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Scientific Article

Propagation of *Streptosolen jamesonii* (Benth.) Miers by stem cutting treated with IBA in different substrates

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Abstract

The mamalade shrub [*Streptosolen jamesonii* (Benth.) Miers] is an ornamental species with great potential of use in gardens. These plants have an intense contrast of colors among the flowers and leaves, being the blooming in all seasons during the year. The propagation of this species is mainly by using stem cuttings, besides the vegetative propagation of mamalade is still poorly known. Thus, knowledge about auxins and substrates for rooting may be important for the cultivation and increase the popularization use of these plants for garden purposes. Therefore, this study aimed to evaluate the effect of indolbutiric acid (IBA) and substrates on stem rooting and quality of marmalade bush plants shoot production. The experimental design was completely randomized, in a 5x3 factorial scheme, with 8 replications and one stem per plot. The A Factor consisted of 4 concentrations of IBA 500; 1000; 2000 and 3000 mg L-1 and control (only distilled water). The B factor consisted of the substrates: vermiculite, sand and one commercial -Plantmax®. The herbaceous cuttings were standardized by length, measuring 10 cm with 6 leaves. The treatment was performed submerging the base of the cutting, 3 cm, in an IBA solution for 1 min and then planted in the tested substrates. After 30 days, there were evaluated the percentage of rooting and surviving of the cuttings, number of roots and shoots, length of roots and shoots; length of roots and shoots, and fresh weight of roots and shoots. The IBA concentrations or the substrates do not affect the rooting or survival of the cuttings, however, better quality plantlets are obtained in cuttings treated with 750 to 1456 mg L-1 IBA using the commercial substrate Plantmax®, showing the highest number of roots and the better root and shoots development.
Keywords: asexual propagation, auxin, floriculture, landscaping, ornamental bush.

Resumo

Propagação de *Streptosolen jamesonii* (Benth.) Miers por estacas caulinares tratadas com IBA em diferentes substratos

O arbusto de mamalade [*Streptosolen jamesonii* (Benth.) Miers] é uma espécie ornamental com grande potencial de uso em jardins; estas plantas têm um intenso contraste de cores entre flores e folhas e sua floração ocorre em praticamente todas as estações do ano. Esta planta é propagada principalmente por estacas de caule, mas a propagação vegetativa desta planta ainda é pouco conhecida. O conhecimento sobre as ações de auxinas e substratos no enraizamento de estacas pode ser útil para o cultivo e promoção da popularização dessas plantas para fins de ornamentação de jardins. Por isso, objetivou-se nesse trabalho avaliar efeito do uso de ácido indolbitírico (IBA) e substratos sobre o enraizamento de estacas caulinares do arbusto marmelada. Os tratamentos foram arranjados em esquema fatorial (5x3) no delineamento inteiramente casualizado, com oito repetições, com uma estaca por repetição. O fator A foi constituído de quatro concentrações de IBA: 500 mg L^{-1}; 1000 mg L^{-1}; 2000 mg L^{-1} e 3000 mg L^{-1}, mais uma testemunha 0 mg L^{-1} (água destilada sem IBA); o fator B constituiu-se dos substratos vermiculita, areia e substrato comercial Plantmax®. A unidade amostral foi constituída de uma estaca herbácea padronizada com 10 cm de comprimento e seis folhas. O tratamento do caule consistiu em submergir os 3 cm basais durante 1 min na solução contendo IBA, sendo posteriormente estaqueadas nos substratos vermiculita, areia ou substrato comercial. Após 30 dias do estaqueamento foram avaliados a porcentagem de enraizamento e sobrevivência de estacas, o número de raízes e brotações, o comprimento das raízes e das brotações e o peso fresco das raízes e brotações. As doses de IBA ou os substratos não afetam o enraizamento ou a sobrevivência das estacas, no entanto mudas de melhor qualidade são obtidas em estacas tratadas com 750 a 1456 mg L^{-1} IBA em substrato comercial Plantmax® onde o maior número de raízes e o maior desenvolvimento de raiz e novas brotações são obtidos.
Palavras-chave: Propagação assexuada, arbusto ornamental, auxina, paisagismo, floricultura

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Introduction

Aesthetic elements such as shape and color are important for landscape composition, so mastering techniques of propagation and cultivation of little known plants is essential to enlarge the possibility of new compositions in gardens (Siqueira, 2017). Among new proposals for landscape composition is the marmalade bush [*Streptosolen jamesonii* (Benth.) Miers] stand out by the beautiful contrast between their flowers and leaves whose flowering occurs practically in all seasons of the year (Lorenzi, 2008). *Streptosolen jamesonii*, is unique species from *Streptosolen* genera, belonging to Solanaceae Family; is a native plant from Equator, Peru and probable South of Colombia (Hunziker, 2001). Marmalade bush is, in Brazil, used as ornamental plants in gardens or parks. These plants have shrubby habit of fast-growing; they produce orange flowers with lots of nectar, which are very attractive to birds and other animals (Haynes et al., 2004; Betancour et al., 2008).

