THE INFLUENCE OF STEM CUTTING TYPE AND IBA CONCENTRATION ON VEGETATIVE GROWTH OF BOUGAINVILLEA

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Abstract
Bougainvillea is one of the ornamental plants usually use for landscaping because of its colorful leaves and flowers. It is also used as a stabilizer and environmental preserver of pollution. This plant is propagated by cutting, however, there is a need to ensure easy growth of roots. Therefore, the purpose of this research was to determine the influence of stem cutting type and IBA concentration on vegetative growth of bougainvillea. The study was conducted in the experimental garden of the Faculty of Agriculture, UPN "Veteran" Yogyakarta, between October 2019 and January 2020 using a Randomized Completely Block Design (RCBD) with a factorial arrangement. The factors include the terminal, middle, and basal types of stem cutting while the IBA concentration was varied between 50, 100, 150 ppm and without IBA. The result showed 100 ppm IBA on the middle and basal type produced higher shoot number and shoot length of bougainvillea. The middle and basal type produced the best of percentage cutting to life, root number, length of longest root, and root volume. The giving IBA in cuttings produced the better root growth than without IBA.
Keywords: *bougainvillea, IBA concentration, stem cutting type*

INTRODUCTION

In 1769-1776, Philbert Comerson, a scientist, and Louis Antoine de Bougainvillea, a French sailor, discovered this plant on a voyage in the Pacific Ocean and gave it the name Bougainvillea in honor of the sailor. (Panjaitan *et.al*, 2014). Bougainvillea plants are preferred due to the colorful appearance of their leaves and flowers and the ability to grow in several environmental conditions and soils with low nutrition. They produce many flowers in the dry season and are also used as a stabilizer and environmental preserver of pollution. This is the reason it is usually planted in green open spaces, urban areas, office parks, tourist areas, and home gardens.

Bougainvillea belongs to the family *Nyctaginaceae* and has the ability to flourish in lowlands as well as highlands reaching an altitude of 1.400 m above sea level. It is a drought-resistant plant with low maintenance requirements. The plant has excellent business prospects and high commercial value because it is needed in large quantities by consumers. Bougainvillea is propagated through the use of a vegetative method involving cutting and grafting. However, cutting is most preferable due to its simplicity and ability to grow many plants and its success is determined based on its ability of the plant to grow roots. The high lignin content and continuous sclerenchyma ring inhibit the appearance of adventitious roots.

The growth of the cuttings is influenced by internal factors such as the type of cutting material and its age, plant growth regulator, and carbohydrate content. Moreover, the types of the materials including terminal, middle, and basal stem have been discovered to have the ability to cause variations in the root system. According to Amri *et al* (2009), basal has a better root than both terminal and middle types on *Dahlbergian melanoxylon* due to the presence of plants nutrient content especially carbohydrates, proteins, lipids, nitrogen, enzymes, hormones, and rooting cofactor. Another research conducted by Lesmana *et al* (2018) showed basal cutting produced the best root number, length, and dry weight.

It has also been reported that the plant physiological conditions influencing cutting include the age of the material, kind of plant, young shoot and leaf, food supplies, and plant growth regulator which is usually used to accelerate the growth of roots and shoots (Zong *et al*, 2008). An example of these is the auxin which has the ability to aid the growth of adventitious roots and it is available in commercial synthetic forms as *Indole Butyric Acid* (IBA).

IBA has the ability to increase root cell extension and stimulate growth, and according to Irwanto (2001), 100 ppm of this regulator provided a significant effect on the length and dry weight of *Shorea montigena* root. It has also been reported to have improved rooting in many woody species including Bougainvillea. Moreover, Sing *et.al*. (2017) found the wide use of IBA to be due to its nontoxicity on plants over a wide concentration range. Sing *et. al*., (2018) further observed the significant influence it has on the root of Bougainvillea glabra variegate.

According to Putri *et. al.* (2017), 100 ppm IBA has the ability to increase the root length and shoot number on cutting *S, Cylindrica* var canaliculate. It has also been discovered that the soaking of *Mussaenda frondosa* cutting in auxin for 1 hour provided the best result on the spouting time, root length, leaf number, leaf area, and percentage of sprouting (Junaedy, 2017). However, low concentrations of this regulator have been discovered to show no significant effect while high concentrations inhibit vegetative growth. This, therefore, means auxin should be used in the right concentration to stimulate root and shoot growth. The purpose of this research was to determine the influence of stem cutting type and auxin concentration on vegetative growth of bougainvillea.

