Comparative evaluation of hardwood and semi-hardwood cutting with different rooting hormone in (Bougainvillea buttiana) cv. Mahara

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Abstract

An experiment on “comparative evaluation of hardwood and semi-hardwood cutting with different rooting hormone in (Bougainvillea buttiana) cv. Mahara” using three different rooting hormones (IAA, IBA and NAA) was conducted under shade net, at Department of horticulture research field of Sam Higginbottom University of Agriculture, Technology and Sciences, from the month of April to July 2019. The experiment was laid out in a Completely Randomized Design (CRD) with three replicates. Data were collected on Days to first Sprout, no of vegetative buds sprouted/cutting, sprouting percentage number of leaves /cutting, number of shoots / cutting, plant height, stem girth, length of longest shoot/cutting, number of roots / cutting, length of longest root/cutting, mortality rate. The results showed that hardwood cuttings were found to give significantly better results than semihardwood cuttings treated with different rooting hormones (12hrs). A long dip (12hrs) treatment of IBA1500ppm for hardwood cuttings showed significantly better results than control and all the other treatments with respect to minimum Days to first Sprout (15.723), maximum no of vegetative buds sprouted /cutting (4,000), maximum sprouting percentage(60.000%), number of leaves /cutting(52.333), number of shoots/cutting(36.667), length of longest shoot/ cutting (42.270cm), plant height (45.603cm), maximum stem girth (1.227cm), number of roots/cutting (26.943), length of longest root/ cutting (19.267cm), minimum mortality rate (40.000%) whereas in case of semi hardwood cutting the long dip (12hrs) treatment with IBA1500ppm cuttings was significantly better than control and all the other treatments with respect to minimum Days to first sprout (17.167), maximum sprouting percentage (40.000%), maximum number of leaves /cutting (31.500), maximum length of longest shoot (31.030cm), maximum plant height (33.697cm), maximum Stem girth (0.827 cm) maximum number of roots (22.833), longest root (17.500cm), minimum mortality rate (60.000%) whereas maximum vegetative buds sprouted (3.000) was obtained in cuttings treated with NAA(1500ppm), maximum number of shoots per cutting (3.000) was obtained in cuttings treated with IAA(1000ppm), IAA(1500ppm) and IBA(500ppm).

Keywords: Bougainvillea, IBA, NAA, growth regulators, ppm, rooting hormone

Introduction

The genus bougainvillea is endemic to south America and was firstly reported in Brazil in 1778 before being introduced to Europe, by French military commander Louis Antoine de Bougainville from Rio De janeiro, Brazil after whom it is being named. They are bushes spread in vines or small ornamental trees. Bougainvillea was first collected by commerson, a French botanist. Bougainvillea is a genus of native flowering plant in south America, originated from west Brazil to southern Argentina. Belonging to the family Nyctaginaceae it has ten species of which only three species are of horticultural importance namely, B. spectabilis, B. glabra and B. peruviana. However, in addition to above three B. buttiana is a natural hybrid between B peruviana and B. glabra (Holtum, 1970) [12]. It is a quick growing shrub and varies in height according to different species. They possess stout spines for climbing and possess three brightly colored petal like bracts. In recent years, some multibracted bougainvillea’s have been introduced where the number of bracts is more than three and in such cultivar there is no true flower. One such cultivar is ‘Mahara’ (syn. ‘Million dollar’, ‘Manila magic red’, ‘Manila red’). Flowers appear in large clusters. It is a free bloomer. The peak flowering time is September to December and again from February to June. In the horticultural industry most of perennial ornamental plants are multiplied and propagated vegetatively through cuttings, layering or grafting. Generally, the most commonly applied
technique is the use of cuttings obtained from stems, leaves, roots or terminal buds, due to its practicability and simplicity. Bougainvillea, because of its special characteristics, such as; high variation in type of foliage, production of many flowering inflorescence on one plant and continuous blooming of flowers with short production cycle has been very useful in the ornamental industry. They are widely cultivated as porch, adornments, arbour and ornaments. Their growth habits and beautiful showy bracts make them popular for landscapes. They are also used in mass planting, as shrubs or bushes, ground covers, as hedge plants, barrier plants and slope coverings, in hanging baskets, and in containers for Bonsai.