Marmalade bush has potential for use as a cutting having up to 26 days longevity, however, the irregular growth of cut flowers has still limited their use for this purpose (Bredmose, 1987). These plants have been most commonly grown in gardens because of contrasting of orange flowers and green leaves. marmalade bush can be used in garden an isolated plant, in borders or massive plants. It is recommended cultivate on well-drained soil being and more indicate to regions where frost doesn't occur (Lorenzi, 2008).

To propagation of marmalade bush the stem cuttings should be harvested after flowering. The propagation by cutting is considered a traditional methodology of propagation, used for many ornamental plant species, but the rooting is dependent of internal and external factors to propagative material (Barbosa et al., 2007). Among these factors, it is possible to highlight a presence of rooting inductors and substrate used.

The auxin is a class of plant hormones that promotes rooting of stem cuttings; however, for some species produces low levels of auxins limit the propagation by cutting being treat the propagules with exogenous growth regulator to improvement the rooting (Pizzatto et al., 2011). The pattern of auxin action, although important on role in adventitious root development, is still poorly understood, therefore, studies on molecular biology and gene expression has been performed to elucidate the mechanism of action of hormones (Pop et al., 2011; Bielach et al., 2012). However, it is well known that auxins are required in the initial phases of the root formation involving the reactivation of cell division in cells not directly involved in the formation of root meristemoids (De Klerk et al., 1990; Altamura, 1996; Pop et al., 2011).

The rooting cut of ornamental plants can be affected by physical properties of substrate such as porosity, density and water retention capacity; this characteristics can be limitations factors on vegetative propagation causing physical restrictions to emissions and growing of roots (Barbosa and Lopes, 2007; Pêgo et al., 2016). In another hand, chemical characteristics as pH should be affect the roots production in stem cutting because a low pH as the high pH induces over callusing and may delay rooting in the nursery plants (Hamid et al., 2006).

The treatment with IBA often stimulates rooting and enables high-quality cuttings, since a quality root system is essential for the establishment of seedlings in the field and adequate plant development (Silva et al., 2012; Véras et al., 2017). Plant quality can also be influenced by substrate quality that provides adequate physical and chemical characteristics (Kämpf, 2000).

Although this plant has been used for the ornamental purpose, low information on the efficiency of growth regulators and rooting in substrates is found. Therefore, this work aimed evaluated the effect of indolbutiric acid (IBA) and substrates on stem rooting and quality of Marmalade bush.

Material and Methods

Apical herbaceous cuttings were obtained from healthy marmalade bush mother-plants in vegetative stage. The cutting were selected standardized by of length of 10 cm, maintain six leaves and 3 to 4 mm of diameter. The experiment was carried out in the months of May and June, equivalent to the autumn-winter season when the parent plants, about 3 years old, were closing the flowering.

The treatments were arranged in a factorial scheme (5x3) in the completely randomized design, with eight replications. Factor A consisted of four concentrations of indolbutyric acid (Sigma Aldrich Chemical®): 500 mg L^{-1}; 1000 mg L^{-1}; 2000 mg L^{-1} and 3000 mg L^{-1} and a control 0 mg L^{-1} (distillated water without IBA) totaling five treatments. The B factor was constituted of substrates: vermiculite, sand and commercial substrate whose physical and chemical proprieties were showed in table 1.

Table 1. Wet density (WD), dry density (DD), water retention capacity (WRC) (water (g)/substrate (g)), pH and electrical conductivity (EC) of substrates.

Substrates	WD (Kg m^{-3})	DD (Kg m^{-3})	WRC	pH	EC (mS cm^{-1})
Vermiculite	145.3	136.2	4.5	6.5	0.10
Commercial	490.0	470.0	3.3	5.8	2.20
Sand	1413.5	1382.4	0.3	6.7	0.11

The treatment was performed submerging the base of cutting, 3 cm in length, in solution of IBA for 1 min in the solution containing IBA and disposed in substrates vermiculite, sand or commercial substrate, according to treatments. The cuttings were placed to rooting in trays with 128 cells filled with each substrate and kept in a chamber, with a 50% shade mesh at 1.0 m height, with intermittent periods of spraying each six seconds with interval of 12 min. The average temperature during the rooting was approximately 28 °C.

