Kirkuk University Journal for Agricultural Sciences
ISSN:2958-6585
https://kujas.uokirkuk.edu.iq

RESEARCH ARTICLE
https://doi.org. 10.58928/ku24.15201

Effect of different concentrations of Indole Butyric Acid on the rooting of Hard-wood cuttings of four cultivars of Bougainvillea sp.

Janan Abdulkhaleq sadeeq
Department of Horticulture, College of Agricultural Engineering Sciences, Dohuk University-Dohuk, IRAQ.
*Corresponding Author: Janan.sedeeq@uod.ac.

Received: 18/02/2024 **Revised: 25/03/2024** **Accepted: 07/04/2024** **Published: 01/06/2024**

ABSTRACT

This research was conducted in the plastic house that belongs to the Nursery of Duhok University, located on the Zanko campus between February and June 2022. To study the impact of various Indole Butyric Acid concentrations (IBA) at (0, 1500, 3000 and 4500) mg L^{-1} on the capacity of hardwood stem cuttings to root of four different cultivars of Bougainvillaea, including: Flame, Ambience, Imperial Delight and Lady Mary Baring. The results indicate that the growth is affected by cultivars, and the greatly elevated majority of growth characteristics may be the result of Flame cultivars' cuttings compared with other cultivars. Among all IBA concentrations the maximum rooting percentage (62.86%), roots number per cutting (14.81 root $cutting^{-1}$), longest root (12.50 cm), stems number per cutting (2.00 stem $cutting^{-1}$), longest shoot length (18.06 cm) and plant weight (14.04 g) were observed under 3000 mg L^{-1} IBA concentration. In contrast, combining different cultivars and varying IBA concentrations resulted in a significant increase across all parameters. Notably, the highest rooting percentages of 86.60% and 86.13% were shown in the cuttings of Imperial Delight cultivars treated with IBA concentrations of 3000 and 4500 mg L^{-1}, respectively.

***Keywords*:** Bougainvillea cultivars, IBA, rooting.

INTRODUCTION

The Nyctaginaceae family includes the *bougainvillea* plant, which is one of the most significant climbing flowering shrubs in the tropics and subtropics. It's also important and popular perennial ornamental crop in floriculture for multipurpose use commonly used as a shrub, hedge and climber in the garden. *Bougainvillea* includes five species: *Bougainvillea glarba*, *Bougainvillea buttiana*, *Bougainvillea peruviana*, *Bougainvillea spectabilis* and *Bougainvillea spinosa*. The plant's flower is tiny and typically white, but three to six bracts around each cluster of three flowers. Bracts come in a variety of hues, including purple, violet, orange, red, scarlet, crimson, pink, and yellow, ranging in color from deep purple to white. A slender, five-lobed achene is the fruit [1].

The rooting capacity of stem cuttings in the propagation of *Bougainvillea* through vegetative method is influenced by various factors. These factors include the type of stem cuttings used, which can be hardwood, semi-hard, or soft-wood. Additionally, the rooting capacity is affected by the juvenility and condition of the stock plant, as well as the specific requirements of the species and cultivar. The source, location, and kind of cuttings taken, along with practices such as wounding or leaf removal, stock plant etiolation, and girding, also play a role in determining the success of rooting. It is important to consider all these factors when determining the date of cutting for optimal results [2].

A large number of *Bougainvillea* varieties are available, and varieties suitable for different situations and purposes can be selected for planting. Most cultivars have very limited success in propagating cuttings; rooting response varies among cultivars [3]. The propagation technique commonly involves utilizing cuttings from semi-deciduous stems, and it is widely acknowledged that rooting most commercially accessible species and cultivars can be challenging.

Rooting hormones are crucial for enhancing the root system's quality, reducing the time required for rooting, and improving the success rate of cuttings in plants that are both easy and difficult to root [4]. To promote the accidental rooting of Bougainvillea cuttings, plant growth regulators are frequently employed either alone or in conjunction with other substances [5,6,7,8] IBA is one of the most common materials used to stimulate rooting. Relatively slow and weak auxin-IBA, an enzyme of auxin-degrading material is chemically stable, has a great effect on root production [9].

