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Development of *in vivo* Plant Propagation Protocol in *Euphorbia milii* var. 'Pink Bold Beauty'

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A B S T R A C T

Experiment was conducted to develop plant propagation protocol via cutting in *Euphorbia milii* with the basic objective to enhance branching to obtain more number of cuttings for rooting and to standardize rooting treatment and rooting media. Pinching and foliar application of plant growth retardants significantly influenced vegetative growth and branching pattern of *Euphorbia milii*. Reduced plant height with thickest stem and maximum branches with more number of leaves was observed in pinched plants treated with Alar at 300 mg/l (P_1R_6) in var. 'Pink Bold Beauty'. Further, Maximum number of cuttings (7.19, 7.47) for propagation was obtained from pinched plants with foliar application of Alar at 300 mg/l during the experiment. Treatment of IBA (0, 250, 500, 750 mg/l) and rooting media (sand, cocopeat and cocopeat + banana pseudo stem fibers) significantly influenced rooting in cuttings of *Euphorbia milii* and their shoot growth. Cuttings treated with IBA (750 mg/l) as quick deep method and stumped in cocopeat media (M_2I_4) showed early sprouting with highest sprouting percentage. Cuttings of *Euphorbia* planted in cocopeat media after treatment of 750 mg/l IBA (M_2I_4) showed higher number of roots per cutting (14.37, 15.71), maximum root length (7.98, 9.27) and higher survival percentage (91.52, 89.03 %) in var. 'Pink Bold Beauty' during the consecutive years of study.

Introduction

Euphorbia milii (Crown of thorns, Christ plant and Christ-thorn) is a succulent species of flowering plant in the spurge family Euphorbiaceae and native to Madagascar. The species is mainly appreciated for the beauty of the inflorescence, continuous flowering and the hardiness of the plants (Jankalski, 2000). The plants of *Euphorbia* can be grown year-round in dry, high temperature and high solar radiation areas as potted, bedding, or garden plants (Jankalski, 2000). *Euphorbia milii* is a much esteemed plant for pot culture owing to its brilliant inflorescences. Crown of thorns is commercially propagated by tip cuttings (Smoley, 2000), but slow-growing and limited-branching habit is a major hurdle for propagation.

Physical control of apical dominance thorough pinching and application of plant growth retardants *viz.* Alar and TIBA aids to improve branching pattern in plants which can help for rapid multiplication through cuttings as quality planting material. Further,

rooting media and IBA treatment promotes rooting of ornamental plant cuttings. Hence, an experiment was planned in two parts to develop *in vivo* plant propagation protocol in *Euphorbia milii* in var. 'Pink Bold Beauty' with following objectives. Part – 1 was framed to study the effect of pinching and different plant growth retardants on branching habit of *Euphorbia* plants to obtain quality planting material for rapid multiplication. Part – 2 was designed for the standardization of rooting media and IBA concentration for efficient rooting in *Euphorbia* cuttings.

Materials and Methods

The present study was conducted in two different parts under naturally ventilated polyhouse located at ATC of Soilless System, Dept. of Floriculture and Landscape Architecture, ACHF, NAU, Navsari, Gujarat during 2015-2017. Both the experiments were laid out in Completely Randomized Design with Factorial concept (FCRD) and repeated thrice.

In part – 1, factor one consisted of two levels one being with pinching (P_1) and another without pinching (P_2) and factor two consists of 7 levels of foliar sprays, 50 mg/l TIBA (R_1), 100 mg/l TIBA (R_2), 150 mg/l TIBA (R_3), 100 mg/l Alar (R_4), 200 mg/l Alar (R_5), 300 mg/l Alar (R_6) and control *i.e.* no spray (R_7).

Pinching was performed at 5-6 cm height after transplanting of plants in pots. Apical portion of shoot was cut with the help of sharp secateurs. Spraying was followed two days after pinching at 15 days interval twice. The data on plant height (cm), stem girth (cm), number of leaves per plant, number of branches per plant were recorded at 30 and 60 DAS and number of cuttings suitable for rooting from each plant were harvested and recorded during the experiment.

