Rooting Enhancers in The Production of Bougainvillea Seedlings (*Bougainvillea Sp.)*

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ABSTRACT

This work aimed to evaluate the effect of different rooting enhancers on the development of Bougainvillea cuttings (Bougainvillea spetabilis Willd), aiming to accelerate rhizogenesis for seedling production. Semi-hardwood cuttings standardized in fifteen centimeters in length and diameter of approximately one centimeter were used. After collected, one third of the basal part of cuttings was immersed according to the following treatments: water (control); commercial product (RADIMAXi 20® at concentrations: Ca 25.6%, S 1.8%, Zn 2.5%, Co 1.5%); coconut water (Cocos nucifera L.); Tiririca extract (Cyperus rotundus L.) and Lentil extract (Lensculinaris Medik), for about two seconds. After immersion, cuttings were planted in polyethylene bags filled with 50% of Carolina Soil® commercial substrate and 50% of washed sand, packed under screen (50%) with a micro sprinkler irrigation system. The experimental design used was completely randomized, with five treatments and ten replicates. Results were submitted to analysis of variance and the means of treatments to Student's t test at 5% probability. Evaluations were carried out at 45 days after installation and variables analyzed were: number of sprouts per cutting, length of the largest sprout, percentage of rooted cuttings and non-rooted live cuttings, length of the largest root, fresh and dry matter of roots, fresh and dry matter of shoots. Treatments that showed statistical difference were lentil extract, with the highest number of sprouts and the highest percentage of rooted cuttings and non-rooted live cuttings, and treatment with coconut water obtained the highest result in relation to variable length of the largest sprout, standing out as a promising sustainable alternative in the vegetative production of Bougainvillea seedlings.

Keywords: Plant extracts; floriculture, propagation of ornamental plants; rhizogenic process.

1. INTRODUCTION

Floriculture is an important economic activity in agribusiness due to social, cultural and ecological function [1]. In the last five years, the ornamental plants segment has grown significantly, as this segment of horticulture is no longer seen only as an aesthetic issue, but also as a synonym for well-being and quality of life [2].

In Brazil, among the species of ornamental plants, Bougainvillea (*Bougainvillea spectabilis* Willd), belonging to the Nyctaginaceae family, also known as três-marias, ceboleiro, santa-rita, espinho-de-santa rita, is a popular ornamental plant grown in many parts of the world in tropical and subtropical gardens for its colorful bracts of red, pink, yellow and white flowers [3] [4]. In addition, its leaf extract has shown medicinal properties of anti-inflammatory [5] and hypoglycemic activity in diabetic rats [6].

Bougainvillea is considered a rustic plant with low demand for cultural treatments; it is a climbing plant with trunk protected by strong thorns that branch every year, growing in a disorderly manner, reaching up to 9 m in height [7].

The production of seedlings of this species can be made using propagating methods [8], and cutting is the most used technique for commercial production [9] [10]. However, the species has low rooting rates [11] [12] [13].

The difficult rooting of some species can be explained by the fact that cuttings do not have sufficient reserves of rooting cofactors required for this process [14]. For this reason, developing propagation techniques and improving them aiming at the production of better quality seedlings and greater uniformity are of great importance to make commercial cultivation feasible [10]. In this sense, non-conventional and natural rooting-inducing plant regulators are promising options for the production of seedlings in a sustainable and economic way.

Thus, the aim of this study was to evaluate the effect of synthetic and natural rooting enhancers on Bougainvillea cuttings (*Bougainvillea spectabilis* Willd.), searching for alternatives for the production of healthy and quality seedlings.

2. MATERIAL AND METHODS

The experiment was carried out in an agricultural greenhouse of Pad & Fan type, belonging to the Faculty of Agricultural and Technological Sciences - FCAT / UNESP, located in the municipality of Dracena / SP, whose geographical coordinates are 21° 28'57 ”S and 51 ° 31'58 ”W and 421 m a.s.l.

The climate is classified as Subtropical cwa (mild, dry winters followed by very hot summers) [15] with average annual temperature of 23.6 ° C.

Semi-hardwood *Bougainvillea spectabilis* Willd cuttings were collected in the winter period from mother plant with purple colored flowers, located at Rodovia Comandante João Ribeiro Barros, km 653 in the municipality of Dracena - SP, standardized with 15.0 centimeters in length and 1.0 cm in diameter.

The experimental design used was completely randomized, with 10 replicates per treatment and 5 treatments: T0 - water; T1 - Radimaxi 20® commercial product (concentrations: Ca 25.6%, S 1.8%, Zn 2.5%, Co 1.5%), diluting 3 tablets per liter of water, as indicated by the manufacturer; T2 - fresh liquid endosperm (*Cocos nucifera* water); T3 – *Cyperus rotundus* L. extract (Tiririca); and T4 - lentil extract (*Lensculinaris* Medik).