MATERIALS AND METHOD

This research was conducted in the experimental garden of the Faculty of Agriculture, UPN "Veteran" Yogyakarta located at an altitude of 191m above sea level between October 2019 and January 2020. The maximum and minimum mean daily temperatures of the area ranged between 26.5oC and 31.6oC while the relative humidity was 92% and 68%, respectively. The Bougainvillea spectabilis stem cuttings used in this experiment consisted of three types of material including terminal, middle, and basal stems at a length of 20 cm. They were obtained from a healthy parent stock early in the morning to ensure the plant is fully turgid, subsequently stem of bougainvillea was cut using a sharp thin-bladed pocketknife.

Smooth and slanting cuts were administered at the stalk and lower ends below the node, respectively, and prepared by removing the entire leaf. All the three types of cuttings were submerged in a solution of IBA (*Indole Butyric Acid*) at 50, 100, and 150 ppm concentrations as well as distilled water to represent 0 ppm. Moreover, the basal ends of the cuttings were soaked in IBA solution for 1 hour before they were planted in the growing media which is soil and compost at a ratio 1:1 by volume. The whole experiment was conducted under shading net and covered by tight polyethylene to maintain high relative humidity.

A Completely Randomized Design using two factors including (1) stem cutting type consisting of the terminal, middle, and basal, and (2) IBA concentration of 50, 100, 150 ppm and without IBA, were utilized. Each experimental unit contained 10 cuttings planted in a plastic pot of 20 cm diameter and the parameters including percentage cutting to live, shoot number, length of shoot (cm), length of root (cm), root volume and root number were evaluated 90 days after they were planted in the rooting medium. The data obtained were analyzed using the Analysis of Variance (ANOVA) at a significance level of 5% and those observed to have significant effects were further analyzed using Duncan Multiple Range Test (DMRT) at 5% significant levels.

RESULT AND DISCUSSION

The effects of the two factors on the shoot number were evaluated and the results are presented in Table 1. It was discovered that the middle and basal stem cutting has the most significant numbers with those soaked in 100 ppm IBA found to have produced the highest values in comparison with the terminal cutting.

It has been reported that different types of cuttings cause variations in the ability to sprout and root with the basal stem of *Arbutus andrachne* treated with IBA found to have better-rooting ability compared to the apical (Agbo and Obi, 2007). This is possibly due to the higher nutrition content especially carbohydrate, protein, lipid, nitrogen, enzyme, plant growth regulator, and rooting cofactor in the middle and basal cutting materials. These two types also tend to have fewer levels of endogenous auxin which makes it possible for them to have the highest carbohydrate and nitrogen content required to aid the formation of shoots. According to Haissig (1974), phenols in juvenile tissues of certain plants tend to be higher than in the mature forms where the root formation is partially inhibited.

Ahmed *et al.* (2015) also concluded Bougainvillea cuttings should be obtained from the middle or basal part of a mature and almost stiff wood to have a better result for rooting.

Table 1. The influence of stem cutting type and IBA concentration on shoot number of bougainvillea

Treatment	IBA concentration				
	0 ppm	50 ppm	100 ppm	150 ppm	Average
Terminal	1,67 e	3,22 cd	3,78 bc	3,56 bcd	3,06
Middle	2,78 d	3,56 bcd	5,44 a	3,44 bcd	3,81
Basal	4,11 bc	4,33 b	5,78 a	4,22 b	4,61
Average	2,85	3,70	5,00	3,74	

Similar letters indicate means which are not significantly different according to Duncan Multiple Range Test 5%.

The length of the longest shoot of bougainvillea (table 2) was showed by the 100 ppm IBA on the cutting of the middle and basal stem treatment. The giving 100 ppm IBA as exogenous auxin can induce endogenous plant growth regulator activity on the middle and basal cutting. IBA can stimulate cell division and elongation in the cutting of stem bougainvillea, furthermore, the shoot of bougainvillea became longer than the other treatment. The higher and lower concentration of IBA inhibits cell division in all types of stem cuttings, so that shoot became shorter if it was compared to 100 ppm IBA. According to Suyanti *et. al*. (2013), stated that 100 ppm IBA can add longer of *Strobilanthes Crispus* shoot.

