Effect of indole-3-butyric acid and *Trichoderma harzianum* Rifai on asexual cape gooseberry propagation (*Physalis peruviana* L.)

Efecto del ácido indol-3-butírico y *Trichoderma harzianum* Rifai en la propagación asexual de uchuva (*Physalis peruviana* L.)

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ABSTRACT

The growth and development of cape gooseberry plants obtained from cuttings is affected by microorganisms in the substrate and by the concentration of plant growth regulators applied during planting. Using a factorial design, the effect of four concentrations of indole-3-butyric acid (IBA) (0, 800, 1,200, and 1,600 mg L^{-1}) and four suspensions of *Trichoderma harzianum* (0, 2·10^6, 3·10^6, and 4·10^6 cfu/mL) on the growth of cape gooseberry cuttings was evaluated. Apical cuttings were used, 20 cm long, from 20-month-old plants of the Colombian ecotype, which were planted in pots (2 L) using peat moss with burned rice husks as the substrate at a 3:1 ratio (v/v). The 800 mg L^{-1} of IBA application showed the highest accumulation of total dry mass (DM) and root DM. Moreover, 800 mg L^{-1} of IBA resulted in the highest leaf chlorophyll content, showing significant differences from 1,600 mg L^{-1}, which had the lowest value. The 3·10^6 cfu/mL suspension of *T. harzianum* caused a greater accumulation of root DM and total DM and a higher leaf area in the plants. The most favorable interaction between the factors, which favors the growth of cape gooseberry plants obtained from cuttings, was observed with the application of 800 mg L^{-1} of IBA and 3·10^6 cfu/mL of *T. harzianum*.

Key words: plant growth regulators, auxin, biocontrol, cuttings, growth.

RESUMEN

El crecimiento y desarrollo de los esquejes de uchuva es afectado por los microorganismos presentes en el sustrato y por la concentración de hormonas aplicada al momento de la siembra. Mediante un diseño factorial se evaluó el efecto de cuatro concentraciones de ácido indol-3-butírico (AIB) (0, 800, 1.200 y 1.600 mg L^{-1}) y cuatro suspensiones de *Trichoderma harzianum* (0, 2·10^6, 3·10^6 y 4·10^6 ufc/mL) en el crecimiento de esquejes de uchuva. Se usaron esquejes apicales de 20 cm de largo obtenidos de plantas de 20 meses de edad, ecotipo Colombia, los cuales fueron sembradas en materas de 2 L en un sustrato de turba rubia y cascarilla de arroz quemada en relación 3:1 en volumen. Al aplicar 800 mg L^{-1} de AIB las plantas presentaron la mayor acumulación de masa seca (MS) total y MS de raíces. Además, la concentración de 800 mg L^{-1} de AIB presentó el mayor contenido foliar de clorofila mostrando diferencias significativas con la dosis de 1.600 mg L^{-1}, la cual tuvo el menor valor. La suspensión de 3·10^6 ufc/mL de *T. harzianum* provocó una mayor acumulación de MS de raíces, MS total y área foliar de la planta. La interacción entre factores que más favoreció el crecimiento de las plantas de uchuva, provenientes de esquejes, se dio cuando se aplicaron 800 mg L^{-1} AIB y 3·10^6 cfu/mL de *T. harzianum*.

Palabras clave: fitoreguladores, auxina, biocontrol, estaca, crecimiento.

Introduction

The cape gooseberry (*Physalis peruviana* L.) is a native plant from the South American Andes. This plant is the best known species of the *Physalis* genus and is characterized by a sweet fruit (highest Brix grades of 17.2) that contains a high content of vitamins A and C, iron and phosphorus (Galvis *et al*., 2005; Fischer *et al*., 2011). This fruit, along with mango, passion fruit, pitahaya, tree tomato, and baby banana, is part of the promising exportable fruits from Colombia, of which cape gooseberry ranks first (Fischer *et al*., 2007).

The propagation of this plant is mostly done by seed and, to a lesser extent, asexually (López *et al*., 2008), but the cape gooseberry also responds well to asexual propagation through cuttings (Fischer *et al*., 2014). Asexual propagation ensures a greater uniformity of the crop and the same genetic characteristics as the parent plant (Hartmann *et al*., 2010), which is practical for the management of cultures of identical plants.

