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# Auxins Treatment of Hardwood Cuttings of *Bougainvillea* for Inducing Rooting

**Anuradha and Parminder Singh**

*Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana-141 004, India*
*E-mail: choudharyanu41192@gmail.com*

***Abstract*:** In present studies, auxins were used to allow rooting in hard to root *Bougainvillea* varieties viz. Shubra, Lady Mary Bearing and Zakiriana. Hardwood cuttings of these varieties were treated with different auxins concentrations and combination with dipping them for a long duration (for 12 hours) with lower concentrations and then planted in polybags containing garden soil. The cuttings treated showed that NAA+IBA (100+100 ppm) resulted in maximum shoot emergence (40.00%) among all the treatments. The treatment with IBA 500 ppm resulted in maximum mean number of shoots (1.86), mean shoot length (7.11 cm), number of branches (1.84), number of roots (3.07). The maximum mean per cent establishment (35.56%) of plants was in combination treatment with NAA+IBA (100+50) ppm. Among all the three varieties, Zakiriana recorded maximum shoot emergence , number of shoot, ae shoot length number of leaves , number of branches , number of roots , length of roots and establishment of plants . This indicated that higher concentrations upto 500 ppm are more beneficial along with higher concentration combinations i.e. NAA+ IBA (100+100) ppm. IBA showed better results than NAA.

**Keywords:** *Bougainvillea*, Rooting, Hardwood, Auxins

*Bougainvillea* is very versatile plant, originated in South America, belongs to family Nyctinaginacea, has 14 species and 3 are horticulturally important: *B spectabilis* Willdenow, *B glabra* Choisy and *B peruviana* Humboldt and Bonpland (Heimerl 1900). *Bougainvillea*is a very hardy shrub most popular to be used as roadside plant, for shrubbery border, as standard shrub or as a beautiful pot plant or as hanging baskets too. Mainly for propagation, hardwood and semi-hardwood cuttings are used. In general, *Bougainvillea* is easy to root but few varieties are difficult to root, so they are treated with auxins solutions to initiate rooting in these difficult to root varieties. Use of growth regulators is crucial for floriculture industry. Auxins increases cell divisions and also cell enlargement, and results in hydrolysis of carbohydrates, accumulation of metabolites and synthesis of new proteins at site of application of auxins (Root tips). Auxin only initiates the rooting but do not increase the size of already sprouted roots but are helpful in stimulating adventitious root formation. Root promoting methods are mostly used to basal portions of cutting by using liquid and talc formulations of auxins (Naija et al 2009). An extended basal method may be utilized to for some difficult-to-root species, Hartmann et al (2002) and Ibironke (2019)also reported that root initiation in cuttings of *Bougainvillea* could be enhanced with IBA or dipped coconut water for 5 minutes enhanced growth. Auxins treatments are helpful as a conservative strategy to save those species which are otherwise difficult to root naturally. Shekhawat and Manokari (2016) first reported of vegetation propagation of *Couroupita guianensis*and its conservation and sustainable utilization of this medicinal tree. The objective of study is find out best rooting media for propagating *Bougainvillea* hardwood cuttings by dipping cuttings for long durations (12 hours) by using lower concentrations of auxins.

## MATERIAL AND METHODS

In this study, hardwood cuttings of three varieties of *Bougainvillea* i.e. Shubra, Lady Mary Baring and Zakiriana were treated with auxins solutions for rooting as these are hard to root varieties. The hardwood cuttings (8-10˝ long) of pencil thickness were be prepared during Jan-Feb, 2016 at Punjab Agricultural University by giving slanting cut at the upper end and straight cut below the basal bud and then planted in the polythene bagsin factorial completely randomized block design and each treatment was replicated thrice. Different solutions of auxins were IBA (Indole butyric acid) (100, 300 and 500 ppm) and NAA (Naphthalene acetic acid) (100, 300 and 500ppm) and their combinations i.e. NAA+IBA (50+100 ppm), NAA+IBA (100+50 ppm) and NAA+IBA (100+100 ppm) were used and cuttings were dipped for 12 hours with control (distilled water) and parameters of plants for rooting were taken after 4months of planting.