In case of part – 2, uniform semi hardwood cuttings were collected from part – 1 and kept for overnight to prevent latex accumulation at basal end. Next day basal end of cuttings were treated with 0, 250, 500 and 750 mg/l Indole-3-Butyric Acid (IBA) by quick deep method. Cuttings were placed into trays filled with three different subtracts [sand (1 part), cocopeat (1 part) and cocopeat + banana pseudostem fiber (3:1 v/v)].

Rooting media were drenched every 15 days with 2 g/litre copper oxychloride for fungal disease control. Data on the sprouting percentage, days taken for new sprouting, length of shoot number of roots per cutting, root length and survival percentage were collected at 60 days after planting.

The statistical analysis was done by adopting the appropriate standard error (S.Em ±) method in each case as suggested by Panse and Sukhatme (1985).

Results and Discussion

Part – 1: Effect of plant growth regulation techniques on branching habit

Individual effect

Individual effects of pinching and foliar application of PGRs were found significant on plant height, stem girth, number of leaves per plant, number of branches per plant and number of cuttings per plant for propagation of *Euphorbia milii*. Pinched plants (P_1) showed minimum plant height with thickest stems and maximum branches with higher number of leaves as compared to unpinched plants (P_2) during experiment (Table 1). Among PGRs application, 300 mg/l Alar (R_6) reduced plant height with thicker stems and increase number of branches per plant with maximum leaves in *Euphorbia milii* which was followed by or at par with application of 200 mg/l Alar (R_5) during experiment.

Maximum number of cuttings was obtained from pinched plants as well as application of Alar at 300 mg/l concentration during both the seasons (Table 2).

Interaction effect

Foliar application of Alar at 300 mg/l in pinched plants (P_1R_6) recorded minimum plant height at 30 DAS (7.48 and 7.30 cm) as well as at 60 DAS (9.26 and 9.02 cm) with thicker stems and higher number of leaves during first and second year, respectively. Maximum plant height with minimum stem girth and leaves per plant was recorded in unpinched plants without any foliar application *i.e.* P_2R_{10} at 30 and 60 DAS during experiment. Auxins are synthesized in shoot apical meristems and young leaves, promote elongation and cell enlargement as a result of an increase in the intensity of an osmotic driving force and tend to inhibit the activation for rapid elongation and division of stem tissue (Taiz and Zeiger, 2003) (Table 3–5).

Table.1 Effect of pinching and plant growth retardants on plant height of *Euphorbia milii* var. 'Pink Bold Beauty' at 30 and 60 DAS

	2015-2016						2016-2017					
	30 DAS			60 DAS			30 DAS			60 DAS		
	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)
R_1	10.29	13.60	11.95	15.31	20.48	17.89	9.96	13.06	11.51	14.59	19.41	17.00
R_2	9.44	12.88	11.16	13.49	18.92	16.20	9.08	12.45	10.76	12.87	18.04	15.45
R_3	9.17	12.52	10.84	12.89	18.14	15.52	8.84	12.04	10.44	12.33	17.28	14.80
R_4	8.88	11.07	9.98	12.29	15.03	13.66	8.94	10.05	9.50	12.05	13.96	13.01
R_5	7.76	10.71	9.24	9.87	14.25	12.06	7.57	10.10	8.83	9.58	13.53	11.56
R_6	7.48	10.35	8.91	9.26	13.47	11.37	7.30	9.73	8.52	9.02	12.80	10.91
R_7	12.52	16.49	14.51	20.14	26.69	23.42	11.69	16.65	14.17	18.65	25.96	22.31
Mean (P)	9.37	12.52		13.32	18.14		9.05	12.01		12.73	17.29	
	P	R	P X R	P	R	P X R	P	R	P X R	P	R	P X R
S.Em. ±	0.05	0.09	0.13	0.02	0.04	0.06	0.22	0.42	0.59	0.31	0.59	0.83
C.D.	0.14	0.26	0.37	0.06	0.12	0.17	0.65	1.20	NS	0.91	1.71	NS