In some cases, propagation through cuttings is successful and the plant material does not need further treatment to generate a whole plant, but in others, this type

of propagation is unsuccessful due to environmental conditions or intrinsic factors of the plant and it becomes necessary to subject the cuttings to different treatments, such as the application of plant growth regulators (PGR), microorganisms and the use of certain substrates in order to generate a new vigorous plant (Moreno *et al.*, 2009). In this regard, López *et al.* (2008) found that cape gooseberry cuttings selected from the top of the reproductive shoot showed better results in rooting than cuttings taken from the middle or lower position of the shoot. Miranda and Perea (2012) explained that the better rooting of apical shoot cuttings is due to the higher concentration of endogenous promoting substances that originate in apical buds; also, younger cuttings have more cells that are capable of becoming meristematic.

The application of auxin to induce the rooting of cuttings has been reported by several authors (Ramírez-Villalobos *et al.*, 2004; Miranda, 2005; Roh *et al.*, 2005; Moreno *et al.*, 2009; Ruiz-Solsol and Mesén, 2010), who showed that these plant growth regulators are essential for rooting in different plant species. Moreno *et al.* (2009) used indole-3-butyric acid (IBA) at concentrations of 200 to 800 mg L^{-1} to induce cape gooseberry rooting and found that the rooting was directly proportional to the increase in the IBA concentration, although the authors did not establish at what concentration the growth curve had a slope that was equal to zero or negative, meaning that the auxin concentrations that increased or reduced the growth were not determined. In general, IBA is applied to the base of cuttings; however, Pacholczak *et al.* (2012) found that, in *Cotinus coggygria,* a greater effect on rooting was seen using 200 mg dm^{-3} of foliar IBA, as compared to dipping the base of the stems in the hormone solution.

The fungus *Trichoderma harzianum* has been used as a biological control for diseases; for example, in onions, the substrate application of *T. harzianum* reduced infection by *Fusarium oxysporum* and caused an increase in the bulb diameter (Coskuntuna and Özer, 2008). It is also widely used in the control of postharvest diseases ever since Batta (2007) established that the application of an emulsion based on *T. harzianum* in fruits such as apple, strawberry, pear, peach, kiwi, and grape reduced the injury diameter caused by *Rhizopus stolonifer*, *Botrytis cinerea*, and *Penicillium expansum* and provided protection for up to two months against these diseases. Moreover, in addition to its antibiotic properties and fungal antagonism, *T. harzianum* also promotes the growth of plants. Apart from the above mentioned benefits, *Trichoderma* sp. also generates a greater availability of nutrients, such as phosphorus and iron, in the soil and stimulates the production of growth regulators in plants (Hoyos-Carvajal *et al.*, 2009), which may be advantageous for crops, such as passion fruit (Cubillos-Hinojosa *et al.*, 2009). Therefore, in order to stimulate growth and generate more vigorous plants at transplanting, the present study aimed to determine the effect of the application of indole 3-butyric acid and *T. harzianum* on the development and growth of cape gooseberry cuttings.

Materials and methods

The experiment was carried out in a plastic greenhouse at the Universidad Pedagogica y Tecnologica de Colombia, Tunja (Boyaca, Colombia), which had an inside average temperature of 18°C and relative humidity of 75% and is located at 2,690 m a.s.l.

Cuttings, 20 cm in length and with a pair of leaves, were taken from the top of the shoots of 20-month-old cape gooseberry plants, ecotype Colombia, because this type of cuttings presented better rooting (López *et al.*, 2008). The cuttings were immersed in different auxin solutions for 5 min and then planted in 2 L pots filled with a Californian peat moss mixed with burned rice husks at a proportion of 3:1 (v/v). After planting, the individual suspensions of a commercial strain of *T. harzianum* were applied to the substrate.

A completely randomized 4x4 factorial design was used, where the first factor corresponded to the application of indole-3-butyric acid (IBA) (RADIX® 1500, Intercontinental Import Export, Mexico DF) at different concentrations (0, 800, 1,200, or 1,600 mg L^{-1}) and the second factor to the application of *T. harzianum* at different suspensions (0, 2·10^6, 3·10^6, or 4·10^6 cfu/mL) for a total of 16 treatments. Each treatment had three replicates, resulting in 48 experimental units (EU), where each EU accounted for two cape gooseberry cuttings.