The untreated form of Bougainvillea and other ornamental shrub species did not show any signs of rooting. However, when treated with IBA at concentrations ranging from 3000-6000 mg L^{-1}, significant amounts of roots were observed in both fresh and dry root weights [10]. [11] discovered that an IBA concentration of 2000 mg L^{-1} greatly improved the rooting of Bougainvillea stem cuttings, which are typically difficult to root. Additionally, [12] found that Bougainvillea exhibited optimal rooting ability when treated with 4000 mg L^{-1} IBA.

This study aimed to investigate the effect of different concentrations of IBA on the rooting potential of stem cuttings from four different Bougainvillea cultivars.

Materials and Methods

The research was carried out between February and June 2022 within a temperature-controlled greenhouse belonging to Nursery in Duhok University. The aim was to examine the impact of different concentrations (0, 1500, 3000, and 4500 mg. L^{-1}) of Indole Butyric Acid (IBA). Percentage of rooting and growth of hardwood stem cuttings of the four Bougainvillaea cultivars (Flame, Ambience, Imperial Delight and Lady Mary Baring). Terminal stem cuttings of *Bougainvillea* at a length of 10 ±2 (cm) with diameter ranges of 0.8-1.3 (cm), were collected from healthy stock plants in early morning to ensure the plant is fully turgid, they were immediately placed in water and kept moist then treated with IBA concentrations by a quick-dip method for 10 second. All cuttings were treated with (Benomyl 25%) as powder and planted in growing media consisting of coarse river sand and peat moss (1:1) by volume in propagation beds (specific propagation wood boxes 1×1.5 m). The space between cuttings was 8 cm, and between lines 12 cm for 8 weeks.

The study took place in a plastic greenhouse equipped with a sprinkler irrigation system. A Randomized Complete Block Design (RCBD) was employed for the experiment, with four replications and 10 cuttings per replication. The aim was to assess the statistical significance of treatment effects. Significance was determined via the SAS program, and Duncan's Multiple Ranges test was used for the means comparison at a 5% level. Various parameters were measured, including rooting percentage (%), root number (root $cutting^{-1)}$, longest root length (cm), shoot number (shoot $cutting^{-1)}$, longest shoot length (cm), and plant weight (g).

Results and Discussions

1- Influence of IBA concentrations

The results in Table (1) showed that IBA at used concentrations had significant effects on rooting characteristics of *Bougainvillea* cuttings, treated cuttings with 3000 and 4500 mg L^{-1} of IBA gave significantly higher percentage of rooting 62.86, 62.01% and number of roots per cutting 14.81 and 13.88 roots $cutting^{-1}$ respectively in comparison with 0 and 1500 mg L^{-1} IBA. On the other hand, the data clearly showed that there were significant differences in the treatment of the longest root length, the cuttings that were treated with 3000 mg L-1 IBA gave the highest value for the longest root length, 12.50 cm, compared with other treatments. IBA concentrations significantly influenced the number of stems per cutting. The highest number of shoots per cutting, 2.00 - 2.06 shoots per cutting, was obtained when cutting was treated with 0,1500 and 3000mg L-1 IBA concentration, and did not differ significantly between them. The lowest number of shoots was 1.56 shoots per cutting recorded on a cutting treated with 4500mg L^{-1}. On the other hand, IBA had a significantly effect on longest shoot length cutting treated with 3000mg L^{-1} gave 18.06cm compared with 12.06cm for control. Also the plant weight significantly increased when cutting treated with 3000mgL^{-1} which gave 14.04 g while the lowest value 5.70 g was for control treatment.

Table (1): Effect of IBA concentrations on some characteristics of *Bougainvillea* hardwood stem cuttings.