Table 2. The influence of stem cutting type and IBA concentration on length of the longest shoot of bougainvillea

Treatment	IBA concentration				
	0 ppm	50 ppm	100 ppm	150 ppm	Average
Terminal	28,36 e	31,11 bcd	31,81 bc	31,56 bc	30,71
Middle	29,92 d	30,47 cd	33,96 a	31,00 cd	31,34
Basal	31,37 bcd	32,57 b	34,23 a	31,13 bcd	32,33
Average	29,88	31,38	33,33	31,23	

Similar letters indicate means which are not significantly different according to Duncan Multiple Range Test 5%.

The middle and basal cutting comparably provided the best result in terms of percentage cutting to live as well as the number, length, and volume of the root due to the higher amounts of reserved carbohydrates in them compared to the terminal cutting. Moreover, the food materials stored with the aid of plant growth regulators hastened the sprouting thereby enhancing the utilization of carbohydrates at the base of cuttings through photosynthesis (Sing, 2018). This is reinforced by the statement of Supriyanto and Prakasa (2011) that the ability to form roots in a type of plant is influenced by the carbohydrate content as well as the hormonal balance in the cutting material.

Table 3. The influence of stem cutting type and IBA concentration on percentage cutting to live, root number, length of longest root and root volume of bougainvillea

Treatment	Percentage cutting to life (%)	Root number	Length of the longest root (cm)	Root volume (mm)
Terminal	68,33 b	7,33 b b	1,61 b	3,92 b
Middle	78,33 a	12,08 a	2,58 a	6,25 a
Basal	80,00 a	13,83 a	2,77 a	7,50 a
Without IBA	64,44 q	5,33 q	1,44 r	3,56 q
50 ppm IBA	80,00 p	12,11 p	2,27 q	6,44 p
100 ppm IBA	82,22 p	15,89 p	3,18 p	7,00 p
150 ppm IBA	75,56 p	11,00 p	2,38 q	6,56 p

The means of each parameter followed by the same letter within a column are not significantly different according to Duncan Multiple Range Test 5%.

Carbohydrate accumulation was found in the base of the cuttings and this allows it to be the only part with the ability to grow roots, especially due to the presence of high C/N ratio required for easier and faster root formation. This is in accordance with the findings of Hartman *et.al.* (2002) that a low C/N ratio inhibits root initiation even though it has high carbohydrate content. However, nitrogen has been discovered to have a negative correlation with the process of cutting roots.

The application of IBA to the rooting substrate of bougainvillea cutting significantly increased percentage cutting to live as well as the number, length, and volume of the root per cutting compared to the control treatment which was without IBA. Moreover, according to Table 3, there was no significant effect of 50 and 150 ppm on the length of the longest root of bougainvillea while 100 ppm showed a substantial influence. Therefore, the optimal IBA concentration required for the enhancement of root growth was 100 ppm while 150 ppm exceeded the optimum value and 50 ppm was ineffective. Furthermore, root growth inhibition is strongly influenced by endogenous auxins in the cuttings due to high IBA concentrations as well as the presence of inhibitors such as phenol and manganese which, in turn, reduces the auxin content in the cuttings.

The root is formed when the cell wall is made more elastic by slowing the appearance of compounds associated with calcium pectate formation through the use of auxins (Hastuti, 2002). The cytoplasm pushes against the cell wall and expands the cell volume while the auxin subsequently causes an exchange between H^+ ions with K^+ ions and allows the K^+ ions to enter the cytoplasm to stimulate water absorption to maintain turgor pressure required for cell expansion. After the cell has expanded, the cell wall becomes stiff due to the absorption of Ca^+ ions from the outside to make the arrangement of calcium pectate in the cell wall becomes more perfect.

The treatment without IBA has a lower percentage of cutting to live as well as the number, length, and volume of roots due to the absence of the endogenous auxin which led to the inadequate IBA needed to accelerate the formation of roots. The results showed the shoots in the cuttings being the source of the auxin grew first and later stimulated the growth of the roots. This is in line with the findings of Hidayanto, *et.al* (2003) that exogenous auxin used in shoot formation was able to stimulate endogenous auxin activity required for root growth.