During the experiment, the substrate remained at field capacity and the plants were kept under a shade net (50% light reduction) during the first 50 d in order to avoid severe dehydration of the cuttings; furthermore, the flowers were removed in order to encourage vegetative growth. Beginning after 40 d of planting and for 4 months, a foliar fertilizer (g L^{-1}) was applied weekly at a concentration of 200.00 of nitrogen (urea), 2.50 of MgO, 0.30 of B, 5.00 of S, 0.25 of Cu, 1.00 of Fe, 1.60 of Zn, 0.55 of Mn, and 0.03 Mo, which also contained 0.50 g L^{-1} naphthalene acetic acid (NAA).

After 110 d of the trial, the dry mass (DM) and fresh mass (FM) of the roots, stems, and leaves were measured with an electronic balance with 0.01 g accuracy (Acculab VIC 612, Bradford, MA), along with leaf area with a Li-Cor analyzer 3000 A (Licor, Lincoln, NE) and root length. Also, the leaf chlorophyll content was measured with a SPAD 502 Plus chlorophyll meter (Spectrum Technologies, Aurora, IL).

The results were subjected to the normality test of Kolmogorov-Smirnov and analysis of homogeneity of variance (Levene). Subsequently, an analysis of variance (ANOVA) was conducted to determine statistical differences between the treatments, followed by the multiple comparison Tukey test ($P \leq 0.05$). For the statistical analysis, SAS® v.8.1e (SAS Institute, Cary, NY) was used.

Results and discussion

Total leaf area

According to the ANOVA, for leaf area, there was no significant difference between the IBA levels. The average leaf area for the different IBA concentrations was 353.7 cm^2 with a standard deviation of 45.8 cm^2. Although no significant differences between the concentrations of IBA were found, the difference between the treatments with the lowest and highest leaf areas was over 100 cm^2 (Tab. 1), which could result in greater light absorption and, therefore, more photosynthetic activity and growth (Taiz and Zeiger, 2010).

The relationship between the leaf area and IBA doses showed a polynomial behavior (Fig. 1), different from the

findings of Moreno *et al.* (2009) who observed a lineal behavior. This result, which indicated that the auxin did not promote growth, may have been due to high concentrations of auxin (IAA), which stimulate the synthesis of abscicic acid (ABA), ethylene, and jasmonic acid, and, in certain concentrations, reduce plant growth (Hansen and Grossmann, 2000; Grossmann, 2010) or, in this case, nearly inhibit it. Therefore, under higher concentrations of 1,200 mg L^{-1} of IBA and more, the leaf growth of cape gooseberry cuttings may not increase.

$$y = -5 \cdot 10^{-05}x^2 + 0.1476x + 278.37$$
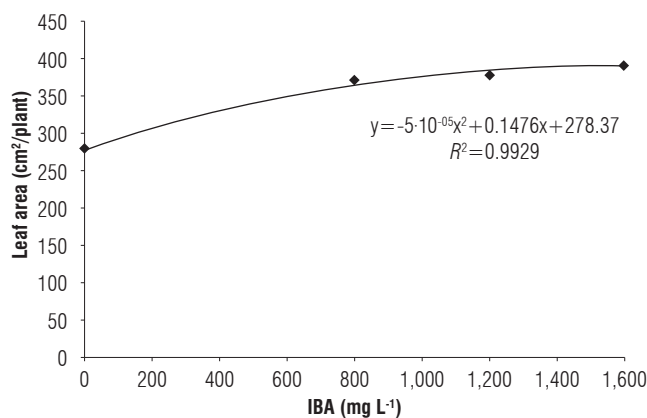$$R^2 = 0.9929$$

FIGURE 1. Effect of indole-3-butyric acid (IBA) concentrations on the leaf area of cape gooseberry plants developed from apical shoot cuttings.

The plants with a higher leaf area were those that received a 3·10^6 cfu/mL suspension of *T. harzianum*, but significant differences were only found between this treatment and the 2·10^6 cfu/mL suspension (Tab. 2). No direct relationship between the leaf area and increased population of the fungus was observed, which indicates that this variable was not stimulated by the increase of the concentration of *T. harzianum*, but responded favorably to the 3·10^6 cfu/mL suspension.