After 30 days were evaluated the percentage of rooting and surviving of cutting, number of roots and shoots, length of roots and shoots, fresh weight of roots and hoots. The results were submitted to analysis of variance at 5% of probability using the Sisvar statistic program and the graphics were plotted using the Sigmaplot statistical program.

Results and Discussion

There was no significant difference on the percentage of rooting and survival of cuttings between the doses of IBA or substrates tested. On average, 95% of rooted cuttings and 95% of survival were obtained at the end of 30 days of propagation. No significant interaction between treatments was observed. This shows that marmalade bush present any restrictions to the rooting of cuttings.

The highest number of roots was obtained in stem treated with IBA 1456 mg L^{-1} in vermiculite reaching about 59 roots per stem cut, while the maximum of 45 roots were formed in the cuttings treated with IBA 1400 mg L^{-1} when maintained in commercial substrate (Figure 1). In average 52 roots was obtained in stem cut rooting in sand when they was treated with 1376 mg L^{-1} of IBA.

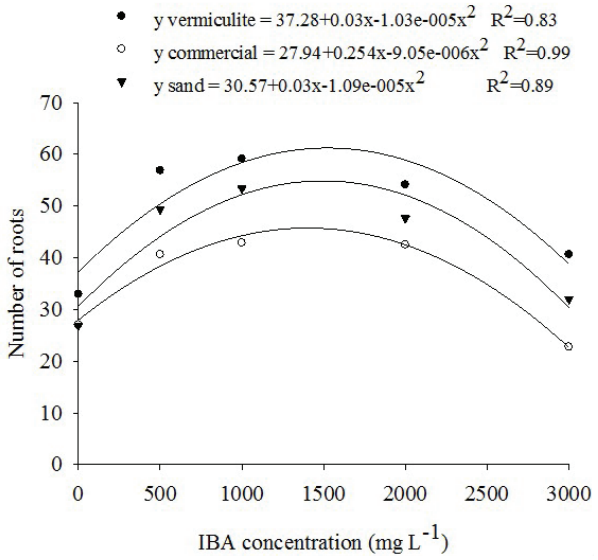

Figure 1. Number of roots per cuttings of marmalade bush treated with indolbutyric acid (IBA) in different substrates.

It can be observed that the process of rooting of marmalade bush cuttings is improved by the treatment of these vegetative propagules with auxin, however, high doses of this growth regulator affect negatively the root production (Hartmann et al., 2002). The lower growth of associations may promote the production of plants with less vigor and thus compromise a quality of planting making it the longest production period or one of a lot of heterogeneous plants.

The auxins present interesting biological functions to production of ornamental plants; one of them is the rooting of cuttings. These phytohormones improve the rooting of cuttings of different plant species such as hibiscus (*Hibiscus rosa-sinensis* L.), roses (*Rosa caninna* L.), chrysanthemum (*Chrysanthemum morifolium* L.) and goldenrod (*Solidago canadensis* L.) among outers (Barbosa et al., 2005; Pizzatto et al., 2011; Muniz et al., 2015, Mehrabani et al., 2016). The roots formation in cuttings dependent of concentration

of auxin content, however the effect can be optimized in synergism with others components as, for example, carbohydrates, diphenyls and ethylene (Henrique et al. 2006). Auxins act on cambium or parenchyma of the stem cuttings starting the cellular division and the emission of root primordia when used in the suitable concentrations (Barbosa and Lopes, 2007).

The type of substrate can affect the roots development in general the densities between 250 and 800 kg m^{-3} are suitable for the cultivation of ornamental plants (Kämpf, 2000). Although, in this research, the sand has extrapolated the recommended values, its higher density does not seem to be a barrier to the emission of new roots in marmalade bush cuttings.

There was no significant difference between substrates to roots growing in length. However, treatment of cuttings with IBA up to maximum 750 mg L^{-1} promoted root growth by 7% when compared to untreated cuttings, from 8.2 cm to 8.9 cm, respectively (Figure 2). It was observed, however, IBA concentrations above 1500 mg L^{-1} caused detrimental affected on root growth in length because these roots were shorter.

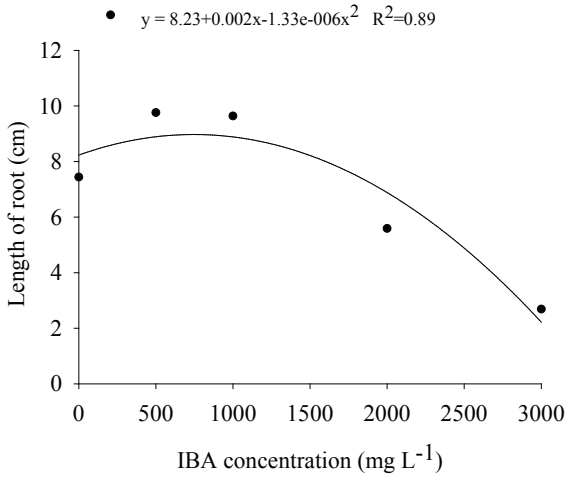

Figure 2. Length of roots of cuttings of marmalade bush treated with indolebutyric acid on different substrate.

