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Effect of growth regulator treatment on bud sprouting of hardwood cutting in different ornametal plants

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Abstract: The hardwood cuttings of *Calliandra haematocephala, Cassia biflora, Pyrostegia venusta* and *Clerodendrum splendens* were treated with different growth regulator concentrations and combinations (T1: NAA100 mg/l, T2: NAA 300 mg/l, T3: NAA 500 mg/l, T4: IBA100 mg/l, T5: IBA 300 mg/l, T6: IBA 500 mg/l, T7: NAA 100 mg/l + IBA 50 mg/l, T8: NAA 50 mg/l + IBA100 mg/l, T9: NAA 100 mg/l + IBA100 mg/l and T10: Control) for 12 h and planted either in polybags containing soil or in sand beds for callusing. The treatment of hardwood cuttings with T6: IBA (500 mg/l) for 12h resulted in the maximum (33.33%) mean per cent sprouting 60 days after direct planting in all the four genotypes. Among the genotypes, the per cent sprouting was significantly more in *C haematocephala*(47.33%), followed by *P venusta* (8.66%), *C splendens* (7.33%) and *C biflora* (7.33%), irrespective of the growth regulator treatment. The hardwood cuttings, planted in the sand beds for callusing (2 weeks) exhibited the maximum (28.33%) mean per cent sproutingwith T6: IBA (500 mg/l, 12h), 60 days after transplanting in the polybags in all the four genotypes. Among the genotypes, the per cent sprouting was significantly more in *C haematocephala*(48.67%), followed by *P venusta* (6.67%) and *C splendens* (2.67%), irrespective of the growth regulator treatment, however, the cuttings failed to exhibit sproutingin *C biflora*. The treatment of cutting with IBA 500 mg/l increase the sprouting percentage in *C haematocephala*, *P venusta and C splendens* which otherwise were difficult to propagate through cutting.

Keywords: *Calliandra haematocephala*, Growth Regulators, Hardwood cutting, IBA, NAA

INTRODUCTION

The ornamental shrubs and climbers rank next to the trees in landscape plant material especially where space is less for planting of the trees. *Calliandra haematocephala* (Leguminosae) and *Cassia biflora* (Leguminosae) are woody perennials shrubs with multiple stem and valued for their attractive shape, flowers and flower colour. Likewise, *Pyrostegia venusta* (Bignoniaceae) and *Clerodendrum splendens* (Verbenaceae) are also woody perennials climbers with multiple stem and bear modified organs (tendrils, thorns, rootlets etc.) to climb up the support (Arora, 2013).Vegetative propagation is the most important method for large scale propagation and is widely used for quick establishment of new plantations.The propagation of plants through layering in *C haematocephala*, *C biflora* and *P venusta* and root cuttings in *C splendens* limits the propagation due to extensive damage of the mother plants while propagation, However, the propagation of plants through cuttings is advantageous and treatment with synthetic growth regulators (Naphthalene acetic acid NAA and Indole butyric acid IBA) have been reported to improve rooting in many ornamental plants. The treatment of cuttings with combination of both IBA and NAA had significant effect on rooting of cuttings in *Tecomella undulata* (Karami and Salehi, 2010). In *Coriaria nepalensis* that cuttings resulted in the best rooting with IBA 100 mg/l treatment (Joshi *et al* 1992). The application of IBA significantly increased rooting of cutting in *Prunus spp.* (Ribeiro *et al*., 2010). The plant growth regulator treatments for short- and long – duration to induce rooting of cuttings have, therefore,been used by many research workers. The present investigation was undertaken in hard to root cuttings of four genotypes (*C haematocephala*, *C biflora*, *P venusta* and *C splendens*) by treating with different growth regulator concentrations and combinations for 12 hand planting directly in (i) polybags containing soil directly or (ii) after callusing in sand beds.