Similar results were reported by Donoso *et al.* (2008), who observed that the application of 2·10^6 cfu/mL of *T. harzianum* on cuttings promoted leaf DM accumulation in *Pinus radiata*; furthermore, Lo and Lin (2002) found that the application of a native strain of *T. harzianum* on *Cucumis sativus* plants increased plant growth and resulted in a

TABLE 1. Response of growth variables and chlorophyll content of cape gooseberry plants developed from apical shoot cuttings under different concentrations of indole-3-butyric acid(IBA).

IBA (mg L^{-1})	Leaf area (cm^2)	Leaf number	Root length (cm)	Chlorophyll content (SPAD units)	Total plant DM (g)
0	277.65 a	25.45 b	28.27 b	39.61 ab	3.85 b
800	369.04 a	32.33 ab	41.16 a	41.96 a	6.04 a
1,200	378.37 a	35.37 a	25.00 b	39.42 a	5.83 a
1,600	389.77 a	32.08 ab	32.83 ab	36.63 b	5.63 a

Means with different letters indicate significant differences according to the Tukey test ($P \leq 0.05$).

TABLE 2. Growth variables and chlorophyll content of cape gooseberry plants developed from apical shoot cuttings under different suspensions of *Trichoderma harzianum*.

Trichoderma harzianum (cfu/mL)	Leaf area (cm^2)	Leaf number (g)	Stem DM (g)	Leaf DM (g)	Root DM (g)	Root length (cm)	SPAD units	Total plant DM (g)
0	368.2 ab	33.8 a	2.3 ab	1.8 ab	1.5 ab	32.7 ab	39.3 a	5.6 ab
2·10^6	271.9 b	23.5 b	1.6 b	1.2 b	1.0 b	25.7 b	39.1 a	4.0 b
3·10^6	447.8 a	38.1 a	2.7 a	2.2 a	1.8 a	42.9 a	41.0 a	6.9 a
4·10^6	326.8 ab	29.7 ab	1.9 b	1.4 b	1.4 ab	25.8 b	38.1 a	4.7 b

Means with different letters indicate significant differences according to the Tukey test ($P \leq 0.05$).

higher leaf area (197%) and total DM (272%), as compared to the control treatment.

Fresh and dry mass of roots

The root FM and DM showed significant differences for the two evaluated factors and for their interaction. The plants treated with 800 mg L^{-1} and 1,600 mg L^{-1} of IBA developed the highest root FM (Fig. 2A). A similar DM behavior was observed, with a curve that peaked at 800 mg L^{-1}. The interaction showed that the combination of 800 mg L^{-1} of IBA and 0 cfu/mL of *T. harzianum* was the best way to promote root growth (Tab. 3).

The mass increase of the roots with the 800 mg L^{-1} of IBA applications was probably due to the fact that auxin promotes adventitious root formation in cuttings, which increases root growth (Acosta *et al.*, 2008; Hartmann *et al.*, 2010). Therefore, we infer that, without an IBA application, there was less root growth in the cuttings, resulting in a lower absorption of water and nutrients and, consequently, a slower growth of the plants. Santelices (2007) found similar results with *Nothofagus glauca*, where rooting increased proportionally with the IBA level at a concentration of 1.5%. Roh *et al.* (2005) observed that, 45 d after the application of 2,000 ppm of IBA on *Ardisia crenata*, the rooting percentage was 76% higher than the control plants. A higher and earlier rooting promotes rapid root growth and, therefore, a greater accumulation of FM and DM in this organ.

The DM accumulation tended to decrease with applications of IBA higher than 800 mg L^{-1}. Thus, the lower accumulation of DM in the 1,200 and 1,600 mg L^{-1} treatments possibly could have been due to the chain of reactions that induce a high concentration of auxins, triggering ethylene production, which, according to Acosta *et al.* (2008), strongly inhibit root growth through the reduction of cell length growth.

In *Myrciaria dubia*, Olival and López (2005) reported that the application of 100 mg kg^{-1} of naphthalene acetic acid (NAA) induced a rooting percentage of 24.5, but that increasing the dose to 200 and 300 mg kg^{-1} caused the rooting to decrease by 6.7 and 2.3%, respectively, lower than the control (4.5%). Therefore, it can be deduced that increasing the IBA concentration above 800 mg L^{-1} results in root growth that does not increase but remains constant and possibly decreases. In this regard, Taiz and Zeiger (2010) affirmed that root growth only requires very low concentrations of auxin, while higher concentrations (which promote stem elongation) inhibit it.