Though bougainvillea are primarily propagated by stem cutting and ground layering, the success of propagation by stem cutting is very limited; growers observed poor rooting percentage due to lack of competence to form adventitious roots by cuttings which occurs routinely and is an obstacle for their vegetative propagation.

Adventitious root formation is a key step in vegetative propagation of woody or horticultural species, and problems associated with rooting of cuttings frequently result in significant economic losses, preventing growers from realizing the full potential of propagation. The key to overcoming this challenge is the application of exogenous auxin/rooting hormones.

The commercially available exogenous auxins that aids the formation of adventitious roots are; Indole-3-acetic acid (IAA), Indole-3-butyric acid (IBA) and Naphthalene Acetic acid (NAA). IBA or NAA or combination of both is recommended for rooting of cuttings and are available in liquid, talc, tablet, and gel formulations. Other than this (IAA, IBA) naturally occurring auxins favours apical dominance, helps control xylem differentiation and help in cell division. NAA is a synthetic plant hormone in the auxin family and is an ingredient in many commercial plant rooting horticultural products; it is a rooting agent and used for the vegetative propagation of plants from stem and leaf cuttings, it is also used for plant tissue culture.

Materials and Methods

The experiment was carried out under shade net in department of horticulture research field of Sam Higginbottom University of Agriculture, Technology and Sciences. The hardwood cuttings (20cm length, pencil thickness) of B. buttiana cv. mahara, were prepared in April, and long dip (12 hrs.) treatment with different concentrations of IAA (Indole-3-acetic acid), IBA (Indole-3 butyric acid), NAA (Naphthalene acetic acid) were applied. The stock solution of ppm was prepared by dissolving IAA, NAA or IBA 1mg/liter distilled water. IAA, IBA and NAA directly does not dissolve in distilled water so ethyl alcohol was used. The required concentrations were prepared by diluting the stock solution with distilled water. The pH was adjusted to 5.8-6.0 by using the 1N NaOH. The hard wood and semihardwood cuttings were treated with growth regulator with different concentrations as given below:

Details of Treatments

The cuttings were planted in poly bag with mixture of sand, soil, FYM (1:1:1) in month of April to June and kept in shade net conditions. The experiment was laid out in completely randomized design with three replications to determine the statistical significance of treatment effects. Results were considered significant at 5% level of significance.

T1: IAA 500ppm T2: IAA 1000ppm T3: IAA 1500ppm T4: IBA 500ppm T5: IBA 1000ppm T6: IBA 1500ppm T7: NAA 500ppm T8: NAA 1000ppm T9: NAA 1500ppm T10: Control (Without Hormones)

Results and Discussion

Effect on shoot characters

The results showed that a long dip (12hrs) treatment of IBA1500ppm for hardwood showed significantly better results than control and all the other treatments with respect to minimum Days to first Sprout (15.723), maximum no of vegetative buds sprouted /cutting (4.000), maximum sprouting percentage(60.000%), number of leaves /cutting(52.333), number of shoots/cutting(3.667), length of longest shoot/cutting (42.270cm), plant height (45.603cm), maximum stem girth (1.227cm). In case of semi hardwood cutting the long dip (12hrs) treatment with IBA1500ppm cuttings was significantly better than control and all the other treatments with respect to minimum days to first sprout (17.167), maximum sprouting percentage (40.000%), maximum number of leaves /cutting (31.500), maximum length of longest shoot (31.030), maximum plant height (33.697), maximum Stem girth (cm) (0.827) whereas maximum vegetative buds sprouted (3.000) was obtained in cuttings treated with NAA(1500ppm), maximum number of shoots per cutting (3.000) was obtained in cuttings treated with IAA(1000ppm), IAA(1500ppm) and IBA(500ppm).