For treatment 2, coconut water extracted from fresh green coconut was used on the day the experiment was implemented. For treatment 3, 100 g of *Cyperus rotundus* L. and leaves, roots and bulbs were collected, which were washed and crushed in blender containing one liter of water. In treatment 4, 500 g of lentil seeds were previously weighed, placed to germinate in 2 liters of water and after germination, seedlings were ground in blender with water.

The basal third of cuttings was immersed in rooting enhancers for two seconds and placed in polyethylene bags measuring 15 x 30 cm (diameter x length) filled with 50% Carolina Soil® commercial substrate and 50% washed sand, packed in greenhouse with screen (50%) with micro sprinkler irrigation system, ten times a day at flow rate of 118 liters per hour.

Forty-five days after cutting, the following morphological analyses were performed: percentage of non-rooted live cuttings (EVNE) and rooted cuttings (EE); number of sprouts (NB): healthy sprouts were those larger than one centimeter; length of the largest sprout (CMB) and the largest root (CMR) (mm); fresh (MFR) and dry matter of roots (MSR) (g); as well as fresh (MFPA) and dry matter of shoots (MSPA) (g). For fresh matter, samples were weighed on precision scale (0.01g) and subsequently packed in paper bags and taken to oven with forced air circulation for drying at 65 ° C for 48 hours until reaching constant weight to obtain dry matter.

Data were analyzed using the SISVAR 5.6 software [16]. The normality hypothesis was tested by the Shapiro-Wilk test and analysis of variance was performed by the F test (5% probability) to detect differences among treatments. When significant difference was found for each variable, the Tukey test (5% probability) was performed to compare means.

3. RESULTS AND DISCUSSION

TABLE 1: Number of sprouts (NB), percentage of non-rooted live cuttings (PENE), percentage of rooted cuttings (PEE), length, in centimeters, of the largest sprout (CMB) and the largest root (CMR) and bougainvillea cuttings with different rooting enhancers. UNESP, Dracena - SP, 2019.

SOURCES OF VARIATION	NB	PENE (%)	PEE	CMB	CMR
	Mean Square				
Rooting enhancers	0.9343*	1500.00*	1000.00*	1564.2554*	719.0144NS
CV (%)	39.00	23.57	35.36	42.93	52.74
Rooting enhancers	Means				
Water	2.10 B	60.00±18.71 B[1]	60.00±18.71B[1]	58.92±11.04 AB	55.85±15.57
RADIMAXi 20	3.50 AB	100.00±0.00 A	90.00±10.00A	57.96±6.52 AB	60.28±10.11
Coconut water	3.50 AB	90.00 ±10.00 A	70.00±12.25AB	74.22±11.35 A	79.57±11.25
Tiririca extract	2.90 AB	100.00±0.00 A	90.00±10.00A	54.52±7.71 AB	60.99±11.98
Lentil extract	4.00 A	100.00±0.00 A	90.00±10.00A	38.22±4.32 B	75.78±17.01
General average	3.2	90.00	80.00	56.23	67.32

* Significant and NS not significant by F test at 5% probability. [1] Means with the same capital letter in the column do not differ by the Tukey test at 5% probability.

Table 1 shows that the vast majority of variables analyzed differed statistically from each other, and for variable number of sprouts, it appears that it was higher for bougainvillea cuttings treated with lentil extract, with average of 4 sprouts per cuttings, almost double in relation to control, which had average of 2.1 shoots per cuttings, thus obtaining the lowest average in relation to the other variables analyzed.

The presence of leaves in semi-hardwood cuttings is essential for the formation of new roots, since the production of carbohydrates by photosynthesis occurs in leaves, in addition to auxins and other substances necessary for rooting [17].

In addition, sprouts are very important since natural auxin is produced in leaves and buds, and naturally moves to the bottom of the plant, increasing its concentration at the base of the cut, along with sugars and other nutritious substances. In many ornamental plants, rooting is maximized by the application of auxins [18].

In variable percentage of non-rooted live cuttings (PENE) and percentage of rooted cuttings (EE), cuttings treated with regulators did not show statistical difference from each other, but presented better results in relation to control, being statistically different from it. Table 1 shows that control presented 60% PENE and the same percentage for PEE, and treatments obtained average percentage between 90% to 100% PENE and 70% to 90% PEE, and treatments consisting of commercial product and lentil and tiririca extracts stood out.