**Statistical analysis**: The data were analyzed by software CPCS1 and by Duncan's Multiple Range Test (DMRT).

## RESULTS AND DISCUSSION

The hardwood cuttings of all three varieties of *Bougainvillea* viz. Shubra, Lady Mary Baring and Zakiriana

planted after auxins treatments (long duration; 12h) exhibiting sprouting and (Table 2). The treatment of cuttings with auxins had significant effect on shoot emergence. The mean shoot emergence was maximum in NAA+IBA (100+100 ppm) (40.00%) and minimum in NAA 100 ppm (15.56%), irrespective of the varieties. The difference was significant among varieties, maximum in Zakiriana (44.33%) and followed by Lady Mary Baring and Shubra irrespective of auxins treatment. Renuka and Sekhar (2014)observed effect of IBA and NAA at different concentrations on the rooting of carnation (*Dianthus caryophyllus* L.) cuttings of cv. Dona recorded that IBA 200 ppm and IBA 100 ppm + NAA 50 ppm superseded the rest. Kumari et al (2013) reported in *Jatropha curcas* that IBA (200 ppm) resulted in early emergence of shoots, sprouting and rooting.

The treatment of cutting with auxins had non-significant effect on number of shoots per cuttingrecorded at monthly intervals (Table 1). The mean number of shoots was maximum in IBA 500 ppm (1.86) and minimum in control (0.98), irrespective of the varieties. The difference among varieties was significant, the maximum was in Zakiriana (1.69), followed by Lady Mary Baring . Shubra. Singh (2000) also reported thattreatment of cuttings with IBA (500 ppm) in *Bougainvillea peruviana* cv. Shubra resulted in number of shoots per cutting (1.37).

Auxinstreatment significantly affects the average shoot length and number of leaves as at monthly intervals (Table 1). The mean shoot length varied from to IBA 500 ppm to NAA+IBA (100+100 ppm) with non-significant differences. The minimum was in control (1.95 cm), irrespective of the varieties. The difference among varieties was non-significant and maximum shoot length was obtained in Zakiriana (6.12 cm), followed by Lady Mary Baring and Shubra, irrespective of auxins treatment. The number of leaves was at par in treatments but significantly better than the control (10.96), irrespective of the varieties. The difference had significant effect among the varieties, and was maximum was in Zakiriana, followed by Lady Mary Baring and Shubra, irrespective of auxins treatment.Singh (2000) reported in *Bougainvillea peruviana* cv. Shubra that the treatment of cuttings with IBA (500 ppm) resulted in significantly more sprouting and average shoot length.

Significant effect was observed by treating the cuttings with auxins on per cent of cutting exhibiting rooting and number of roots but treatments showed non-significant effect on average length of root (Table 3). The mean per cent of cutting exhibiting rooting was maximum in NAA+IBA (100+50 ppm) 40.00%) and minimum in control (15.60%), irrespective of growth regulator treatment. The difference among the varieties had significant effect on per cent of cutting exhibiting rooting and the maximum was in Zakiriana (43.40%), followed by Lady Mary Baring and Shubra, irrespective of auxins treatment. The mean number of roots was at par in all the treatments but was significantly better than all other treatments, however, minimum was in NAA 300 ppm (2.09), irrespective of the varieties. The difference among varieties was non-significant for number of roots, maximum was in Zakiriana (2.64), followed by Lady Mary Baring and Shubra,

