material with high-quality and compatible costs (Franco et al., 2008; Altoé and Marine, 2012).

One aspect that affects the process of commercial propagation by cuttings in guava, aiming to produce fruit with quality, is the cutting type. For this crop, herbaceous cutting has been widely used, since the plantlets grows more quickly, provides a homogeneous orchard, demands less time of work, and provides high-quality plantlets at lower cost (Zietemann and Robert, 2007; Zem et al., 2015).

Another preponderant issue in the propagation of guava tree is the type of substrate. There is a wide variety of commercial substrates in the market that can be used for the rooting of fruit crops; however, small nursery owners do not have access, considering their high cost, and, furthermore, the rooting percentage for some species may be influenced by the material that composes the substrate. Thus, the mixture of raw material obtained regionally allows to lower the cost of production of seedlings. However, the materials used in this purpose must be easily accessible, continuously available, and have low cost, and that can be obtained from agricultural wastes, conditioning similar qualities or higher than those achieved with the commercial substrates (Catunda et al., 2008; Cardoso et al., 2011). An example of material of easy obtaining, availability, and very high quality is the carbonized rice husk and the organic compost (Boechat et al., 2010; Cardoso et al., 2011) that are alternative substrates that can be used in several regions.

To improve the rooting process in guava, plant growth regulators, based on synthetic auxin, is a widespread practice, especially for those species where there is difficulty in rooting, making the production of seedlings viable by the cutting method. Among the synthetic auxins used as rooting inducers, there is the indolbutyric acid – IBA (Yamamoto et al., 2010).

However, there are other compounds used by the nurseries owners, such as mixed mineral fertilizer that contains some nutrients like zinc, which acts on tryptophan synthesis, an auxin precursor (Hartmann et al., 2002). One of these products is the Radimaxi 20®, which is a mixed mineral fertilizer developed for the production of fruit crop seedlings, having in its composition 25.6% Ca, 1.8% S, 2.5% Zn and 1.5% Co, which stimulates rooting (Oliveira et al., 2010; Malvezzi, 2016).

The mineral nutrition may affect adventitious rooting as it interferes in the morphogenetic responses of plants such as rhizogenesis, the density, and the modulation of their length (Assis et al., 2004). Thus, Cunha et al. (2009)
between inducers and substrates. However, other variables showed no interaction and did not fit with any regression model.

For the percentage of cuttings with callus, there was a significant interaction between inducers and substrates (Figure 1A) observing a higher percentage of callus for IBA with 20% in the formulation S2 (25% CRH + 75% OC) and 33% for Radimaxi 20® in formulation S5 (100% CRH). When Radimaxi 20® was used as rooting inducer, the percentage of cuttings with callus increased linearly; while with the application of IBA, there was only 5.33% of cuttings with callus. As one of the origins of rhizogenesis in the cutting process is the callus, there is a possibility of formation of adventitious roots if a time greater than 70 days for completion of the assay is used. The fact that the Radimaxi 20® has zinc in its composition, what promotes auxin synthesis, may have resulted in increased callus formation.

Ferreira (2013) noted that vine cuttings treated with zinc had higher rooting than those untreated, showing that zinc may have enabled the synthesis of tryptophan, an auxin precursor. However, a higher auxin/cytokine ratio is necessary for the rooting occurrence (Hartmann et al., 2002). Probably, the levels present in the cuttings and the exogenous application of inducers have not been enough to put this ratio in a favorable rate to promote rooting of ‘Paluma’ cuttings.

For the live rootless cuttings (Figure 1B), there was a significant interaction between the inducers and the substrates, presenting a higher percentage of live rootless for IBA with 13.33% in the formulations S1 (100% OC) and S3 (50% CRH + 50% OC), and 40% for Radimaxi 20® in formulations S5 (100% CRH). The use of Radimaxi 20® gave a linear and increasing response with the rise of proportions of rice husks in the substrate, providing 22.67% of cuttings, which have been kept alive, while with the application of IBA was observed only 5.33%. Thus, it can be noticed that the application of Radimaxi 20® and the use of substrates with high proportions of carbonized rice husks only acted in maintaining the survival of cuttings. Probably, there would be necessary more time for the development of roots than the used herein.