According to the results, the development of the marmalade bush roots is more dependent of growth regulators concentrations than substrates tested; even there are significant differences of the density and electric conductivity of the substrates used, indicating that this plant is rustic and vigorous to root emission. This fact is important because one of the principles of the use of substrates in floriculture is that it should be low cost and easily accessible to favors its establishment as a commercial ornamental plant (Barbosa and Lopes, 2007).

The shooting o of marmalade bush cuttings treated with IBA was negatively affected by increasing of concentration, independent of substrate used; the reduction of shooting was in up to 54%, 70% and 81% when the highest concentrations , up to 3000 mg L^{-1}, was used compared to the untreated cutting (Figure 3). Untreated stem cuttings produced more shoots when kept in commercial substrates and stem cutting with few shoots observed in vermiculite. The sand made possible had intermediate values.

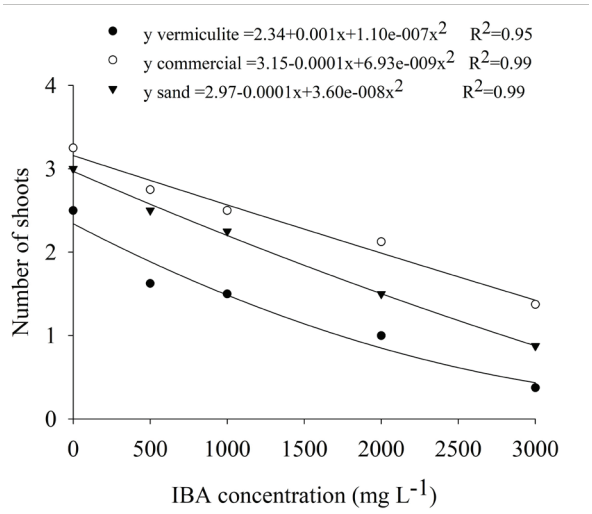

Figure 3. Number of shoots of cuttings of marmalade bush treated with indolebutyric acid (IBA) in different substrates.

The inhibition of shoots emission with increased exogenous auxin concentration in marmalade bush stem may have been limited by the effect similar to apical dominance and, consequently, the inhibition of lateral shoots development which auxin presents (Taiz and Zeiger, 2013). Moreover, excessive concentrations of auxin may inhibit shoot proliferation or over-favoring rooting if combined with outers growing regulators as cytokines (Grattapaglia and Machado, 1998).

The length of the new shoots were significantly affected by IBA concentration and substrate used. The highest shoots, with a maximum length of 1.6 cm, were obtained on commercial substrates when the cutting was treated with approximately 900 mg L^{-1} of IBA (Figure 4). In the vermiculite and sand substrates, the largest shoot produced was less than 0.8 cm, regardless of the concentration of IBA used.

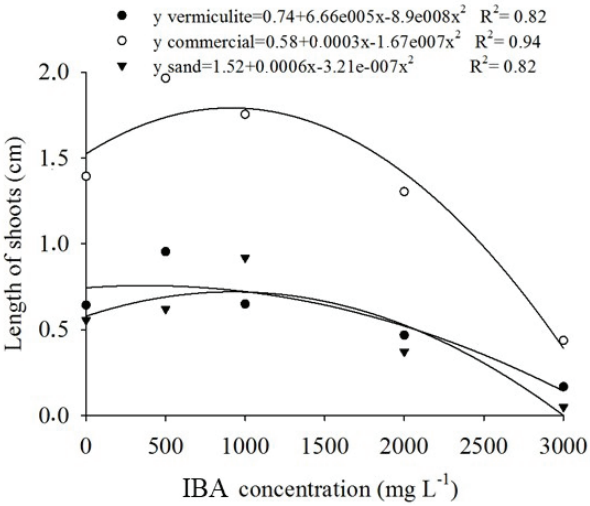

Figure 4. Length of shoots of cuttings of marmalade bush treated with indolebutyric acid (IBA) in different substrates.