The treatments of 800 mg L^{-1} of IBA with 0 cfu/mL of *T. harzianum* and 1,600 mg L^{-1} of IBA with 3·10^{6}cfu/mL of *T. harzianum* generated cape gooseberry plants with a higher DM accumulation (Tab. 3). However, these applications do not show a significant trend when analyzed separately. The fact that the interaction was significant but the separate factors were not was probably due to the fact that, during rooting and subsequent plant growth, many variables, *e.g.* the substrate, the concentration of endogenous plant growth regulators and the plant nutrition, are involved, in addition to the relationship that can be established between the microorganism and the IBA (Hermosa *et al.*, 2012).

For the root FM there were significant differences between the higher concentration treatments (3·10^6 and 4·10^6 cfu/
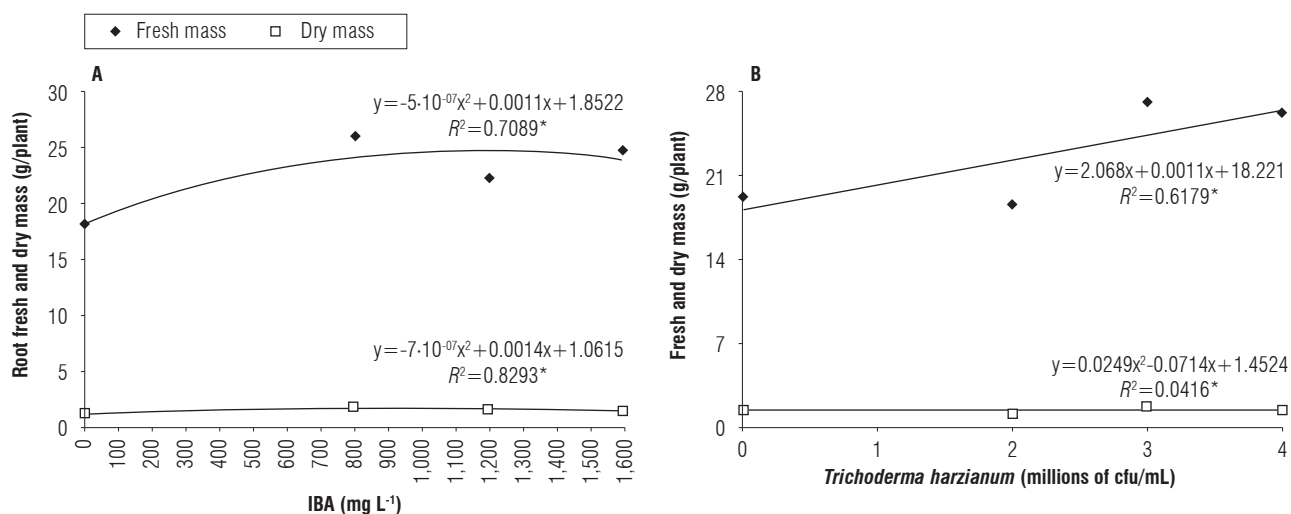

FIGURE 2. Effect of different indole-3-butyric acid (IBA) concentrations (A) and suspensions of *T. harzianum* (B) on the fresh and dry root mass of cape gooseberry plants developed from apical shoot cuttings.

mL) and the lower ones (without *T. harzianum* and the 2·10^6 cfu/mL treatment) (Fig. 2B). These results are different from those found with other plant organs (Tab. 2), where slower growth was presented by the control and the 4·10^6 cfu/mL suspensions, which shows that *T. harzianum* promotes root growth but not necessarily shoot growth. This higher accumulation of FM in the roots was probably due to the fact that, when the fungal hyphae establishes a close relationship with the root (Hoyos-Carvajal *et al.*, 2009), it increases the specific area of this organ and, thus, moisture retention.

TABLE 3. Combined effect of different indole-3-butyric acid (IBA) and *T. harzianum* levels on the root dry mass of cape gooseberry plants developed from apical shoot cuttings.

T. harzianum (millions of cfu mL^{-1})	IBA (mg L^{-1})	Root dry mass (g/plant)
0	0	0.73 b
0	800	2.65 a
0	1,200	1.57 ab
0	1,600	1.07 ab
2	0	1.14 ab
2	800	1.59 ab
2	1,200	0.76 b
2	1,600	0.89 ab
3	0	1.03 ab
3	800	1.90 ab
3	1,200	1.97 ab
3	1,600	2.64 a
4	0	1.26 ab
4	800	1.22 ab
4	1,200	1.73 ab
4	1,600	1.42 ab

Means with different letters indicate significant differences according to the Tukey test ($P \leq 0.05$).