The earliest sprouting of cuttings treated with IBA (1500ppm) is attributed to better absorption of nutrient from root to shoot. Itbronke OA. (2013) [13] taking into consideration number of days to sprouting, plant height, stem girth, stem length, wet root weight, dry root weight, the number of leaves per cutting and length of longest roots reported that root initiation in cuttings of Bougainvillea could be enhanced with Indole -3-butyric acid (IBA) or dipped in coconut water for 5 minutes and growth was also enhanced using the hard wood cuttings. The maximum number of sprouts per cutting with optimum IBA treatments might be attributed to better root growth which initiated absorption and translocation of nutrients from soil which take active part in various plant metabolic processes. Similar result also reported by Deshmukh et al. (2006) [6] where IBA at 6000ppm was found significantly superior for increasing sprouting percentage of Bougainvillea buttiana cv. Mahara. The application of IBA which initiates root formation by increasing internal free IBA, or synergistically modifying action of IAA or endogenous synthesis of IAA could be a reason for high sprouting percentage. Alshammary et al (2013) [3] reported in Bougainvillea peruviana cv. Shubra and Hamelia patens that IBA (2000ppm) resulted in maximum establishment percentage (60.3% and 42.3%) respectively.

Increase in the new leaf production in cuttings might be assigned to an increased root number and root length in growth regulator treated cuttings that might have enabled cuttings to absorb more water and nutrients from rooting media, leading to better growth and production of new leaves. These results are in close agreement with the findings of Ingle and Venugopal (2009) [14] in Stevia. These observations in the present study are supported by the findings of Gandotra (1975) [7] who recorded higher number of leaves per cutting with the application of higher concentration of IBA (6000ppm) in Bougainvillea. Deshmukh et al. (2006) [6] reported that IBA at 6000ppm was found significantly superior for number of shoots of Bougainvillea buttiana cv. Mahara. Auxin enhanced cell division and cell enlargement
and promotion of protein synthesis which might have resulted in enhanced vegetative growth (Evans, 1973). Similar findings were observed by Nagraja et al. (1991) in Jasmine. Enhancement of vegetative growth by auxins may have contributed to overall increase in plant height. Awad et al. (1988) reported that the branch length increases with the

Table 1: Comparative evaluation of hardwood and semi hardwood cutting for sprouting percentage, and plant growth characters with different rooting hormone in (bougainvillea buttiana) cv. Mahara

| Treatments | Number of leaves/ cutting |
|------------|--------------------------|
| Days to first sprout | 3.720 |
| Number of buds sprouted / cutting | 0.016 |
| Sprouting percentage | 0.015 |
| Number of shoots per cutting | 0.014 |
| Length of longest shoot per cutting | 0.013 |
| Plant height | 0.012 |
| Stem girth | 0.011 |
| T1 | 2.833 |
| T2 | 3.000 |
| T3 | 3.000 |
| T4 | 3.000 |
| T5 | 3.000 |
| T6 | 3.000 |
| T7 | 3.000 |
| T8 | 3.000 |
| T9 | 3.000 |
| T10 | 3.000 |
| C.D. | 3.000 |
| SE(m) | 3.000 |

Table 2: Comparative evaluation of hardwood and semi hardwood cutting for pant growth characters with different rooting hormone in (bougainvillea buttiana) cv. mahara.

| Treatments | Number of shoots per cutting |
|------------|-----------------------------|
| Number of buds sprouted / cutting | 0.016 |
| Sprouting percentage | 0.015 |
| Number of leaves/ cutting | 0.014 |
| Length of longest shoot per cutting | 0.013 |
| Plant height | 0.012 |
| Stem girth | 0.011 |
| T1 | 2.833 |
| T2 | 3.000 |
| T3 | 3.000 |
| T4 | 3.000 |
| T5 | 3.000 |
| T6 | 3.000 |
| T7 | 3.000 |
| T8 | 3.000 |
| T9 | 3.000 |
| T10 | 3.000 |
| C.D. | 3.000 |
| SE(m) | 3.000 |