IBA conc. mg L^{-1}	Rooting percentage (%)	Roots number (root $cutting^{-1}$)	Longest root length (cm)	Shoot number (shoot $cutting^{-1}$)	Longest shoot length (cm)	Plant weight (g)
0	36.06 c	7.19 b	8.44 b	2.04 a	12.06 c	5.70 c
1500	50.02 b	8.56 b	9.44 b	2.06 a	13.38 bc	8.34 b
3000	62.86 a	14.81 a	12.50 a	2.00 a	18.06 a	14.04 a
4500	62.01 a	13.88 a	9.75 b	1.56 b	14.44 b	8.88 b

2- Influence of cultivars

The rooting characteristics of *Bougainvillea* cuttings were significantly influenced by the different cultivars, as indicated by the data in Table (2), where (Flame) and (Imperial Delight) cultivars gave significantly higher rooting percentages of 72.54, 70.76%, which decreased to 42.42% and to 25.23%. in variations (Lady Mary Baring) and (Ambiance). The data in the same table obvious that (Imperial Delight) reveal significantly higher roots number per cutting 18.31 root $cutting^{-1}$ compared with other cultivars, (Imperial Delight) and (Flame) cultivars give the longest root per cutting 11.50, 11.13 cm respectively which was as significantly higher than other. Also it can be observed from same table that the all four cultivars did not differ between them significantly on number of stems while the highest shoot length 20.56 cm was observed in different cultivars (Flame) whereas the lowest shoot length 9.50 cm was obtained on (Ambiance). (Flame) gave a plant weight 14.24 g which significantly defer from other cultivars.

Table (2). Effect of cultivars on some characteristics of *Bougainvillea* hardwood stem cuttings.

Cultivars	Rooting percentage(%)	Roots number (root $cutting^{-1}$)	Longest root length (cm)	Shoot number (shoot $cutting^{-1}$)	Longest shoot length (cm)	Plant weight (g)

Flame	72.54 a	12.25 b	11.13 a	1.94 a	20.56 a	14.24 a
Ambiance	25.23 c	8.75 c	8.38 b	1.79 a	9.50 d	6.10 c
Imperial Delight	70.76 a	18.31 a	11.50 a	1.94 a	15.94 b	9.87 b
Lady Mary Baring	42.42 b	5.13 d	9.13 b	2.00 a	11.94 c	6.75 c

3- Effect of interaction between IBA concentrations and cultivars

The data in Table (3) indicated that the interaction between IBA concentrations and cultivars had significant effect on rooting characters the cutting of (Imperial Delight) variety when treated with each concentration of IBA (3000 , 4500 mg L^{-1} gave a higher rooting percentage (86.60 , 86.13%) respectively on the other hand wood stem cuttings of (Flame) treated with 4500 mg L^{-1} also gave higher rooting percentage reach 86.10% these values differed significantly from the other interaction values. The highest roots number per cutting reach 23.25 roots which obtained from cutting of (Imperial Delight) treated with 4500 mg L^{-1} IBA. While the lowest value 3.00 root $cutting^{-1}$ recorded in untreated cuttings of (Lady Marry Baring) with IBA (control). Also the interaction between (Imperial Delight) cuttings and 3000
mg L^{-1} IBA significantly gave and the highest value of root length 14.00 cm while the lowest value 6.00 cm was recorded on untreated cuttings of (Lady Marry Baring) with IBA. There were no significant effects between cultivars and IBA concentrations on the number of shoots per cuttings. A significant variation in longest shoot per cutting can be observed in (Flame) cuttings treated with 3000 mg L^{-1} IBA which gave highest shoot length 29.75 cm whereas the lowest value reach 6.00 cm in untreated cuttings of (Ambiance) with IBA. However, the plant weight was significantly affected by the interaction between cultivars and IBA concentration. (Flame) Cuttings treated with 3000mg L-1 IBA gave the highest plant weight, 22.78 g, compared with the lowest value, 3.15 g, which was recorded for untreated cuttings of (Ambience) with IBA (control).

Table (3): Interactive effects of IBA concentration and cultivars on some characteristics of *Bougainvillea* hardwood stem cuttings.

