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An Investigation of Indole Butyric Acid Effects on Growth and Development of Dwarf Bougainvillea

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Abstract

Plant growth regulators play a crucial role in various aspects of plant propagation and development. Synthetic auxins, such as IBA, are widely used to promote root development in stem cuttings. This study was conducted to evaluate the effects of different concentrations of IBA (0, 500, 1000, 1500, and 2000 ppm) on the successful cuttings percentage, days for leaf sprouting as well as shooting and rooting characteristics. Soaking stem cutting with IBA led to decreasing days for leaf sprouting and increasing success cutting percentage, plant height, stem diameter, number of branches and leaves, root length as well as fresh and dry weights of shoot and root. All those characteristics significantly increased with increasing IBA levels, and the highest values have been observed when cutting treated with IBA at 2000 ppm. The results of this study recommend soaking bougainvillea stem cutting with IBA at 2000 ppm for two hours to ensure the success of rooting and to obtain greater vegetative and root system growth in the long term for the plant.

***Keywords*:** IBA; Bougainvillea; leaf sprouting; stem cutting; shooting and rooting

Introduction

Plant growth substances refer to natural or synthetic compounds that can modify or control the growth and maturation of plants through physiological actions. Phytohormones, also known as plant hormones, are compounds produced within the plant that classified into five major classes: auxins, cytokinins, gibberellins, ethylene, and abscisic acid [1]. Plant growth regulators (PGRs) play a crucial role in various aspects of propagation, such as vegetative propagation, seed treatment,

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in vitro and *in vitro* rooting of ornamental plants [2, 3].

Among PGRs, auxins are a class of plant hormones that are vital for growth and development [3]. Auxins are produced in the shoot and root apices, which are responsible for promoting growth along the longitudinal axis of the plant. Auxins are distributed throughout the plant, and particularly abundant in the growing tips of plants including coleoptile tip, buds, root tips, and leaves [2]. Indole Acetic Acid (IAA) is the only naturally occurring auxin in plants. While synthetic auxins such as Indole Butyric Acid (IBA) and Naphthalene Acetic acid are also used to promote root development in stem cuttings and in vitro rooting [2].

IBA is a naturally occurring auxin and is second only to IAA in terms of abundance. In many plant species, IBA is known to be converted into IAA. Due to its high rooting capacity, IBA is the most commonly used auxin hormone. However, unlike IAA, it is not degraded during long-distance transport [4].

Bougainvillea is a genus of flowering plants that is indigenous to South America, and was initially discovered in Brazil in 1778 by Commerson, a French botanist. *Bougainvillea* is a woody evergreen vine that grows as a climber, spreads horizontally or hangs downwards with arching canes. It can grow up to 12 meters tall, and is armed with stout spines in its stem. It belongs to the Nyctaginaceae family that has a significant value as an ornamental plant, and has 10 species, of which *B. spectabilis*, *B. glabra*, and *B. peruviana* are the most significant from a horticultural perspective [5]. The leaves of *Bougainvillea* are simple, alternate, and come in a variety of shapes, including roundish, ovate, or elliptic-lanceolate. *Bougainvillea* is renowned for its three brightly colored, petal-like bracts, which make it a sought-after ornamental shrub with profuse branching, making it ideal for landscape gardening [6].

Propagation by stem cuttings is a widely used technique for producing ornamental shrubs. However, the success rate of this method is highly dependent on the rooting capacity of the cutting. The appropriate use of the hormones can significantly increase the success rate of rooting and ultimately lead to the successful propagation of ornamental shrubs. The objective of this study was to compare the effect of different concentrations of IBA on the stem cuttings of the ornamental shrub dwarf bougainvillea, *Bougainvillea glabra*.