**Table 1.** Comparative effect of different auxins treatments (12h) on number of shoots and hoot length (cm) in *Bougainvillea*

| Treatments (ppm) | Number of shoots | | | | Average shoot length (cm) | | | | Number of leaves | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Shubra | Lady Mary Baring | Zakiriana | Mean | Shubra | Lady Mary Baring | Zakiriana | Mean | Shubra | Lady Mary Baring | Zakiriana | Mean |
| NAA 100 | 0.67 | 1.52 | 1.85 | 1.35 | 3.30 | 4.73 | 4.09 | $4.04^{bcdefghi}$ | 9.67 | 26.12 | 29.37 | $21.71^{abcdef}$ |
| NAA 300 | 0.33 | 2.06 | 1.87 | 1.42 | 3.27 | 6.56 | 6.10 | $5.31^{abcdfg}$ | 4.67 | 31.86 | 35.95 | $24.16^{abcdef}$ |
| NAA 500 | 1.00 | 2.50 | 1.75 | 1.75 | 5.70 | 4.58 | 6.20 | $5.49^{abcdef}$ | 16.17 | 27.33 | 32.44 | $25.13^{abcd}$ |
| IBA 100 | 0.67 | 1.44 | 1.91 | 1.34 | 4.03 | 4.89 | 7.67 | $5.53^{abcde}$ | 10.67 | 29.28 | 34.83 | $24.93^{abcde}$ |
| IBA 300 | 1.17 | 1.89 | 1.75 | 1.60 | 6.08 | 8.79 | 5.68 | $6.85^{ab}$ | 18.50 | 26.89 | 36.50 | $27.30^{ab}$ |
| IBA 500 | 1.67 | 2.00 | 1.92 | 1.86 | 7.32 | 5.99 | 8.01 | $7.11^{a}$ | 19.83 | 28.45 | 27.66 | $25.32^{abc}$ |
| NAA+IBA (50+100) | 1.67 | 1.28 | 1.40 | 1.45 | 7.73 | 3.98 | 7.57 | $6.43^{abc}$ | 25.67 | 28.00 | 32.77 | $28.81^{a}$ |
| NAA+IBA (100+50) | 0.67 | 1.87 | 1.58 | 1.37 | 3.27 | 5.95 | 7.82 | $5.68^{abcd}$ | 9.67 | 26.03 | 32.26 | $22.65^{abcdef}$ |
| NAA+IBA (100+100) | 1.33 | 1.50 | 1.28 | 1.37 | 3.73 | 6.38 | 5.06 | $5.06^{abcdefgh}$ | 14.00 | 24.61 | 29.78 | $22.80^{abcdef}$ |
| Control | 0.78 | 0.56 | 1.61 | 0.98 | 1.30 | 1.58 | 2.97 | $1.95^{ij}$ | 8.00 | 8.44 | 16.44 | $10.96^{j}$ |
| Mean | $1.00^{c}$ | $1.66^{b}$ | $1.69^{a}$ | | 4.57 | 5.34 | 6.12 | | $13.68^{c}$ | $25.70^{b}$ | $30.80^{a}$ | |
| CD (p=0.05) | Varieties (A)=0.34; Auxins treatments concentrations (B)= NS; Interaction (A×B)= NS | | | | Varieties (A)= NS; Auxins treatments concentrations (B)=2.90; Interaction (A×B)= NS | | | | Varieties (A)=4.50; Auxins treatments concentrations (B)=8.21; Interaction (A×B) = NS | | | |

*Different letters in each column are significantly different at P≤0.05 by Duncan's Multiple Range Test (DMRT)

irrespective of the varieties. The mean shoot length of root (cm) was the maximum in IBA 300 ppm (12.76 cm) and minimum was in control (4.96 cm), irrespective of the varieties. The difference among the varieties was significant with respect to shoot length, however, the maximum shoot length was in Zakiriana (13.25 cm), followed by Lady Mary Baring and Shubra, irrespective of the auxins treatment. Shabha and Alshammary (2013) reported in *Bougainvillea* cv. Shubra that treatment of cuttings with IBA (500 ppm) resulted in the highest rooting percentage and more number of roots per cutting. Singh (2000) reported in *Bougainvillea peruviana* cv. Shubra, the treatment of cuttings with IBA (500 ppm) resulted in significantly more rooting (57.5%).