cultivars	IBA conc. mg L^{-1}	Rooting percentage (%)	Roots number (root $cutting^{-1}$)	Longest root length (cm)	Shoots number (shoot $cutting^{-1}$)	Longest shoot length (cm)	Plant weight (g)
Flame	0	55.00 e	8.00 d-f	10.75 a-c	2.50 a	12.50 d-f	8.90 c-f
	1500	69.05 c	11.00 cd	9.25 b-d	2.00 a	16.00 cd	11.08 bc
	3000	80.00 b	20.75 ab	13.25 ab	1.75 a	29.75 a	22.78 a
	4500	86.10 a	9.25 d	11.25 a-c	1.50 a	24.00 b	14.20 b
Ambiance	0	22.25 h	3.75 gh	6.00 d	1.68 a	6.00 h	3.15 g
	1500	20.68 h	5.00 e-h	9.00 b-d	2.00 a	10.25 fg	6.49 d-g
	3000	39.73 g	7.50 d-g	9.50 d-d	2.00 a	13.75 c-f	10.08 b-d
	4500	18.28 h	18.75 b	9.00 b-d	1.50 a	8.00 gh	4.68 fg
Imperial Delight	0	45.50 f	14.00 bc	11.00 a-c	1.50 a	18.00 c	4.93 fg
	1500	64.80 d	13.75 bc	11.50 a-c	2.50 a	17.00 c	10.12 b-d
	3000	86.60 a	22.25 ab	14.00 a	2.25 a	13.75 c-f	13.38 b
	4500	86.13 a	23.25 a	9.50 b-d	1.50 a	15.00 c-e	11.05 bc
Lady Mary Baring	0	21.50 h	3.00 h	6.00 d	2.50 a	11.75 d-g	5.80 fg
	1500	45.55 f	4.50 f-h	8.00 cd	1.75 a	10.25 fg	5.69 fg
	3000	45.10 f	8.75 de	13.25 ab	2.00 a	15.00 c-e	9.91 b-e
	4500	57.53 e	4.25 f-h	9.25 b-d	1.75 a	10.75 e-g	5.61 fg

In this study, stem cuttings were used to propagate *Bougainvillea*. The findings indicated that the rooting percentage, roots number, longest root length, shoots number, longest shoot length, and plant weight were significantly influenced by cuttings from various strains of *Bougainvillea* cultivars. The physiological stage of the mother plant is the primary factor influencing the rooting success of most ornamental plants, as stated by [13] the time of planting cuttings [14,15] and the type of growth regulators used [16]. Rooting percentage varies according to the genetic influence of species and cultivars, with certain species

and cultivars rooting more easily than others [17]. The rooting ability of stem cuttings is influenced by various factors, including species, rootstock morphology, anatomy, and environmental conditions [18,19]. The increase in root length per cutting can be attributed to two factors: primarily, the genetic composition, which refers to a combination of genes that are suitable for establishing a root system, and secondly factor is the amount of foliage on the above part of the plant. This food is subsequently transported to the underground portion (roots) to facilitate their growth. This process occurs independently of genetic factors [20]. Furthermore, disparities in the genetic makeup or variances in the concentration of endogenous auxin can lead to variations in the number of roots generated from cuttings [21].

The promotion of root growth is contingent upon the genetic response of plant species. The responses exhibited by different cultivars may be attributed to the specific interaction between beneficial microorganisms and traits that are unique to them, for the optimal development of roots, factors such as environmental conditions, nutritional needs, and hormonal requirements play a crucial role [22].

The use of IBA resulted in an improvement in various aspects of plant growth compared to the untreated treatment. These improvements include an increase in rooting percentage, root number, root length, shoot number, longest shoot length, and plant weight. The IBA significantly enhances the formation of adventitious roots in various species. In addition, the application of auxin treatment, as mentioned by [23] has been found to enhance both the quality and quantity of roots produced by cuttings, while also promoting uniformity in rooting. Another study focused on the effect of IBA hormone treatment on *Bougainvillea* cuttings, using different concentrations of IBA to assess root number, length, diameter, and weight compared to a control group [24] This study reported that the highest number of germinated cuttings was observed under a concentration of 3000 mg L^{-1} of IBA for *Bougainvillea* Var. Torch Glory or Re-Shining [25]. Cutting base dipped in IBA powder produced the following results: rooting ratio, number of roots, length of roots, dry weight of roots, number of leaves, and dry weight of vegetative growth (outperforming in the majority of the evaluated criteria) [26].

Conclusions

The findings indicate that the rooting ability of cuttings was significantly influenced by the application of IBA at a concentration of 3000 mg L^{-1}, as compared to other concentrations and the control group (0 mg L^{-1}). Additionally, the type of plant species, especially the *Bougainvillaea cultivars, played a significant role in the performance of the cuttings in terms of rooting and shoot growth*. Among the cultivars, the Flame cultivars yielded the best results, including the maximum rooting percentage, longest root length, number of shoots, longest shoot length (cm), and plant weight. The Imperial Delight cultivar's cuttings, when treated with 3000 mg L^{-1} IBA, displayed the highest percentage of rooting and the longest roots. On the other hand, the Flame cultivars, also treated with the same concentration of IBA, resulted in the longest shoots and the highest plant weight.