Materials and methods

The present study was carried out during the two successive seasons of 2021/2022 and

2022/2023 at Floriculture Nursery, Faculty of Agriculture and Natural Resources, Aswan University, Aswan, Egypt (23°59'53.0"N 32°51'29.5"E). The main objective was to examine the effect of growth regulator (IBA) on rooting and shooting of hard-to-root ornamental shrub; dwarf Bougainvillea. Five concentrations of IBA were used; control, 500 ppm, 1000 ppm, 1500 ppm, or 2000 ppm according to [7]. The experiments were designed using a completely randomized design with three replicates and each replicate consisted of 10 pots.

Stem cuttings preparation and planting

Healthy mother plants of dwarf Bougainvillea grown at Floriculture Nursery, Faculty of Agriculture and Natural Resources, Aswan University, were used as a source of stem cuttings. On Feb 25th of 2021 and 2022 seasons, the stem cutting had been taken from middle part of one-year-old branches of species. These cuttings had uniform length (15 cm long) and mean thicknesses of 1.5 cm. The base of stem cuttings was soaked in IBA solution for two hours before planting. The stem cuttings were planted in plastic pots of 15 cm diameter filled with a mixture of peat moss and perlite (1:1 in v/v). The experiment consisted of three replicates, and each plot consisted of 10 pots, with total of 300 pots for each season.

Growth characteristics

One year after planting, cutting were dug up and cleaned, and then the shoot and the root were separated. The data were collected in the end of February for both seasons and the following data were recorded: Percentage of success cuttings, days for leaf sprouting, plant height, stem diameter, number of lateral branches, number of leaves, root length, fresh weight of shoots and roots as we as dry weight of shoots and roots.

Statistical analysis

Obtained data was subjected to statistical analysis using “F” Test [8], and the means were compared using a least significant difference (L.S.D.) test according to [9]. Statistical analysis was performed using Microsoft Office 365 Excel program.

Results

Analysis of Variance showed significant effect of IBA concentration on all vegetative growth characterizes of *Bougainvillea* plant. Figure (1) showed that increasing IBA concentration significantly led to increasing percentage of success cuttings. Also, IBA at high concentration (1500

and 2000 ppm) led to earlier leaf sprouting compared to low concentrations. Successful percentage increased from approx. 17% under control to reach 87% at 2000 ppm IBA. Also, leaf sprouting took about three weeks under control, while took about two weeks under 2000 ppm IBA with one week less for leaf sprouting.

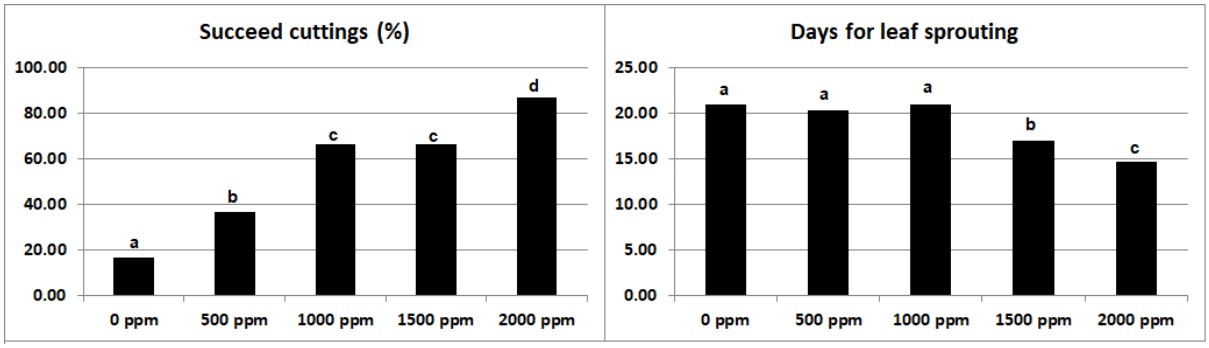

Figure (1): Effect of IBA concentrations on successful cuttings percentage and days for leaf sprouting of dwarf *Bougaianvillea*. Data represented means of two seasons, and different letters represented significant differences at probability of 0.05%.