Table.2 Effect of pinching and plant growth retardants on stem girth of *Euphorbia milii* var. 'Pink Bold Beauty' at 30 and 60 DAS

	2015-2016						2016-2017					
	30 DAS			60 DAS			30 DAS			60 DAS		
	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)
R_1	2.02	1.50	1.76	2.24	1.72	1.98	1.91	1.35	1.63	2.45	1.81	2.13
R_2	2.05	1.53	1.79	2.30	1.78	2.04	1.92	1.37	1.65	2.50	1.85	2.18
R_3	2.11	1.68	1.89	2.34	1.93	2.13	1.96	1.54	1.75	2.50	2.05	2.28
R_4	2.21	1.79	2.00	2.45	2.01	2.23	2.04	1.65	1.85	2.63	2.16	2.39
R_5	2.38	1.95	2.16	2.61	2.17	2.39	2.21	1.80	2.00	2.82	2.33	2.58
R_6	2.44	2.02	2.23	2.68	2.26	2.47	2.26	1.87	2.07	2.88	2.44	2.66
R_7	1.64	1.21	1.42	1.87	1.45	1.66	1.50	1.09	1.30	1.98	1.52	1.75
Mean (P)	2.04	1.62		2.36	1.90		1.97	1.53		2.54	2.02	
	P	R	P X R	P	R	P X R	P	R	P X R	P	R	P X R
S.Em. ±	0.01	0.02	0.02	0.01	0.02	0.03	0.03	0.06	0.09	0.04	0.07	0.10
C.D.	0.02	0.04	NS	0.03	0.05	NS	0.10	0.19	NS	0.11	0.20	NS

Table.3 Effect of pinching and plant growth retardants on number of leaves per plant of *Euphorbia milii* var. 'Pink Bold Beauty' at 30 and 60 DAS

	2015-2016						2016-2017					
	30 DAS			60 DAS			30 DAS			60 DAS		
	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)
R_1	16.74	11.99	14.37	24.96	18.18	21.57	18.81	13.43	16.12	22.57	16.53	19.55
R_2	19.28	13.27	16.27	27.53	19.47	23.50	21.56	14.91	18.24	24.56	17.52	21.04
R_3	20.13	13.90	17.02	28.39	20.13	24.26	22.49	15.64	19.07	25.22	18.03	21.63
R_4	20.97	16.46	18.72	29.24	22.72	25.98	23.62	18.42	21.02	25.89	20.03	22.96
R_5	24.35	17.10	20.73	32.68	23.36	28.02	27.06	19.23	23.19	28.53	20.54	24.54
R_6	25.20	17.73	21.47	33.54	24.01	28.77	27.96	20.07	24.02	29.20	21.03	25.12
R_7	9.97	6.88	8.43	18.09	13.00	15.55	11.21	7.67	9.44	17.27	12.54	14.91
Mean (P)	19.52	13.91		27.78	20.12		21.82	15.64		24.75	18.03	
	P	R	P X R	P	R	P X R	P	R	P X R	P	R	P X R
S.Em. ±	0.38	0.71	1.01	0.44	0.82	1.15	0.27	0.51	0.72	0.45	0.85	1.20
C.D.	1.11	2.08	NS	1.27	2.37	NS	0.80	1.49	NS	1.32	2.47	NS

Table.4 Effect of pinching and plant growth retardants on number of branches per plant of *Euphorbia milii* var. 'Pink Bold Beauty' at 30 and 60 DAS