References

[1] Kobayashi, K. D., McConnell, J. and Griffis J., 2007. Bouganivillea cooperation extension service. College of Tropical Agriculture and Human Resources. University of Hawaii at ManoaOrnamental and Flowers.

[2] Hartmann, H.T., Kester, D.E., Davies, F.T. and Geneve ,R.L. , 2002. Plant propagation: Principles and practices, 7th ed. Prentice Hall, New Jersey, 363-365.

[3] Yadav, L.P., Bhattacharya, A.P. and Pandey, H.S., 1978. Effect of season on the rooting of Bougainvillea cuttings. Prog. Hort., 9(4):32-33.

[4] Salman, M.A., 1988. Horticulture Plants Propagation. Daralkotob publishing and pressing Mosul Univ., Iraq. (In Arabic)

[5] Mahros, O.M., 2000. Rootability and growth of some types of *Bougainvillea* cuttings under IBA stimulation. Assiut. Journal of Agricultural Science, 31(1):19-37.

[6] Ahmad, N., Ishtiaq, M. and Nabi ,G., 2002. Influence of various concentration of indole butyric acid (IBA)on different types of *Bougainvillea glarba* var. Variegata cuttings. Sarhad Journal of Agriculture, 18(3):263-270.

[7] Abdel-Rahman, S.S.A. and El-Dsouky, M., 2010. Effect of indole-3-butyric acid (IBA) and Bacillus subtilis on rooting of *Bougainvillea glarba* var. Sanderiana cuttings. The 5th Scientific Conference for Agricultural Sciences, Fac. Agric. Assiut Univ. Oct.16-17, pp.51-71.

[8] Memon, N.N. Ali, M.A. Baloch and Q. Chachar (2013). Influence of naphthalene acetic acid (NAA) on sprouting and rooting potential of stem cuttings of *Bougainvillea.Sci. Int.*(Lahore),25(2):299-304.

[9] Hartman, H.T. and Kester, D.E., 1975. Plant propagation principles and particles 3rd. Ed; Prention hall Inc. new jersey, pp. 662.

[10] Bose, T.K., Singh ,P.K. and Bose ,S., 1968. Propagation of tropical ornamental plants from cutting under mist. *Indian J. Hort*. 27:213-217.

[11] Mishra, S.N. and Sharma, C.P., 1995. Effect of plant regulators on rooting of stem cutting of Bougainvillea. *Prog. Hort.*1995; 27(1-2):33-38.

[12] Singh, K.K., Rawat, J.M.S. and Tomar, Y.K., 2011. Influence of IBA on rooting potential of torch glory *Bougainvillea glabra* during winter season. Journal of Horticultural Science and Ornamental Plants, 3 (2): 162-165.

[13] Day, J.S. and Loreys, B.R., 1998. Propagation from cuttings of two woody ornamental Australian shrubs, *Boronia megastigma* and *Hypocalymma angustifolium* ,Endl.(White myrtle). Australian Journal of Experimental Agriculture, 38:201-206.