Root length

For this variable, significant differences for the interaction of *T. harzianum* and IBA concentrations were found, as well as for each of the factor levels. The root length did not show an increase proportional to the auxin concentration since the treatments with lower average values corresponded to the control and application of 1,200 mg L^{-1} (Tab. 2). This differs from Moreno *et al.* (2009), who observed that, in cape gooseberry treated with 200 to 800 mg L^{-1} IBA, the root length was directly proportional to the hormone concentration. It also contrasts with reports for *Physalis ixocarpa* cuttings, where root length was higher than the control at concentrations of 1,500 and 3,000 mg L^{-1} IBA (García *et al.*, 2001), which shows the largest differences for the effect of this hormone between plant species of the same genus.

The increased root length growth with 800 mg L^{-1} of IBA could be explained by the ability of auxin to decrease the rigidity of the cell wall by acidifying the same, which causes the production of proteins (expansins) that are also involved in cell wall acidification (Taiz and Zeiger, 2010) causing cell growth to increase its volume.

In this sense, Santelices (2007) established that root length is directly proportional to the concentration of IBA. Similar results were obtained by Ruiz-Solsol and Mesén (2010) in *Plukenetia volubilis*, with concentrations of 0.10, 0.15, and 0.20% of IBA, observing the longest roots with 0.20% of IBA.

In the case of the *T. harzianum* suspensions, the highest root length was presented with the suspension of 3·10^6 cfu/mL and the lowest response was obtained with 2·10^6 and 4·10^6 cfu/mL (Tab. 2). This result coincides with the higher accumulation of DM in the plants when the suspension of 3·10^6 cfu/mL was applied (Tab. 2).

Total dry mass

According to the ANOVA, the total DM showed significant differences between the levels of IBA and *T. harzianum*, but not for the interaction between these factors. The plants with 800 mg L^{-1} of IBA accumulated more DM, but without significant differences with the concentrations of 1,600 and 1,200 mg L^{-1} (Fig. 3).

Figure 3 shows that the shoot was the organ that provided the largest amount of DM in the plants, with an average of 40% for all treatments. The dry biomass accumulation of the shoot is associated with FM accumulation and its length. Blythe *et al.* (2004) found that the foliar application of IBA and NAA or the dipping of cuttings in a solution of auxin (4.920 µM IBA + 2.685 µM NAA) resulted in a higher stem length and more shoot formation in *Aglaonema modestum*, *Ficus benjamia*, and *Gardenia augusta*.

Furthermore, the accumulation of DM tended to decrease when the IBA concentration exceeded 800 mg L^{-1}. Similarly, it was observed that the DM was lower than when the hormone was not applied, which means that IBA generally promotes plant growth.

There was a tendency for reduction of the total DM accumulation when increasing the IBA concentration above 800 mg L^{-1}, which is associated with a reduced accumulation, especially in roots, probably because ethylene and ABA can inhibit their growth, because these plant growth regulators may be produced when substantially increased auxin concentrations occur (Hansen and Grossman, 2000).
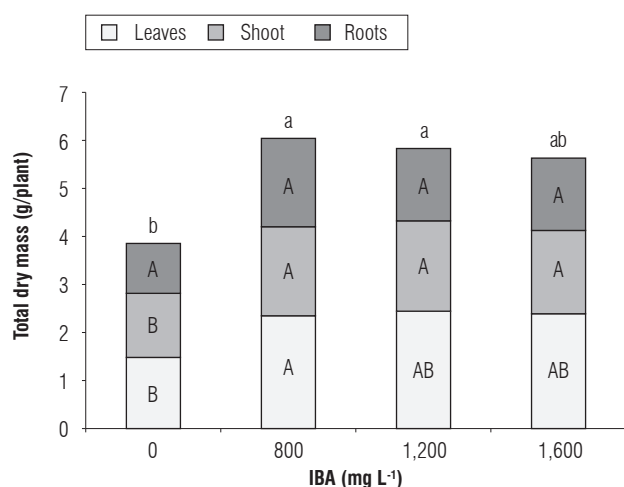
FIGURE 3. Effect of different indole-3-butyric acid (IBA) concentrations on the dry matter accumulation in the roots, stem, leaves, and the whole plant of cape gooseberry developed from apical shoot cuttings. Means with different letters between the plant organs (capital letters) or total plant mass (lowercase letters) indicate significant differences according to the Tukey test ($P \leq 0.05$).