The influence of commercial substrate on shoot height development can be occurred due to composition based of moisture of peat of pinus, peat soil enrichment with mineral nutrients that provided chemical nutrition to initial development of plants while the vermiculite and sand are, basically, inert material. The adequate values for total soluble salts of substrate, measured by means of the electrical conductivity, are between 0.75-2.0 mS cm^{-1}, however the vermiculite and sand presented lowers values than these (Ballester-Olmos, 2013). Although the substrates sand and vermiculite have physical properties that allow the propagation of many species, in this work only the commercial substratum presented values within the range of the recommended values that is of 250 and

800 kg m^{-3} (Kämpf, 2000), which may have contributed to the best shoots development.

There was no significant effect of the substrates for the fresh weight of the marmalade bush stem roots. The production of 0.70 g of roots was obtained in cuttings treated with IBA 1293 mg L^{-1} (Figure 5). As with root length, it appears that the fresh weight root was also affected in high concentrations of auxins.

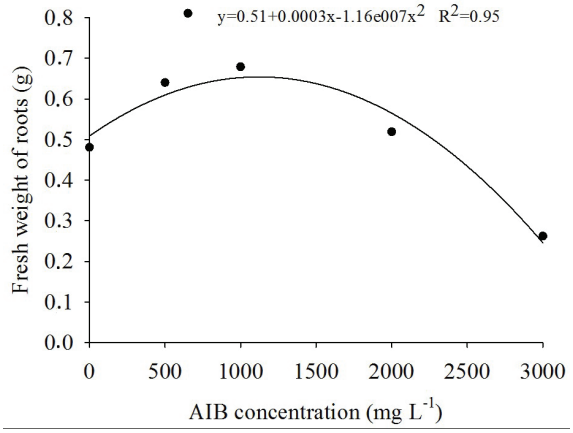

Figure 5. Fresh weight of roots of cuttings of marmalade bush treated with indolebutyric acid (IBA) in different substrates.

There was no significant difference between the substrates for new shots fresh weight. On average, the highest fresh weight of shoots was 0.22 g obtained from cuttings treated with 315 mg L^{-1} of IBA (Figure 6). There was a reduction of fresh weight of shoots with the increasing IBA concentrations; winch reached a maximum of 0.02 g in stem cuttings treated with 3,000 mg L^{-1}.

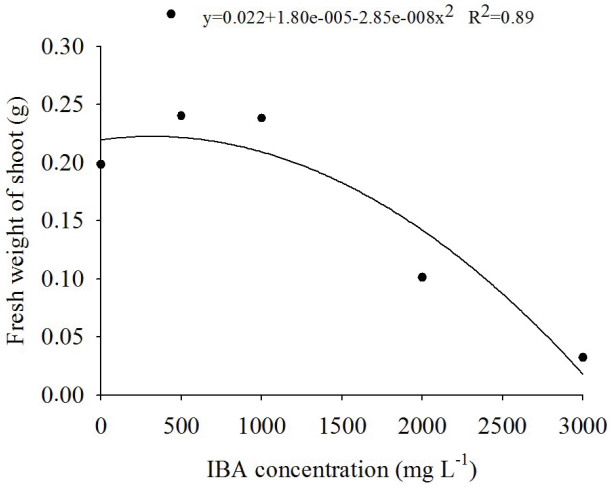

Figure 6. Fresh weight of roots of cuttings of marmalade bush treated with indolebutyric acid (IBA) in different substrates.

The greater weight of shoots formed in marmalade bush is more dependent on the number of shoots formed than the length in height; this can be explained due the difference between the largest and the smallest bud was approximately 0.5 cm. The production of plant biomass is an important indicator of quality of plantlets consisting of the accumulation of new organs developed during propagation. In the case of ornamental plants, this parameter is especially important because the aesthetic characteristic and vigorous establishment of plants are required in landscaping projects.

This study shows important information about the propagation of marmalade bush, presenting viable means of propagation of this plant that will allow the optimization of the asexual multiplication of this ornamental plant and its commercial production as plants for landscaping.

Conclusions

The IBA concentrations or the substrates do not affect the rooting or survival of the cuttings, however, better quality young plants are obtained when the cuttings are treated with 750 to 1456 mg L^{-1} IBA in commercial substrates. In this condition is obtained highest number of roots in stem cutting which allows the production of high quality plantlets due the greater development of root and more shoots.

Author Contribution

R.G.P. 0000-0002-2122-6442: Responsible to proposed the idea that originated the work and elaborate hypotheses; structured the methodology, coordinated and wrote the manuscript. **A.F.L.M.** 0000-0001-6506-9728, **C.V.A.F.** 0000-0002-7787-4481: Review the literature, present important suggestions incorporated into the work **M.V.S.G.** 0000-0001-8201-7401**:** Collected data and performed the routine work.

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