In the same line, the vegetative characters; plant height, stem diameter, number of leaves, number of branches and root length clearly increased with increasing IBA concentration (Figure 2). Plants produced from cuttings treated with 2000 ppm IBA were eight times taller than those from non-treated cuttings. Also, those plant had stem with wider diameter (2.84 mm) compared to control (1.52 mm). Number of leaves was four times higher under 2000 ppm IBA treatment compared to control. The main stem had no lateral branches under control, and branches were emerged when cutting treated with IBA with 3-4 lateral branches under 2000 ppm IBA treatment. Also, root length was taller in plants under IBA treatment compared to control. The root length was approx. 3.37 cm under control treatment and increased to reach 16.67 cm under 2000 ppm IBA treatment.

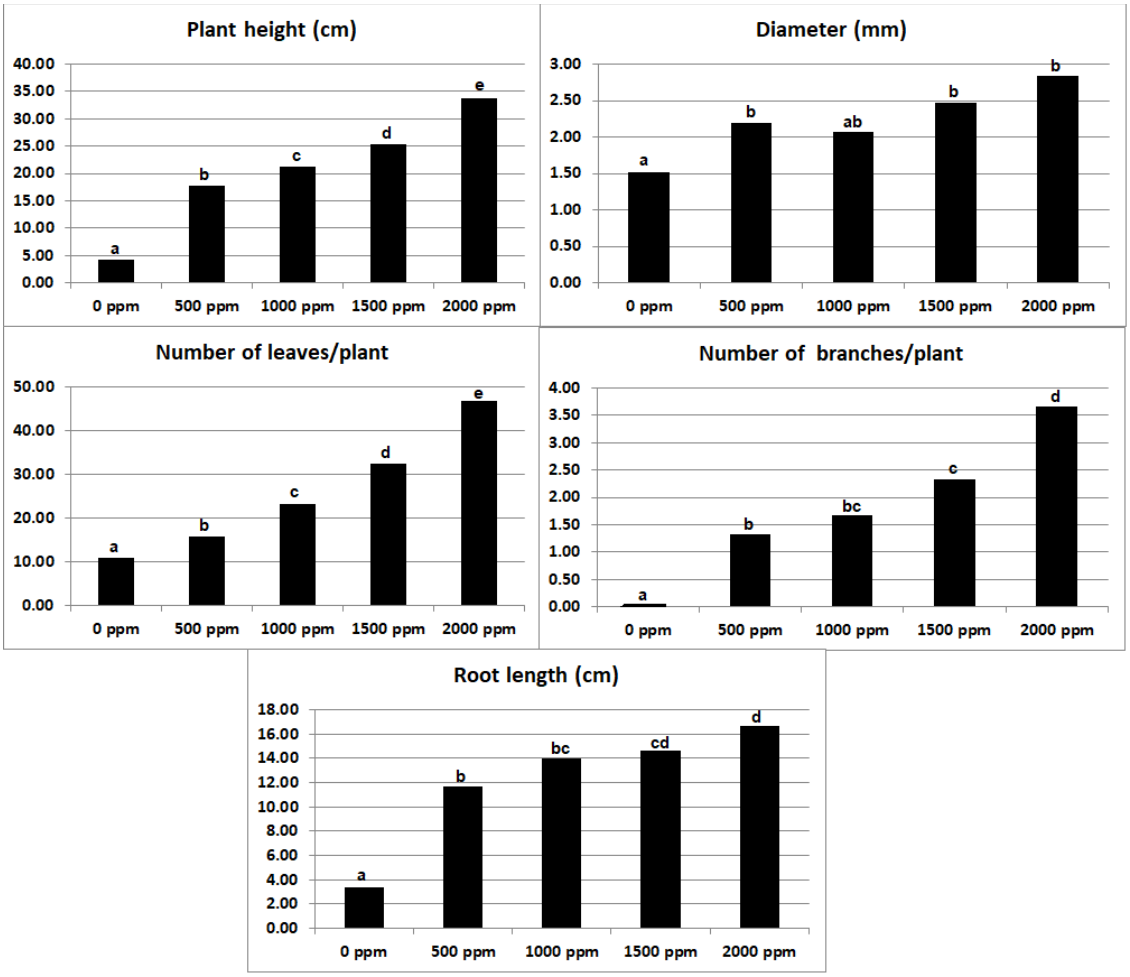