For the number of roots (Figure 1C), there was an adjustment for the quadratic model for the doses effect of IBA, showing at the maximum point 3.58 roots per cutting in the substrate S4 (75% CRH + 25% OC); however, the use of Radimaxi 20® resulted in an average of 0.53. The number of roots in the cuttings was very disparate for the same cultivar, and this corroborates with Zietemann and Roberto (2007) that obtained maximum of 1.88 roots per cutting in the spring, but 4.5 in the summer to ‘Paluma’ guava. However, Vale et al. (2008), working with IBA and sucrose, observed an average of 12 roots per herbaceous cutting of ‘Paluma’ guava, using the concentration of 300 mg L⁻¹ of IBA. The results are consistent with Altoé and Marine (2012) that obtained 3.7 roots by herbaceous cuttings, when assessing the serial minicutting technique in the rooting of ‘Paluma’ guava.

For the foliar retention, there was a quadratic adjustment using IBA, with the maximum retention provided by the substrate S4 (75% CRH + 25% OC); there was no effect of the substrate using Radimaxi 20®, averaging 0.72% of retention (Figure 1D).

The leaf retention in the herbaceous cutting process is important for the rhizogenesis, since it assists in the production and transport of auxin, enables the supply of carbohydrates through photosynthesis, favoring division and elongation (Vignolo et al., 2014). However, leaves do not influence directly the rhizogenesis, but increases the probability of this event happens. In herbaceous cuttings that do not have high levels of reserve compounds, the young leaves are photosynthetically active and present auxin synthesis (Hartmann et al., 2002). Vale et al. (2008) found no relationship between the leaf retention in herbaceous cuttings of ‘Paluma’ guava, with their rooting process. However, Pereira et al. (1993) found that the remaining leaves on the cuttings of ‘Paluma’ guava were effective in the rooting.

The root length was not affected by the factors studied, showing an average of 8.03 cm (Figure 2A). Zietemann and Roberto (2007) also obtained roots with length similar to the cv. Paluma rooted in the spring although it was observed the maximum value of 12.25 cm when the rooting occurred in the summer. But, Altoé and Marine (2012) evaluating the serial minicutting technique in the rooting of ‘Paluma’ guava, length of 5.85 cm in herbaceous cuttings, lower than that obtained herein.

There was no significant difference between the substrates formulations and rooting inducers for the mortality percentage of cuttings, showing a mean value of 65.33% of dead cuttings (Figure 2B). This high percentage of mortality may be related to the physiological condition of the mother plant, as the temperature is very high in the summer season in the Northeast region above 24°C, which and considered ideal to stimulate cell division in rooting area (Hansen, 1989; Yamamoto et al., 2010), and the mother plants, although irrigated, may have increased the level of growth inhibitors, in order to reduce the emission of new sprouts. Although Zietemann and Roberto (2007) have obtained the higher rooting in cuttings of ‘Paluma’ in the summer, in the South region. This time resulted in higher mortality of cutting for this cultivar in the Northeast region.

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In the Figure 2C, there is no effect of stimulators of rhizogenesis, with 20% of rooting, in average. This percentage is low and does not corroborate with those obtained by Zietemann and Roberto (2007) that evaluated the rooting of herbaceous cuttings of ‘Paluma’ guava collected in spring and summer periods in the north of Paraná State, using carbonized rice husk and vermiculite substrates, and doses of IBA; they obtained 53.75% of rooting, regardless the period of collection and the substrates used, but 73.75% of rooting was obtained when 2000 mg L\(^{-1}\) of IBA was applied. These authors recommend the application of carbonized rice husk substrate as the most suitable for the rooting; however, it was verified herein that the S5 (100% of carbonized rice husk) did not increase the rooting percentage. Vale et al. (2008) observed rooting of 60% at a dose of 300 mg L\(^{-1}\) of IBA 60 days after the herbaceous cutting of ‘Paluma’ guava.