By comparing the different doses of *T. harzianum* with each other, the accumulation of total DM was greater for the treatment of $3 \cdot 10^6$ cfu/mL, showing statistical differences with the dose of $4 \cdot 10^6$ cfu/mL, but not with the control (Tab. 2), which shows that the real growth of the plants, expressed in DM, was not favored by the highest concentration of the fungus but only by a specific population of this *Trichoderma*. This increase in growth, as caused by *T. harzianum,* has been reported by other authors, *e.g.* bean plants increased growth when inoculated with *T. harzianum*, which enhanced the DM and stem length (Hoyos-Carvajal *et al.*, 2009). Also, the fungus concentration of $4 \cdot 10^6$ cfu/mL could have generated competition for nutrients due to its high population, affecting the availability of these nutrients for the plant; also, *T. harzianum* produces enzymes that cause cell wall degradation, not only in the plant but also in the fungus, and that are favored by root exudates (Woo *et al.*, 2007).

In this regard, plant growth depends on many factors, including the environmental conditions to which the plant is subjected. The fungus *T. harzianum* has a strong contact with the roots of plants (Hoyos-Carvajal *et al.*, 2009), increasing their specific area and solubilizing different nutrients, such as phosphorus and nitrogen, and has chelating properties, mainly for Fe and Mnions (Altomare *et al.*, 1999), which favor plant development.

The growth inhibition caused by *T. harzianum* at a certain concentration has been reported in some plants. Cubillos-Hinojosa *et al.* (2009) affirmed that the total DM increased

in passion fruit seedlings (*Passiflora edulis*) propagated from seeds and treated with suspensions of 10^4, 10^6, and 10^8 cfu/mL; however, the speed and the germination percentage were lower with the application of 10^4 cfu/mL of the strain TCC-005-104 of *T. harzianum* than without an application. Furthermore, Sosa *et al.* (2006) found that *Brachiaria decumbens* plants inoculated with *T. harzianum* and arbuscular mycorrhizae showed less DM accumulation than when only *T. harzianum* was applied and argued that this inhibition could be due to factors not considered in the study, such as the host plant of *T. harzianum* strain used, type of substrate and the environmental conditions.

Chlorophyll content

A lower concentration of chlorophyll (SPAD units) was found in the leaves of the treatment of 1,600 mg L^{-1} of IBA, whereas that treatment with 800 mg L^{-1} of IBA showed the highest amount of chlorophyll (Tab. 1). As mentioned above, excess IBA can cause the production of ethylene and ABA, which, along with other plant growth regulators, including jasmonic acid, regulate the expression of certain genes involved in the degradation of chlorophyll (Hansen and Grossman, 2000); so, this ethylene production could be involved in the lowest value of the SPAD units registered in the cape gooseberry plants receiving more than 800 mg L^{-1} of IBA.

The leaf chlorophyll content was not significantly affected by the different *T. harzianum* suspensions (Tab. 2), showing an average of 39.4 SPAD units. The beneficial fungus did not significantly affect the chlorophyll content or, presumably, the photosynthetic activity; nevertheless, it facilitated the absorption of nutrients and water, which makes the overall development of the plant more efficient (Hoyos-Carvajal *et al.*, 2009). This differs from the observation of Lo and Lin (2002) in cucurbits, where the application of native strains of *T. harzianum* increased the chlorophyll content by up to 125%, as compared to the control; this difference could have been due to the species or the methodology used.

Conclusions

The results of the present study showed that IBA promoted the growth (FM, DM, and leaf area) of cape gooseberry plants developed from cuttings and that the application of 800 mg L^{-1} of IBA favored root growth, but IBA concentrations above 800 mg L^{-1} did not promote root growth. The application of $3 \cdot 10^6$ cfu/mL suspensions of *T. harzianum* increased the growth of all plant organs, whereas the most favorable interaction between the two factors,

which increased the growth of the cape gooseberry plants, occurred when 800 mg L^{-1} of IBA and *T. harzianum* at a concentration of 3·10^6 cfu/mL were applied.

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