Root Characters and Mortality Rate
The results showed that a long dip (12hrs) treatment of IBA1500ppm for hardwood as well as semihardwood cuttings showed significantly better results than control and all the other treatments with respect to number of roots/cutting (26.943), length of longest root/ cutting (19.267cm), minimum mortality rate (40.00%) in hardwood cuttings and maximum number of roots (22.833), longest root (17.50cm), minimum mortality rate (60.00%) in semihardwood cuttings respectively. IBA is the most effective on promoting root initiation and adventitious root production in stem cuttings (Waisel, 1991) (29). The first adventitious roots appear from callus and they are main roots for cuttings. Callus contains a high amount of auxins [Hartman et al. (2002); Ercisli et al. (2001)]

Supported by the interaction of hereditary factors in stem cells and the following factors: auxin levels, leaves and buds on the cuttings, the amount of carbohydrates reservoir in the cuttings, stage of plant growth, stem location and a type of the cutting tissue (Rosier et al., 2006). Adventitious root formation is regulated by complex interactions between endogenous and exogenous factors which affect the various developmental stages of root formation. Increased rooting response of IBA in cuttings may be attributed to induction of more vigorous cell division at the basal end of cutting and increases accumulation of sugars, which favours callus formation and subsequently rooting. This is in conformity with findings of Sundharai et al. (2002)

Beneficial effects of IBA 2000ppm to 6000ppm were also reported by Singh and Motial (1979) in Bougainvillea cv. Thimma. Awad et al. (1988) and Chovatia et al. (1995) in Bougainvillea cv. Mary Palmer. Secondary growth is characterized by increase in girth of the plant which is attributed to auxins promoting cell division in the lateral meristem.
Gupta and Kher (1991) also reported the maximum length of root in Bougainvillea cuttings with 4000ppm IBA. Panwar et al. (1994) and Chovatia et al. (1995) also found similar results with the application of 2000ppm IBA and 4000ppm IBA, respectively in Bougainvillea. The present investigation was in confirmation with earlier findings. Mishra and Sharma (1995) studied the effect of plant growth regulators on rooting of stem cuttings of Bougainvillea and concluded that higher concentration of IBA (2000 ppm) significantly increased the rooting performance in Bougainvillea cvs. Dr. R. R. Pal and Mrs. H. C. Buck, which were difficult to root and cv. Dr. R. R. Pal performed better than Mrs. H. C. Buck. Sahariya et al. (2013) studied the effect of IBA (0, 1000, 1500, 2000 ppm), on rooting of Bougainvillea var. Thimma and the treatment with IBA 2000 ppm resulted in the maximum number of rooted cuttings (6.33).

Table 3: Comparative evaluation of hardwood and semi hardwood cutting for rooting characters and mortality rate with different rooting hormone in Bougainvillea buttiana cv. mahara.

| Treatments | Number of roots /cutting | Length of longest root | Mortality rate |
|------------|--------------------------|------------------------|---------------|
|            | Hardwood cuttings | Semi hardwood cuttings | Hardwood cuttings | Semi hardwood cuttings | Hardwood cuttings | Semi hardwood cuttings |
| T1         | 20.333 | 16.833 | 11.933 | 13.000 | 66.667 | 66.667 |
| T2         | 19.500 | 17.833 | 14.467 | 13.667 | 73.333 | 73.333 |
| T3         | 19.167 | 18.833 | 13.567 | 14.200 | 73.333 | 73.333 |
| T4         | 18.000 | 15.667 | 14.333 | 15.700 | 73.333 | 73.333 |
| T5         | 22.083 | 20.667 | 15.967 | 15.767 | 66.667 | 66.667 |
| T6         | 26.943 | 22.833 | 19.267 | 17.500 | 40.000 | 60.000 |
| T7         | 19.833 | 5.333 | 17.610 | 15.277 | 73.333 | 93.333 |
| T8         | 17.333 | 5.000 | 18.400 | 15.733 | 73.333 | 86.667 |
| T9         | 26.333 | 21.333 | 16.867 | 16.700 | 53.333 | 73.333 |
| T10        | 7.667 | 3.667 | 8.667 | 8.500 | 86.667 | 93.333 |
| C.D.       | 4.241 | 7.804 | 0.904 | 1.161 | 18.789 | 18.789 |
| SE(m)      | 1.428 | 2.627 | 0.304 | 0.391 | 6.325 | 6.325 |