The fact of obtaining contrasting results for the same cultivar may be related to the age of the mother plant and environmental factors such as the period of collection of cuttings because the summer in the Northeast region is characterized by high temperatures and the plants may have reduced the percentage of rooting promoters as a response for slowing the growth even being irrigated. Hartmann et al. (2002) showed that environmental and physiological conditions of the mother plant can determine the percentage of rooting, since cuttings taken from mother plants that have suffered water stress may have high levels of abscisic acid and ethylene. Therefore, the level of auxin used did not raise the levels of rooting promoters on the cuttings. Palú et al. (2013) also did not observe efficiency in root induction using the Radimaxi 20® in the rooting of passion fruit cuttings.

Regarding the percentage of cuttings with sprouts, there was an increase in the percentage of sprouts in cuttings treated with IBA, being more efficient than Radimaxi 20® (Figure 2D). The emergence of rootless cuttings with sprouts may occur if the cytokinin levels are high, resulting in low ratio of auxin/ cytokinin. The high levels of cytokinin promote sprout formation and not roots (Hartmann et al., 2002), evidencing that the dose of auxin

Figure 1. Cuttings with callus (A), Live rootless cuttings (B), Number of roots (C), and Leaf retention (D) in the cuttings of guava cv. Paluma grown on substrates (organic compost and carbonized rice husks) and treated with inducers at 70 days after planting.
applied did not increase this ratio to promote rhizogenesis. The absence of sprouts in the cuttings treated with Radimaxi 20® can be a result of reserves utilization in the cuttings for the formation of callus (Figure 1A).

For the dry weight of shoot, there was only isolated effect of inducers, with an average weight of 3.17 g for cuttings treated with Radimaxi 20®, and 1.18 g for the cuttings treated with IBA (Figure 3A). With regard to the dry weight of root, there was neither significant interaction nor isolated effects for the studied treatment (Figure 3B). Zietemann and Roberto (2007) also observed the lack of differences between substrates and IBA doses in the study of rooting of herbaceous cuttings of ‘Paluma’ guava. Milhem (2011) working with herbaceous cuttings and minicuttings of ‘Paluma’ guava, did not observe variations to the dry weight of root among the propagules and the used substrates.

The performance of inducers and substrates in the propagation of herbaceous cuttings of guava is highly variable due to genetic material, the edaphoclimatic condition of cultivation area, and the physiological conditions of the mother plants. These interferences allow variations in the percentage of rooting for the same cultivar, as demonstrated herein. The use of Radimaxi 20® was beneficial for the callus formation, but the time for rooting of cuttings must be longer, requiring tests to assess the changes in product concentrations in order to obtain best results.

Conclusions

Both Radimaxi 20® and Indolbutiric Acid – IBA concentration of 2000 mg L⁻¹ and the organic substrates (organic compost and carbonized rice husk) do not affect the rooting of ‘Paluma’ guava cuttings. The use of Radimaxi 20® resulted in a higher percentage of callus

Figure 2. Length of roots (A), Dead cuttings (B), Rooted cuttings (C), and cuttings with sprout (D) in cuttings of guava cv. Paluma, grown on substrates (organic compost and carbonized rice husks) and treated with inducers at 70 days after planting.
Figure 3. Dry weight of shoot (A) and dry weight of root (B) of cuttings of guava cv. Paluma, grown on substrates (organic compost and carbonized rice husks) and treated with inducers at 70 days after planting.

formation and live rootless cuttings.

Conflict of Interests

The authors have not declared any conflict of interests.

REFERENCES