Figure (2): Effect of IBA concentrations on plant height, stem diameter, number of leaves per plant, number of branches per plant and root length of dwarf *Bougaianvillea*. Data represented means of two seasons, and different letters represented significant differences at probability of 0.05%.

The fresh and dry biomass of bougainvillea shoots and roots clearly increased with increasing IBA concentrations (Figure 3). The fresh shoot and root weighs were almost 1.5 and 1.3 g and increased gradually with increasing IBA concentration to reach 6.6 and 7.4 g at 2000 ppm IBA, respectively. Also, the dry shoot and root weight increased from 1.2 and 0.97 g under control to reach 4.43 and 4.16 g under 2000 ppm IBA treatment, respectively.

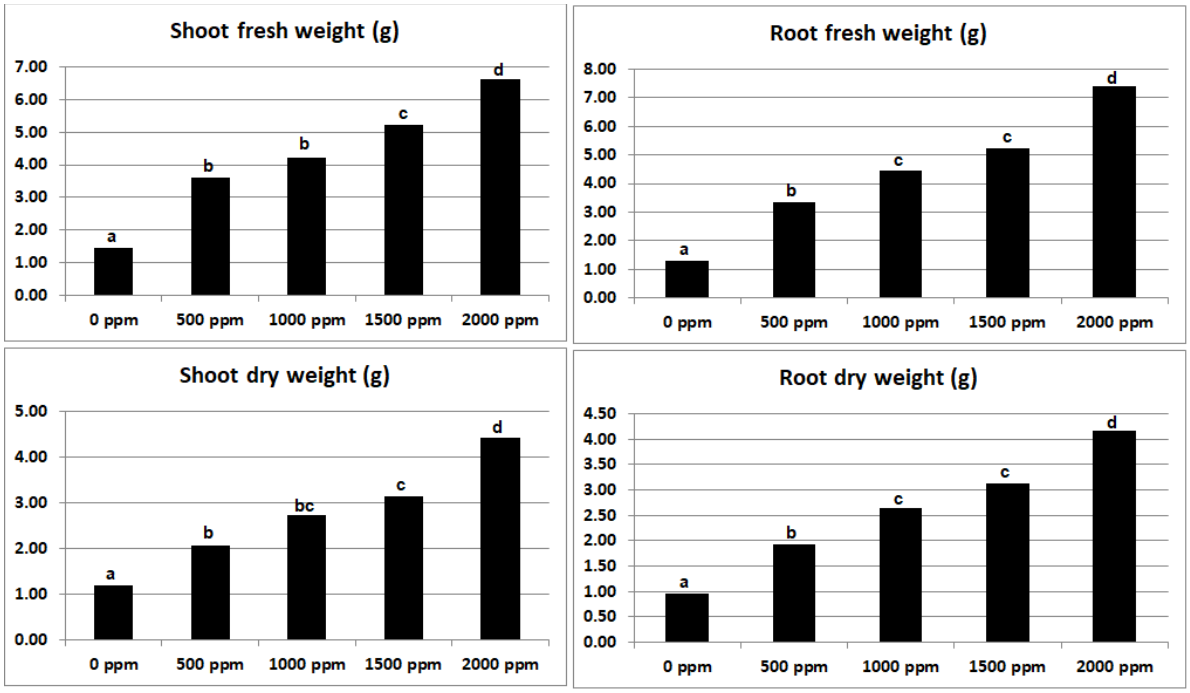

Figure (3): Effect of IBA concentrations on shoot and root fresh and dry weight of dwarf *Bougaianvillea* plant. Data represented means of two seasons, and different letters represented significant differences at probability of 0.05%.