[14] Hartmann, H.T. and Loreti, F., 1995. Seasonal variation in rooting of leafy olive cuttings under mist. Proc. American Society of Horticultural Sciences ,87:194-198
[15] Darwesh, R.S.S., 2000. Studies on propagation of *Ficusretusa* cv. Hawaii, M.Sc. Thesis Faculty Agriculture Cairo University Egypt.
[16] Rowezak, M.M.A., 2001. Response of some ornamental plants to temperature with growth substances. M.Sc. Thesis, Faculty of Agriculture, Cairo University, Egypt.
[17] Hartmann, H.T, Kester, D.E., Davies, F.T. and, Geneve ,R.L., 2014. Hartmann & Kester's Plant Propagation: Principles and Practices, eight editions. Pearson new international edition.
[18] Leakey, R.R.B., 2004. Physiology of vegetative reproduction. In: Burley, J., Evans, J. and Younquist, J.A. (eds) Encyclopedia of forest sciences. Academic Press, London, pp: 1655–1668.
[19] Husen, A. and Pal, M., 2007. Metabolic Changes during Adventitious Root Primordium Development in Tectona grandis Linn. f. (Teak) Cuttings as Affected by Age of Donor Plants and Auxin (IBA and NAA) Treatment. New Forests, 33: 309-323.
[20] Osterbye, U., 1970. Rooting of Rose cuttings. Nord. Jord briforskn, 52: 136-7 (Hort. Abst., 41:240–1).
[21] Nasri, F., Fadakar, A., Saba, M.K. and, B. Yousefi (2015). Study of indole butyric acid (IBA) effects on cutting rooting improving some of wild genotypes of damask roses (*Rosa damascena* Mill.). *Journal of Agricultural Sciences, Belgrade*, 60 (3): 263-275.
[22] Scagel, C.F. (2001). Cultivar specific effects of mycorrhizal fungi on the rooting of miniature rose cuttings. J. Environ. Hort., 19 (1): 15-20.
[23] Blazich, F.A., 1988. Chemical and Formulations Used to Promote Adventitious Rooting. Portland, Ore. pp. 132-149.
[24] Niaz, A. and Muhammad, I., 2002. Influence of various concentration of (IBA) on different types of *Bouganivillea glarba*. *sarhad journal of agriculture*. vol.18/no.3/pp:263-270.
[25] Deo, A.K., Sarnaik, D.A., Kuruwanshi, V.B. and Pal, D.P., 2008. Effect of treatment of stem cutting with IBA and NAA on sprouting, rooting and root biomass in *Bouganivillea* var. Refulgence Adv. in Plant Sci., 21(2):557-558.
[26] Salih, Z. K., Al-Bayati M. Y., Al-Fatlawi K.A.I., All-Kalefa, A.K., and Lateef, M.A., 2021. Effect of Cutting Type and Application Methods of Indole Butyric Acid on Rooting and Growth of *Bougainvillea glabra*. Indian Journal of Ecology 48(15):123-126

تأثير تراكيز(مختلفة من IBA في تجذير العقل الخشبية لأربعة اصناف من نبات الجهنمية ***Bougainvillea* sp.** حامض الاندول بيوترك).

جنان عبدالخالق صديق

قسم البستنة ، كلية هندسة العلوم الزراعية ، جامعة دهوك ، دهوك ، العراق.

الخلاصة

تم تنفيذ البحث في البيت البلاستيكي التابع لمشتل جامعة دهوك الواقع في الحرم الجامعي محافظة دهوك / العراق. في الفترة ما بين شباط وحزيران لعام 2022 ، تناول البحث دراسة تاثير تراكيز مختلفة من حامض الاندول بيوترك (IBA) (0 ،1500، 3000، 4500) ملغم لتر$^{-1}$ في تجذير العقل الخشبية لاربعة اصناف من نبات الجهنمية : Flame, Ambiance, Imperial Delight and Lady Marry Baring. واظهرت من نتائج الدراسة ان نمو النبات يتاثر بالاصناف وان الزيادة المعنوية في معظم الصفات للنمو الخضري والجذري كان للعقل المزروعة لصنف Flame مقارنة ببقية الاصناف ، بينما تبين ان استخدام (IBA) بتركيز 3000 ملغم لتر$^{-1}$ الى الحصول على اعلى نسبة التجذير 62.86 %، عدد الجذور لكل عقلة 14.8 جذر ، طول اطول جذر 12.50 سم ، طول اطول نمو خضري 18.06سم، والوزن الجاف للنبات 14.04 غم مقارنة ببقية التراكيز المستخدمة. ومن نتائج التداخل تبين انه تم الحصول على افضل القيم معنوية لصفات المجموع الخضري والجذري المدروسة بلغت اعلى نسبة التجذير 86.60 % و86.13 %عند زراعة العقل المعاملة ب IBA بتراكيز 3000 و 4500 ملغم لتر$^{-1}$ لصنف Imperial Delight ،على التوالي

الكلمات المفتاحية : اصناف الجهنمية ، IBA ،التجذير.