MATERIALS AND METHODS

This experiment was conducted at Department of floriculture and landscaping, Punjab Agricultural University, Ludhiana during 2012-13. The hardwood cuttings (≈15 cm long and thickness ≈5mm) of *C haematocephala*, *C biflora*, *P venusta* and *C splenden s*with uniform number of nodes (3-4) were prepared by giving slanting cut above the shoot bud on upper end and a straight cut below the basal bud (Hartmann *et al.,*2009). The cuttings were treated with different concentration of NAA, IBA or their combinations, for 12h viz. T1: NAA100 mg/l, T2: NAA 300 mg/l, T3: NAA 500 mg/

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l, T4: IBA100 mg/l, T5: IBA 300 mg/l, T6: IBA 500 mg/l, T7: NAA 100 mg/l + IBA 50 mg/l, T8: NAA 50 mg/l + IBA100 mg/l, T9: NAA 100 mg/l + IBA100 mg/l and T10: Control). The cuttings were treated with different concentration or their combinations of growth regulator by dipping basal end(≈1.0") of cuttings in the jars containing 100 ml of solution. The treated cuttings were planted directly either (i) in garden soil in the polybags or (ii) in the sand bed for callusing. The cuttings were transplanted after 2 weeks in poly bags (5" x7") containing the garden soil after callusing. The observations with respect to sprouting of shoot buds were recorded at 30-, 45- and 60 days after planting. The data was statistically analyzed using factorial completely randomized block design (Fisher, 1950).

RESULTS AND DISCUSSION

Per cent sprouting 30 days: In all the four ornamental plants viz.*Calliandra haematocephala, Cassia biflora, Pyrostegia venusta,* and *Clerodendrum splendens,* planted after growth regulator treatments (12 h), it was observed that the treatment of cuttings with growth regulators had significant effect on per cent sprouting 30 days after direct planting (Table 1). The mean per cent sprouting was at par in treatment with T5: IBA 300 mg/l (15.00%) and T6: IBA 500 mg/l (20.00%) and significantly better than all the other treatments, however, the minimum sprouting (1.66%) was observed in the control. Among the genotypes, the per cent sprouting was significantly more in *C haematocephala*(34.00%), followed by *C. splendens* (5.33%), *P venusta*(4.67%) and *C. biflora* (2.67%), irrespective of growth regulator treatment. Likewise, the hardwood cuttings treated with growth regulators planted after callusing had significant effect on per cent sprouting 30 days after planting (Table 1). The mean per cent sprouting (8.33%) was at par in treatment with T6: IBA 500 mg/l and T2: NAA 300 mg/l (8.33%), T9: NAA 100 mg/l + IBA100 mg/l (8.33%) and significantly better than all the other treatments, however, the minimum sprouting (1.67%) was observed in the control. Among the genotypes, the per cent sprouting was significantly more in *C. haematocephala* (20.00%) and no sprouting was observed in *C biflora*, *P. venusta* and *C. splendens*. Bud break percentage was enhanced by the application of IBA in conformity with the earlier findings in the *Desmodium elegans* (Chauhan *et al.,* 1996), *Ficus glomerata L.* (Bhatt and Badoni,1993), agroforestery trees (Bhatt and Todaria,1990) and *Glycyrrhiza glabra* linn. (Masoodi *et al.,* 1994). Similarly, in *Bougainvillea peruviana* cv. Shubra, the treatment of cuttings with IBA 500 ppm resulted in significantly more sprouting (71.67%) and establishment of plant (51.67%) than all other treatments, irrespective of duration (12, 24 h) of treatment and method of planting (Singh, 2000). The cuttings of *C biflora*, *P venusta* and *C splendens* failed to sprout might be due to higher concentrations beyond tolerable limits of cuttings leading to toxicity of the exogenously applied substances (Hartmann *et al.*, 2009). Sofi *et al*., (2016) reported that treatment of *Acer caesium* cutting with with IBA @ 8000 ppm showed maximum sprouting (74.50%). Stem cuttings of *Clerodendrum splendens* proved superior when treated with 20% IBA followed by 10% IBA. It was also suggested that stem cuttings need IBA at the rate of 20%, while root cuttings should be used without treating with IBA (Jamal *et al.,*2016).