Discussion

Auxins are a group of phytohormones produced in the shoot and root apices, which are responsible for promoting growth along the longitudinal axis of the plant. While auxins are distributed throughout the plant, they are particularly abundant in the growing tips of plants, including coleoptile tip, buds, root tips, and leaves [2]. The use of plant growth regulators, particularly auxins, offers several advantages, including being less time-consuming to apply and being more environmentally friendly. However, their use should be balanced with other cultural practices and environmental considerations to ensure healthy and sustainable plant growth [2, 3]. In this study, treatment with IBA significantly increased sprouting percentage with early sprouting. Sprouting percentage increased 70% with one week earlier under treatment with IBA at 2000 ppm compared to control. These results is consistent with recently study [7] who found that *Bougainvillea* hardwood cuttings treated with 2000 ppm of IBA performed better than the control group in various aspects of growth included a shorter time to sprouting and rooting as well as higher survival percentage of rooted cuttings. Also, these results in harmony with previous studies on rose [10], Dragon fruit [11], guava cuttings [12-14], fig [15] and *Jatropha curcas* [16].

IBA is a naturally occurring auxin and is second only to IAA in terms of abundance. In many plant species, IBA is known to be converted into IAA. Due to its high rooting capacity, IBA is the most commonly used auxin hormone [4]. The synthetic compound IBA was first discovered as an auxin precursor that induced root initiation in various plant species [17]. IBA and IAA are structurally similar, but IBA has a four-carbon side chain, whereas IAA has a two-carbon side chain. The elongated side chain of IBA likely prevents the molecule from adopting a conformation suitable for binding to the TIR1-Aux/IAA co-receptor pocket [18]. This is supported by surface plasmon resonance analysis, which indicates that IBA has no measurable binding activity [18]. These findings are consistent with genetic evidence indicating that IBA's activity results from its conversion to IAA as reviewed by [19]. Subsequently, gas chromatography-mass spectrometry has identified IBA in many plant species, including pea, cypress, maize, carrot, tobacco, and Arabidopsis as reviewed by Ludwig-Müller [20]. The widespread occurrence of IBA in various angiosperms suggests that it plays a conserved role in auxin homeostasis. Initial bioassays showed that applying IBA affected not only rooting but also other auxin-regulated processes, such as leaf epinasty, cell division, and stem bending, which often occurred at a distance from the application site [17]. These responses suggested the presence of an IBA transport system.

The results of this study showed that IBA plays a crucial role in shooting and rooting characterizes of bougainvillea. With increasing IBA treatment, shoot became heavier as a result of taller and wider stem, more leaves and lateral branches, and more shoot biomass. Also, roots became longer with heavier biomass. These results is consistent with recently finding on bougainvillea by Shinde et al. [7] who found that *Bougainvillea* hardwood cuttings treated with 2000 ppm of IBA performed better than the control group in various aspects of root, shoot, and growth parameters. These included a greater number of leaves, a higher number of shoots, greater fresh and dry weight of shoots, increased plant height, a greater number of roots per cutting, longer main root length, greater root volume, greater fresh and dry weight of roots per cutting, and wider stem girth. In addition, these were in harmony with previous observations on bougainvillea and other ornamental shrubs [16, 21-31].

From the results of this study, it is concluded that IBA plays an important role in bougainvillea plant propagation by stem cuttings. IBA is considered as a rooting hormone, as it helps to stimulate and accelerate rooting. In addition to that it considered as a growth hormone, as it helps to stimulate the vegetative growth by increasing lateral branching, the length of branches

and roots, and the diameter of stems, as well as increasing the biomass of shoots and roots.

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