The treatment of cutting with auxins had significant effect

**Table 2.** Comparative effect of different auxins treatments on a percentage sprouting and percent establishment of plants in *Bougainvillea* at after 1 and 4 months

| Treatments (ppm) | Percent sprouting in cuttings | | | | Percent establishment of plants | | | |
|---|---|---|---|---|---|---|---|---|
| | Shubra | Lady Mary Baring | Zakiriana | Mean | Shubra | Lady Mary Baring | Zakiriana | Mean |
| NAA 100 | 6.67 | 36.67 | 40.00 | 27.78$^{e}$ | 6.67 | 33.33 | 33.33 | 24.44$^{e}$ |
| NAA 300 | 3.33 | 30.00 | 43.33 | 25.56$^{f}$ | 3.33 | 26.67 | 43.33 | 24.44$^{e}$ |
| NAA 500 | 13.33 | 16.67 | 63.33 | 31.11$^{c}$ | 13.33 | 16.67 | 63.33 | 31.11$^{b}$ |
| IBA 100 | 6.67 | 23.33 | 33.33 | 21.11$^{g}$ | 6.67 | 20.00 | 26.67 | 17.78$^{g}$ |
| IBA 300 | 16.67 | 13.33 | 30.00 | 20.00$^{h}$ | 16.67 | 13.33 | 30.00 | 20.00$^{f}$ |
| IBA 500 | 20.00 | 26.67 | 40.00 | 28.89$^{d}$ | 20.00 | 20.00 | 40.00 | 26.67$^{d}$ |
| NAA+IBA (50+100) | 16.67 | 30.00 | 50.00 | 32.22$^{b}$ | 13.33 | 30.00 | 40.00 | 27.78$^{c}$ |
| NAA+IBA( 100+50) | 6.67 | 26.67 | 86.67 | 40.00$^{a}$ | 6.67 | 23.33 | 76.67 | 35.56$^{a}$ |
| NAA+IBA (100+100) | 6.67 | 16.67 | 30.00 | 17.77$^{i}$ | 6.67 | 16.67 | 26.67 | 16.67$^{h}$ |
| Control | 10.00 | 10.00 | 26.67 | 15.56$^{j}$ | 6.67 | 6.67 | 16.67 | 10.00$^{j}$ |
| Mean | 10.67$^{c}$ | 23.00$^{b}$ | 44.33$^{a}$ | | 10.00$^{c}$ | 20.67$^{b}$ | 39.67$^{a}$ | |
| CD (p=0.05) | Varieties (A)= 0.54; Auxins treatments concentrations (B)=0.98; Interaction (A×B)= 1.70 | | | | Varieties (A)= 0.47; Auxins treatments concentrations (B)= 0.85; Interaction (A×B)= 1.48 | | | |

Different letters in each column are significantly different at P≤0.05 by Duncan's Multiple Range Test (DMRT)

**Table 3.** Comparative effect of different auxins treatments on a percent of cutting exhibiting rooting, number of roots and average length of roots (cm) of plants in *Bougainvillea* after 4 months