CONCLUSION

The results and discussion showed the use of 100 ppm IBA on the middle and basal type produced higher shoot number and shoot length of bougainvillea. The middle and basal type produced the best of percentage cutting to life, root number, length of longest root, and root volume. The giving IBA in cuttings produce the better root growth than without IBA.

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REFERENCES

Agbo, CU. And LU Obi. 2007. Variability in Propagation Potentials of Stem Cutting of Different Physiological Ages of *Gongronema latifolia* Benth. *World J Agric. Sci. 3(5): 576-581.*

Ahmed M. Eed, B. Albana'a and S. Almaqtari. 2015. The effect of growing media and stem cutting type on rooting and growth of *Bougainvillea spectabilis* plants.Univ. Aden *J. Nat. and Appl. Sc. 19(1): 141.*

Amri, E. Lyaruu, HVM, Nyomora, AS and Kanyeka, ZL. 2009. Vegetatifve Propagation of African Blackwood (*Dalbergia melanoxylon* Guill & Perr.): Effects of Age of Donor Plant, IBA treatment and Cutting Position on Rooting Ability of Stem Cuttings. *New Forests, 39(2): 183-194*

Hartmann HT, Kester DE, Davies FT, Geneve RL. 2002. Plant Propagation: Principles and Practices, 7th ed. Prentice Hall, New Jersey. 363-365.

Haissig, B.E. (1974). Influence of Auxins and Auxin Synergists on Adventitious Root Primordium Initiation and Development. *Newzealand Journal of Forestry Science 4: 311-323.*

Hastuti, ED. 2002. Fitohormon Laboratorium Biologi Struktur dan Fungsi Tumbuhan. Jurusan Biologi Fakultas MIPA UNDIP. Semarang.

Hidayanto, M., S Nurjanah, F. Yossita. 2003. Pengaruh Panjang Stek Akar dan Konsentrasi Natrium Nitrofenol terhadap Pertumbuhan Stek Akar Sukun (*Artrocarpus communis* F.) *Jurnal Pengkajian dan Pengembangan Teknologi Pertanian. 6(2): 154-160.*

Irwanto, 2001. Pengaruh Hormon IBA (*Indole Butyric Acid*) terhadap Keberhasilan stek Shorea (Shorea leprosa). Prosiding Desa Passo, Teluk Ambon Baguala, Ambon.

Junaedy, A. 2017. The success rate of the growth of *Mussaenda frondosa* plants by enclosure and immersion duration of auxin growth regulators cultivated in paranet shading growing environments. *Agrovital Journal Univ. Al. Asyariah. 2(1): 8-14.*

Lesmana, I., D. Nurdiana and T. Siswancipto. 2018. The influence of various Natural Plant Growth Regulator and Origin of Stem Cutting on Vegetative Growth Regulator of White Jasmine Jasminum samnac (L) W. Ait.) *JAGROS 2(2)*.

Panjaitan, LRH., J. Ginting, Haryati. 2014 Respon Pertumbuhan Ukuran Diameter Batang Stek Bugenvil terhadap Pemberian Zat Pengatur Tumbuh. *Jurnal Online Agroekoteknologi. 2(4): 134-1390.*

Putri, K.A., Suwirmen, and Z.A. Noli. 2017. Respon of the material cutting retrieval on Rooting Ability of Alstonia scholaris (L) R.Br. Cuttings in an Effort Provision of Seeds for Degraded Lands. *Jurnal Biologi Universitas Andalas (J. Bio. U.A.) 5(1)-:1-5*

Singh, K.K. 2018. A review: Multiplication of Bougainvillea species through cutting. *International Journal of Chemical Studies. 6(2): 1961-1965.*

Supriyanto dan K. E. Prakasa. 2011. Pengaruh Zat Pengatur Tumbuh Rootone-F terhadap Pertumbuhan Stek Duabanga mollucana Blume. *Jurnal Silvikultur Tropika, 3(1): 59-65.*

Suyanti, Mukarlina, and Rizalinda. 2013. Respon Pertumbuhan Stek Pucuk Keji Beling (Strobilanthes crispus BI) dangan Pemberian IBA. *Jurnal Protobiont. 2(2): 26-31*.

Zong, MC., Y. Li, and Z Zhen. 2008. Plant Growth Regulators Used in Propagation. CRC Press. Boca Raton, Florida.