	2015-2016						2016-2017					
	30 DAS			60 DAS			30 DAS			60 DAS		
	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)
R_1	3.50	2.50	3.00	5.18	3.73	4.45	3.63	2.57	3.10	6.20	4.46	5.33
R_2	4.20	2.86	3.53	6.06	4.18	5.12	4.28	3.00	3.64	7.28	5.03	6.16
R_3	4.44	3.04	3.74	6.35	4.41	5.38	4.50	3.21	3.85	7.65	5.32	6.48
R_4	4.67	3.76	4.21	6.64	5.31	5.98	4.90	3.90	4.40	8.05	6.42	7.23
R_5	5.61	3.93	4.77	7.82	5.54	6.68	5.64	4.21	4.93	9.44	6.74	8.09
R_6	5.84	4.12	4.98	8.11	5.76	6.94	5.88	4.40	5.15	9.80	7.03	8.42
R_7	1.62	1.06	1.34	2.81	1.94	2.38	1.66	1.05	1.35	3.26	2.20	2.73
Mean (P)	4.27	3.04		6.14	4.41		4.36	3.19		7.38	5.32	
	P	R	P X R	P	R	P X R	P	R	P X R	P	R	P X R
S.Em. ±	0.04	0.07	0.10	0.08	0.14	0.20	0.05	0.09	0.13	0.10	0.18	0.26
C.D.	0.11	0.20	0.27	0.22	0.42	0.59	0.14	0.27	0.39	0.28	0.53	0.75

Table.5 Effect of pinching and plant growth retardants on number of cuttings per plant of Euphorbia milii var. 'Pink Bold Beauty'

	2015-2016			2016-2017		
	P_1	P_2	Mean (R)	P_1	P_2	Mean (R)
R_1	4.47	3.26	3.87	4.71	3.43	4.07
R_2	5.28	3.61	4.45	5.54	3.80	4.67
R_3	5.55	3.79	4.67	5.80	3.99	4.90
R_4	5.70	4.62	5.16	5.97	4.82	5.40
R_5	6.91	4.69	5.80	7.18	4.92	6.05
R_6	7.19	4.88	6.03	7.47	5.10	6.29
R_7	2.47	1.73	2.10	2.66	1.86	2.26
Mean (P)	5.37	3.80		5.62	3.99	
	P	R	P X R	P	R	P X R
S.Em. ±	0.09	0.17	0.24	0.09	0.18	0.25
C.D.	0.27	0.50	0.71	0.27	0.51	0.72

Table.6 Effect of different rooting media and IBA concentrations on shoot parameters of *Euphorbia milii* cutting var. 'Pink Bold Beauty'

	Number of days to new sprout								Percentage of Sprouted Cuttings								Length of Shoot (cm)							
	2015-2016				2016-17				2015-2016				2016-17				2015-2016				2016-17			
	M_1	M_2	M_3	Mean (I)	M_1	M_2	M_3	Mean (I)	M_1	M_2	M_3	Mean (I)	M_1	M_2	M_3	Mean (I)	M_1	M_2	M_3	Mean (I)	M_1	M_2	M_3	Mean (I)
I_1	32.01	31.44	36.93	33.46	31.45	29.86	34.58	31.97	77.45	80.84	68.29	75.53	72.36	73.82	71.28	72.48	10.92	11.11	10.80	10.94	10.72	10.81	10.35	10.63
I_2	28.84	28.17	37.59	31.53	26.94	29.58	32.77	29.76	84.96	88.80	82.57	85.44	80.17	86.10	76.21	80.83	11.73	12.46	11.35	11.84	11.93	12.55	11.54	12.01
I_3	30.41	26.16	32.20	29.59	31.00	27.13	32.94	30.35	85.00	90.21	83.20	86.14	82.69	83.03	77.64	81.12	11.92	12.77	11.61	12.10	12.12	12.59	11.60	12.10
I_4	28.29	25.99	31.11	28.46	25.47	24.06	30.22	26.58	87.16	94.19	84.66	88.67	82.80	87.11	77.83	82.58	12.20	13.18	11.71	12.38	12.44	12.75	11.72	12.30
Mean (M)	29.89	27.94	34.46		28.71	27.66	32.62		83.64	88.51	79.68		79.51	83.77	75.74		11.69	12.38	11.38		11.80	12.18	11.30	
	M	I	M X I		M	I	M X I		M	I	M X I		M	I	M X I		M	I	M X I		M	I	M X I	
S.Em. ±	0.70	0.81	1.40		0.70	0.80	1.39		2.36	2.72	4.71		2.43	2.81	4.86		0.28	0.33	0.57		0.33	0.38	0.66	
C.D.	2.05	2.36	NS		2.04	2.36	NS		6.92	7.99	NS		NS	8.24	NS		NS	0.92	NS		NS	1.12	NS	