Conclusion
The results showed that hardwood cuttings were found to give significantly better results than semihardwood cuttings treated with different rooting hormones (12hrs). A long dip (12hrs)treatment with IBA 1500ppm for hardwood cuttings was significantly better results than control and all the other treatments in all the respective observations taken and in case of semihardwood wood cutting the long dip (12hrs)treatment with IBA 1500ppm cuttings was significantly better than control and all the other treatments with respect to minimum days to first sprout, maximum sprouting percentage, maximum number of leaves /cutting, maximum length of longest shoot, maximum plant height, maximum Stem girth, maximum number of roots, longest root, minimum mortality rate whereas maximum vegetative buds sprouted was obtained in cuttings treated with NAA(1500ppm), maximum number of shoots per cutting was obtained in cuttings treated with IAA(1000ppm), IAA(1500ppm) and IBA(500ppm).

References
1. Abu-Zahra TR, Al-Shadaideh AN, Abubaker SM, Qurnfleh IM. Influence of auxin concentrations on different ornamental plants rooting. Int. J Botany. 2013; 9:96-99.
2. Ahmad N, Ishtiaq M, Nabi G. Influence of various concentrations of IBA on different types of Bougainvillea glabra var. Variegata cuttings. Sarhad J Agri. Pakistan. 2002; 18(3):263-270.
3. Alshammary SF, Shabha MA, Abbas MS. Rooting of white shrub and fire bush shrub hardwood cuttings using growth regulators quick dip treatments. J Food Agric Environ. 2013; 11:2775-80.
4. Awad AE, Dawh AK, Attya MA. Cutting thickness and auxin affecting the rooting and consequently the growth and flowering of Bougainvillea glabra L. Acta Hort. 1988; 226(2):445-454.
5. Chovatia VP, Poshiya VK, Shukla PT. Root initiation studies in bougainvillea (Bougainvillea peruviana L.) var. Mary Palmer. G.A.U. Res. J. 1995; 20(2):167-169.
6. Deshmukh KK, Barad AV. Effect of growth regulators on rooting of stem cutting in Bougainvillea buttiana var. Mahara. Crop Research, Hisar. 2006; 32(3):391-393.
7. Gadotra JK, Nair PKR, Dabey KC. Effect of potent growth regulators on propagation of four nodes cutting of Bougainvillea cv. Mary Palmer. Punjab Hort. J. 1975; 15(1-2):71-73.
8. Gupta VM, Banerji BK, Datta SK. Effect of auxin on the rooting and sprouting behavior of stem cuttings of Bougainvillea cv. Los Banos Vairegata Silver-Margin under mist. Haryana J Agri. Sci. 2002; 31(1-2):42-44.
9. Gupta VN, Kher MA. A note on the influence of auxins in regeneration of roots in the tip cutting of Bougainvillea sp. var. Garnet Glory under intermittent mist. Haryana J. Hort. Sci. 1991; 20(1-2):85-87.
10. Hartmann KT, Kester DE, Davies FT, Geneve RL. Plant Propagation: Principles and Practices, Prentice Hall, New Delhi, India, 2002.
11. H Mehraj, IH Shiam, T Toufique, S Shahrin, AFM Jamal Uddin. Influence of indole -3 - butyric acid (IBA) on sprouting and rooting potential of bougainvillea spectabilis cuttings. Bangladesh Res. Pub. J. 2013; 9(1):44-49.