| Treatments (ppm) | Per cent of cutting exhibiting rooting | | | | Number of roots | | | | Average length of roots (cm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Shubra | Lady Mary Baring | Zakiriana | Mean | Shubra | Lady Mary Baring | Zakiriana | Mean | Shubra | Lady Mary Baring | Zakiriana | Mean |
| NAA 100 | 6.67 | 36.70 | 40.00 | 27.88$^{e}$ | 2.33 | 2.48 | 2.74 | 2.52$^{abcd}$ | 6.03 | 10.60 | 9.08 | 8.57 |
| NAA 300 | 3.33 | 30.00 | 43.33 | 25.66$^{f}$ | 1.00 | 2.75 | 2.52 | 2.09$^{abcdefghi}$ | 3.40 | 15.29 | 13.65 | 10.78 |
| NAA 500 | 13.33 | 16.77 | 63.33 | 31.11$^{c}$ | 2.83 | 3.00 | 2.44 | 2.76$^{abc}$ | 7.48 | 10.88 | 13.98 | 10.78 |
| IBA 100 | 6.67 | 23.33 | 33.33 | 21.11$^{g}$ | 2.00 | 2.56 | 2.89 | 2.48$^{abcef}$ | 4.90 | 11.73 | 17.19 | 11.27 |
| IBA 300 | 16.70 | 13.33 | 30.00 | 20.00$^{h}$ | 3.00 | 2.56 | 3.25 | 2.93$^{ab}$ | 9.00 | 16.54 | 12.75 | 12.76 |
| IBA 500 | 20.00 | 26.70 | 40.00 | 28.90$^{d}$ | 3.50 | 2.78 | 2.91 | 3.07$^{a}$ | 10.33 | 12.12 | 13.36 | 11.70 |
| NAA+IBA (50+100) | 16.70 | 30.00 | 50.00 | 32.22$^{b}$ | 3.00 | 2.14 | 2.40 | 2.51$^{abcde}$ | 11.82 | 9.47 | 16.02 | 12.43 |
| NAA+IBA (100+50) | 6.67 | 26.70 | 86.70 | 40.00$^{a}$ | 1.33 | 2.53 | 2.60 | 2.16$^{abcdefgh}$ | 3.90 | 13.51 | 16.61 | 11.34 |
| NAA+IBA (100+100) | 6.67 | 16.70 | 30.00 | 17.80$^{i}$ | 1.67 | 1.94 | 3.16 | 2.26$^{abcdefg}$ | 5.37 | 13.59 | 11.07 | 10.01 |
| Control | 10.00 | 10.00 | 26.70 | 15.60$^{j}$ | 0.83 | 0.67 | 1.50 | 2.15$^{abcdefghi}$ | 2.79 | 3.30 | 8.79 | 4.96 |
| Mean | 10.70$^{c}$ | 23.00$^{b}$ | 43.40$^{a}$ | | 2.15 | 2.34 | 2.64 | | 6.50$^{c}$ | 11.70$^{b}$ | 13.25$^{a}$ | |
| CD (p=0.05) | Varieties (A)= 0.54;Auxins treatments concentrations (B)= 0.98; Interaction (A×B)= 1.70 | | | | Varieties (A)= NS; Auxins treatments concentrations (B)=0.99; Interaction (A×B)= NS | | | | Varieties (A)= 2.70; Auxins treatments concentrations (B)= NS; Interaction (A×B)= NS | | | |

*Different letters in each column are significantly different at P≤0.05 by Duncan's Multiple Range Test (DMRT)

on per cent establishment of the cutting (Table 2). The mean per cent establishment was maximum in NAA+IBA (100+50) ppm (35.56%) and minimum in control (10.00%), irrespective of the varieties. The difference among varieties had significant effect and the maximum was in Zakiriana (39.67%), followed by Lady Mary Baring and Shubra, irrespective of growth regulator treatment. Similarly, Shabha and Alshammary (2013) reported in *Bougainvillea* cv. Shubra that treatment of cuttings with IBA (500 ppm) resulted in the highest establishment percentage. Singh (2000) reported in *Bougainvillea peruviana* cv. Shubra that the treatment of cuttings with IBA (500ppm) resulted in significantly more establishment of plant (51.67%) than all other treatment.

## CONCLUSION

The auxins treatment of hardwood cuttings of *Bougainvillea* by using lower concentrations for long duration (12h) method was the best percent rooting in NAA+IBA (50+100 ppm) and establishment of plants (%) was maximum in NAA+IBA (100+50 ppm).It is more beneficial to have more number of roots to have successful transplant as compared to length of roots, as with increasing number of roots, surface area to absorb nutrients and water from soil is more as compared with long roots, thus IBA 500 ppm is beneficial from this point of view having highest number roots and can be used in much easier way than making combinations. The study showed that either combinations or higher concentrations can be used for good results.

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