The process of root formation in cuttings may be related to the growth regulator. Indole-acetic substances (IAA), a specific plant regulator for root formation, act on apical stem growth, cell membrane division, cell elongation and formation of adventitious roots in cuttings and other explants [19]. Works with alternative rooting enhancers in the rooting of *Spondias* cuttings observed high leafing levels in cuttings treated with lentil extract [20], presenting superior result in relation to the number of shoots when compared to indul-butyric acid used, concluding that lentil extract resembles synthetic auxin, corroborating data found in the present study.

Table 1 also shows statistical difference among treatments for variable length of the largest sprout (CMB), where cuttings treated with coconut water were those that showed the highest results, with averages of 74.22 cm.

The sprouting of vegetative propagules may be correlated with factors intrinsic to the plant material, such as the concentration of phytohormones and carbohydrates in branches [9]. The capacity to provide carbohydrates necessary for the growth of roots and sprouts is greater in woody or basal cuttings [21]. Therefore, these cuttings present optimal conditions in relation to the energy source used for the maintenance of metabolic activities in the plant.

In addition, coconut water contains mineral salts, myo-inositol and cytokinin (s), as well as nucleotides [22]. It also has micronutrients such as inorganic ions and vitamins, which play a vital role in helping the antioxidant system of cells [23], thus being able to provide nutrients for the development of sprouts.

As for the length of the largest root, the highest values may be related to the higher endogenous concentration of sugars and hormones [24], which may have occurred with the use of coconut water and lentil extract, which despite not statistically differing from the other treatments, presented the highest values.

The development of the root system is due to the accumulation of carbohydrate reserves, correlating rooting and the survival of cuttings, because auxin requires a carbon source for the biosynthesis of nucleic acids and proteins [25].

TABLE 2: Fresh matter (MFPA) and dry matter (MSPA) of shoots and fresh matter (MFR) and dry matter (MSR) of roots, in grams, of bougainvillea cuttings with different rooting enhancers. UNESP, Dracena - SP, 2019.

SOURCES OF VARIATION	MFPA	MSPA	MFR	MSSR
	Mean Square			
Rooting enhancers	0.9739NS	0.0339NS	2.4958NS	0.0222NS
CV (%)	54.92	46.35	104.22	84.35
Rooting enhancers	Means			
Water	1.42±0.37	0.29±0.05	0.19±0.03	0.22±0.13
RADIMAXi 20	1.23±0.17	0.26±0.02	0.99±0.37	0.15±0.03
Coconut water	1.75±0.37	0.34±0.06	1.79±0.60	0.17±0.05
Tiririca extract	1.13±0.16	0.23±0.07	0.33±0.09	0.06±0.01
Lentil extract	0.89±0.09	0.18±0.02	1.01±0.22	0.19±0.05
General Average	1.26	0.26	0.93	0.15

* Significant and NS not significant by F test at 5% probability. [1]Means with the same capital letter in the column do not differ by the Tukeya test 5% probability.

Regarding the average fresh matter of shoots (MFPA), fresh matter of roots (MFR), dry matter of shoots (MSPA) and dry matter of roots (MSR) of Bougainvillea (*Bougainvillea spectabilis* Willd), no statistical differences among treatments were observed, as shown in Table 2, but it was observed that treatment with coconut water obtained the highest averages, with the exception of fresh matter of roots (MFR), which obtained the second highest average, only behind commercial product.

The stimulatory effect of coconut water can be explained by the high levels of sugars, sugar alcohols, lipids, amino acids, nitrogen compounds, organic acids and enzymes, which perform different functions in plant systems due to their distinctive chemical characteristics [26]. Coconut water, as it is a natural substance with high zeatin levels, may become a component that successfully replaces synthetic zeatin [27]. Zeatin is the main cytokinin found in vegetables, which function is related to cell division [28].

Regarding the *Cyperus rotundus* L extract, even having phytohormone action, it did not present statistical difference in any of varieties analyzed under the conditions of this experiment. *Cyperus rotundus* L has high level of IBA hormone, specific for root formation, being an important hormone for rooting [29].

C. rotundus has high level of indolbutyric acid hormone (IBA), which are plant regulators responsible for root formation [30]. In tubers, they have large amount of IAA, apparently much more than in other herbaceous species.

However, it was found that *C. rotundus* tuber extract did not improve the rooting of *Duranta repens* L. stem cuttings [31]. It was also found that the use of *C. rotundus* leaf and tuber extract does not have significant effects on *C. citriodora* rhizogenesis, corroborating the results in the present study [32].

Thus, under the conditions in which this study was carried out, an improvement in the rooting of Bougainvillea cuttings (*Bougainvillea spectabilis* Willd) was observed, highlighting lentil extract and coconut water treatments as a promising sustainable alternative in the vegetative production of Bougainvillea seedlings.

4. REFERENCES

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