Per cent sprouting after 45 days: It was observed that the treatment of cuttings with growth regulators had significant effect on per cent sprouting 45 days after direct planting in all the genotypes (Table 2), however, the mean per cent sprouting was significantly more in T6: IBA 500 mg/l (25.00%) than all the other treatments. The differences were non significant among rest of the treatments except T9: NAA 100 mg/l + IBA 100 mg/l (11.66%) and the control (3.33%). Among the genotypes, the per cent sprouting was significantly more in *C haematocephala* (40.00%), followed by *C splendens* (6.66%), *P venusta,* (6.66%) and *C biflora* (5.33%), irrespective of the growth regulator treatment. It was observed that treatment of cuttings with growth regulators for callusing had significant effect on per cent sprouting 45 days after planting (Table 2). The mean per cent sprouting was the maximum (23.33%) in treatment with T6: IBA 500 mg/l and at par among the T7: NAA 100 mg/l + IBA 50 mg/l (16.67%), T5: IBA 300 mg/l (15.00%) and T3: NAA 500 mg/l (15.00%). The minimum sprouting (1.67%) of cuttings was observed in the control. Among the genotypes, the per cent sprouting was significantly more in *C. haematocephala* (36.67%) followed by *C. splendens* (5.33%), *P. venusta* (2.00%), whereas, the cuttings failed to exhibit sprouting in *C. biflora*.

Hartmann *et al.* (2009) reported that IBA was the best auxin for general use because it was nontoxic to plants over a wide range of concentration than NAA, and was effective in promoting rooting of a large number of plant species. Cong (1991) also reported that *Prunus triloba* cuttings treated with IBA 500 ppm and planted in earthen pots containing garden soil resulted in the maximum survival of plants. Akhtar *et al*. (2015) observed that *Rosa centifolia* stem cuttings of treated with IBA 450 ppm produced maximum shoot length (10.67 cm). *Ficus benjamina* hard wood cuttings treated with IBA at 1000 ppm take minimum days to sprouting (Ingole *et al*., 2016). Ratnamala *et al*., (2014) reported that the hardwood cuttings of Phalsa treated with IBA at 200 ppm resulted in minimum number of days taken for sprouting (9.34), maximum number of sprouts per cutting (5.30).

Per cent sprouting after 60 days: It was observed that the treatment of cuttings with growth regulators had significant effect on per cent sprouting even 60

Table 1. Effect of growth regulator treatments (12h) on per cent sprouting in *Calliandra haematocephala, Cassia biflora, Pyrostegia venusta* and *Clerodendrum splendens* after 30 days of planting.

Treatments	Growth regulator concentration (mg/l)	Per cent sprouting of cuttings after direct planting					Per cent sprouting of cuttings after callusing				
		C haematocephala	*C biflora*	*P venusta*	*C splendens*	Mean	*C haematocephala*	*C biflora*	*P venusta*	*C splendens*	Mean
T_1	NAA100	33.33	0.00	0.00	6.66	10.00	6.67	0.00	0.00	0.00	1.66
T_2	NAA300	33.33	0.00	6.66	0.00	10.00	33.33	0.00	0.00	0.00	8.33
T_3	NAA500	40.00	6.66	0.00	6.66	13.33	13.33	0.00	0.00	0.00	3.33
T_4	IBA100	20.00	0.00	13.33	13.33	11.66	13.33	0.00	0.00	0.00	3.33
T_5	IBA300	40.00	6.66	13.33	0.00	15.00	26.67	0.00	0.00	0.00	6.66
T_6	IBA500	53.33	6.66	13.33	6.66	20.00	33.33	0.00	0.00	0.00	8.33
T_7	NAA100+IBA50	26.66	6.66	0.00	13.00	11.66	20.00	0.00	0.00	0.00	5.00
T_8	NAA50+IBA100	40.00	0.00	0.00	6.66	11.66	13.33	0.00	0.00	0.00	3.33
T_9	NAA100+IBA100	46.66	0.00	0.00	0.00	11.66	33.33	0.00	0.00	0.00	8.33
T_{10}	Control	6.66	0.00	0.00	0.00	1.66	6.67	0.00	0.00	0.00	1.67
	Mean	34.00	2.67	4.67	5.33		20.00	0.00	0.00	0.00	
L.S.D. (p = 0.05): Growth regulator concentration (A) = 5.05; Genotypes (B) = 7.99; Interaction (A×B) = 15.98							L.S.D. (p = 0.05): Growth regulator concentration (A) = 2.81; Genotypes (B) = 4.45; Interaction (A×B) = 8.89				

Table 2. Effect of growth regulator treatments (12h) on per cent sprouting in *Calliandra haematocephala, Cassia biflora, Pyrostegia venusta* and *Clerodendrum splendens* after 45 days of planting.