12. Holtum RE. Bougainvillea. In: Manning’s Flowering Vines of World; An Encyclopedia of climbing plants. Edwin, A. (ed.). Hearthside press Inc. Publ. New York, 1970, 233-245.
13. Ibironke OA. Root initiation of bougainvillea from cuttings using different rooting hormones. Adv Plants Agric Res. 2019; 9(1):121–125. DOI: 10.15406/apar.2019.09.00421
14. Ingle MR, Venugopal GK. Effect of different growth regulators on rooting of stevia (Stevia rebaudiana Batons) cuttings. Karnataka J Agri. Sci. 2009; 22:460-461.
15. Masoossdi NA, Shrivastava LJ, Mir NA. Studies on the effect of growth regulators on initiation of rooting in cuttings of *Glycyrrhiza glabra* Linn. Indian J Plant Physiol. 1994; 1:28-29.
16. Mishra SN, Sharma CP. Effect of plant growth regulators on rooting of stem cutting of Bougainvillea. Prog. Hort. 1995; 27(1-2):37-38.
17. Mitra GC, Bose N. Rooting and histological responses of detached leaves to B- Indolebutyric acid with special reference to *Boerhavia diffusa* Linn. Phytomorphology. 1954; 7:370
18. Nagaraja GS, Rai Muthappa BC, Guruprasad TR. Effect of Intermittent mist and growth regulators on propagation of *Jasminum grandiflorum* by different types of cutting. Haryana J Wort. Sci. 1991; 20(3-4):183-188.
19. Pannerselvam K, Bhavanisankar K, Jayapragasam M, Kumar A, Radhakrishan P, Vijayraghavan A et al. Effect of growth regulators and planting media on rooting of cuttings in *Nothopodytes nimmoniana* Mabberily. Indian J. Plant Physiol. 2004; 9(3):308-312.
20. Panwar RD, Gupta AK, Sharma JR, Rakesh. Effect of growth regulators on rooting in Bougainvillea var. Alok. Int. J Trop. Agri. 1994; 12:2561.
21. Parmar BR, Patel VB, Bhalerao PP, Tank RV. Effect of different plant growth regulators on vegetative propagation of *Bougainvillea peruviana* cv. Touch Glory through hard wood cutting. The Asian J Hort. 2010; 5(1):222-224.
22. Ramdayal P, AK Gupta, RS Saini, JR Sharma. Effect of auxin on the rooting of cutting in Bougainvillea var. Mary Palmer. Haryana J Hort. Sci. 2001; 30:215-216.
23. Rosier CL, Frampton J, Goldfarb B, Blazich FA, Wise FC. Improving the rooting capacity of stem cutting of virginia pine by severe stumping of parent trees. Southern J Applied Forestry. 2006; 30(4): 172-181.
24. Sahariya K, Singh JN, Singh A. Studies on the effect of IBA on rooting of bougainvillea (var. Thimma) cuttings in open field and polyhouse conditions. The Asian J Hort. 2013; 8:140-42.
25. Sevik H, Guney K. Effect of IAA, IBA, NAA and GA3 on rooting and morphological features of *Melissa officinalis* L. stem cuttings. Scientific world Journal, 2013, 909507. doi:10.1155/2013/9095
26. Singh SP, Motial VS. Propagation of Bougainvillea cv. Thimma under intermittent mistI. Plant Sci. 1979; 11:53-59.
27. Stancato GC, Aguier FFA, Kanashiro S, Tavares AR. *Rhipsalis grandiflora* Haw. Propagation by stem cuttings. Scientia Agricola. 2003; 56:185-190.
28. Sundharai K, Ponnuswami V, Jaya Jasmine. Effect of growth regulators in the propagation of Thippli (Long pepper). South Ind. Hort. 2002; 48:172-174.
29. Waisel Y, Ashel A, Kafkafi U. Plant roots: the hidden half. New York; March dekker, Inc, 1991.