Treatments	Growth regulator concentration (mg/l)	Per cent sprouting of cuttings after direct planting					Per cent sprouting of cuttings after callusing				
		C haematocephala	*C biflora*	*P venusta*	*C splendens*	Mean	*C haematocephala*	*C biflora*	*P venusta*	*C splendens*	Mean
T_1	NAA100	40.00	6.66	0.00	6.66	13.33	33.33	0.00	0.00	0.00	8.33
T_2	NAA300	40.00	0.00	6.66	6.66	13.33	13.33	0.00	0.00	0.00	3.33
T_3	NAA500	46.66	13.33	0.00	0.00	15.00	60.00	0.00	0.00	0.00	15.00
T_4	IBA100	46.66	6.66	13.33	0.00	16.66	20.00	0.00	6.67	13.33	10.00
T_5	IBA300	26.66	6.66	26.66	13.33	18.33	53.33	0.00	6.67	0.00	15.00
T_6	IBA500	66.66	6.66	20.00	6.66	25.00	66.67	0.00	6.67	20.00	23.33
T_7	NAA 100+IBA50	26.66	13.33	0.00	26.66	16.66	26.66	0.00	0.00	6.67	16.67
T_8	NAA50+IBA100	46.66	0.00	0.00	6.66	13.33	33.33	0.00	0.00	0.00	3.33
T_9	NAA100+ IBA100	46.66	0.00	0.00	0.00	11.66	53.33	0.00	0.00	13.33	8.33
T_{10}	Control	13.33	0.00	0.00	0.00	3.33	6.67	0.00	0.00	0.00	1.67
	Mean	40.00	5.33	6.66	6.66		36.67	0.00	2.00	5.33	8.33
L.S.D.(p = 0.05): Growth regulator concentration (A) = 6.63; Genotypes (B) = 10.49; Interaction (A×B) = 20.98							L.S.D. (p = 0.05): Growth regulator concentration (A) = 4.19; Genotypes (B) = 6.63; Interaction (A×B) = 13.27				

Table 3. Effect of growth regulator treatments (12h) on per cent sprouting in *Calliandra haematocephala, Cassia biflora, Pyrostegia venusta* and *Clerodendrum splendens* after 60 days of planting.

Treatments	Growth regulator concentration (mg/l)	Per cent sprouting of cuttings after direct planting					Per cent sprouting of cuttings after callusing				
		C haematocephala	*C biflora*	*P venusta*	*C splandens*	Mean	*C haematocephala*	*C biflora*	*P venusta*	*C splendens*	Mean
T_1	NAA100	46.66	13.33	0.00	6.66	16.66	46.67	0.00	0.00	0.00	11.67
T_2	NAA300	53.33	13.33	0.00	0.00	16.66	40.00	0.00	0.00	0.00	10.00
T_3	NAA500	46.66	6.66	13.33	6.66	18.33	46.67	0.00	26.67	0.00	18.33
T_4	IBA100	46.66	6.66	6.66	0.00	15.00	26.66	0.00	0.00	0.00	6.67
T_5	IBA300	46.66	0.00	33.33	13.33	23.33	60.00	0.00	20.00	6.67	21.67
T_6	IBA500	80.00	13.33	26.66	13.33	33.33	93.33	0.00	6.67	13.33	28.33
T_7	NAA100+IBA 50	46.66	6.66	0.00	0.00	13.33	46.67	0.00	6.67	0.00	13.33
T_8	NAA50+ IBA100	33.33	6.66	0.00	26.66	16.66	40.00	0.00	0.00	0.00	10.00
T_9	NAA100+ IBA100	53.33	0.00	6.66	6.66	16.66	73.33	0.00	6.67	6.67	21.67
T_{10}	Control	20.00	6.66	0.00	0.00	6.67	13.33	0.00	0.00	0.00	3.33
	Mean	47.33	7.33	8.66	7.33		48.67	0.00	6.67	2.67	
L.S.D.(p = 0.05):		Growth regulator concentration (A) = 7.27; Genotypes (B) = 11.49; Interaction (A×B) = NS					L.S.D. (p = 0.05): Growth regulator concentration (A) = 5.31; Genotypes (B) = 8.39; Interaction (A×B) = 16.78				

days after direct planting in all the genotypes (Table 3). The mean per cent sprouting was significantly more in T6: IBA 500 mg/l (33.33%) than all the other treatments, however, the differences were non significant among T5: IBA 300 mg/l (23.33%), T3: NAA 500 mg/l (18.33%), T1: NAA 100 mg/l, T2: NAA 300 mg/l, T8: NAA 50 mg/l + IBA 100 mg/l and T9: NAA 100 mg/l + IBA 100 mg/l (16.66%). The minimum sprouting (6.67%) was observed in the control. Among the genotypes, the per cent sprouting was significantly more in *C haematocephala* (47.33%), followed by *P venusta* (8.66%), *C splendens* (7.33%), and *C biflora* (7.33%), whereas, the interaction was non significant in all the genotypes. Likewise, hardwood cutting treated with different growth regulator concentration and planted after callusing had significant effect on per cent sprouting even 60 days after planting in all the genotypes (Table 3). The mean per cent sprouting was significantly higher in T6: IBA 500 mg/l (28.33%) than all the other treatments, however, the differences were non significant among T5: IBA 300 mg/l (21.67%), T9: NAA 100 mg/l + IBA 100 mg/l (21.67%), and T3: NAA 500 mg/l (18.33%). The minimum sprouting (3.33%) was observed in the control. Among the genotypes, the per cent sprouting was significantly more in *C haematocephala* (48.67%) followed by *P venusta* (6.67%), *C splendens* (2.67%), whereas, *Cassia biflora* failed to exhibit sprouting. In *C haematocephala,* the per cent sprouting (93.33%) was significantly more in T6: IBA 500 mg/l than all the other treatments and minimum (13.33%) in the control.

The present findings regarding successful sprouting after long duration treatment of cuttings with growth regulators were in confirmation with the earlier findings in *Hamelia patens* with IBA (500 ppm) treatment of Alshammary and Shahba (2013). Nautiyal *et al*. (1991) also observed that *Tectona grandis* produced the best rooting when treated with IBA 100 ppm for 24 h and planted in soil: sand mixture (2:1) in the pots. In *Hamelia patens*, hardwood cutting treated with IBA 500 ppm resulted in significantly more sprouting (77.5%), irrespective of duration of treatment (12, 24 h) and method of planting (Singh, 2000).The enhancing effect with growth regulators might be due to enhanced hydrolysis of carbohydrates accumulation of metabolites at the site of application of auxins, synthesis of new proteins, cell enlargement and cell division induced by auxins (Strydem and Hartman, 1960). The hardwood cuttings of Flordaguard peach (*Prunus persica* L. Batch) treated with 3000 ppm IBA exhibit best vegetative growth and rooting percentage (Kaur, 2017). The shoot cuttings of *Couroupita guianensis* (Nagalingam) resulted in maximum (79%) of stem cuttings response to pre treatment with 300 mg L^{-1} indole-3-butyric acid (Shekhawat *et al.,* 2016).

Conclusion

In all the four genotypes *C haematocephala, C biflora, P venusta,* and *C splendens,* treatment of cuttings with T6: IBA 500 mg/l planted directly resulted in the maximum (33.33%) mean per cent sprouting 60 days after planting. Likewise, the cuttings treated with T6: IBA (500 mg/l) and planted in sand bed for callusing resulted in the maximum (28.33%) mean per cent sprouting, 60 days after planting. The treatment of cutting with IBA 500 mg/l and planting directly in soil help in better sprouting of cutting which otherwise difficult to propagate through hardwood cutting.

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