Table.7 Effect of different rooting media and IBA concentrations on root parameters of *Euphorbia milii* cutting var. 'Pink Bold Beauty'

	Number of roots per cutting								Length of roots (cm)								Survival Percentage							
	2015-2016				2016-17				2015-2016				2016-17				2015-2016				2016-17			
	M_1	M_2	M_3	Mean (I)	M_1	M_2	M_3	Mean (I)	M_1	M_2	M_3	Mean (I)	M_1	M_2	M_3	Mean (I)	M_1	M_2	M_3	Mean (I)	M_1	M_2	M_3	Mean (I)
I_1	10.10	10.37	9.14	9.87	9.68	9.77	9.51	9.65	5.12	5.21	4.87	5.07	4.92	5.30	4.91	5.05	65.95	69.68	67.83	67.82	76.12	63.56	59.68	66.45
I_2	12.71	12.90	11.24	12.28	12.09	13.08	10.72	11.96	5.68	6.55	5.34	5.86	6.15	7.27	5.42	6.28	72.82	80.20	72.92	75.32	71.72	73.48	73.23	72.81
I_3	12.79	13.09	11.49	12.46	12.10	13.86	10.86	12.27	6.34	7.68	5.35	6.46	6.72	7.74	5.57	6.68	74.99	76.07	69.55	73.53	65.16	84.42	68.06	74.08
I_4	12.82	14.37	12.19	13.13	12.40	15.71	11.84	13.32	6.43	7.98	5.57	6.66	7.20	9.27	5.69	7.39	78.14	91.52	68.11	79.26	69.00	89.03	69.69	75.91
Mean (M)	12.11	12.68	11.02		11.57	13.10	10.73		5.89	6.86	5.28		6.25	7.40	5.40		72.98	79.36	69.90		70.50	77.62	67.67	
	M	I	M X I		M	I	M X I		M	I	M X I		M	I	M X I		M	I	M X I		M	I	M X I	
S.Em. ±	0.31	0.36	0.62		0.33	0.38	0.66		0.12	0.14	0.23		0.13	0.15	0.26		1.58	1.83	3.16		1.95	2.26	3.91	
C.D.	0.91	1.05	NS		0.97	1.12	NS		0.34	0.40	0.69		0.38	0.44	0.76		4.64	5.36	9.28		5.74	NS	11.48	

Reduction of the shoot growth and internodal length of many ornamental plants can be obtained by the use of synthetic plant growth retardants like Alar and TIBA (Warner and Erwin, 2003) and by elimination of the apical dominance (Lodeta *et al.,* 2010 and Hashemabadi *et al.,* 2012). According to Menhennet (1980), Alar blocks particularly 3β-hydroxylation, which inhibits formation of highly active GA_3 from inactive precursors at late stage (stage 3) of GA metabolism and thereby affects plant height in plants. The application of Alar has been shown to reduce the plant height in a number of plant species such as Chrysanthemum (Kahar, 2008) and Poinsettia (Lodeta *et al.,* 2010). Increase in production of more leaves may be related to increase in number of branches due to inhibition of apical dominance caused by auxin and diversion of photosynthets towards the axillary buds as explained earlier in China aster by Gyandev (2006) and in rose by Shivangi (2012).

Pinched plants treated with Alar at 300 mg/l (P_1R_6) significantly produced maximum number of branches at 30 DAS (5.84 and 5.88) and at 60 DAS (8.11 and 9.80) as well as maximum number of cuttings (7.19 and 7.47) which was at par with P_1R_8 treatment combination. Minimum number of branches and number of cuttings were observed in unpinhced plants without any retardants treatment *i.e.* P_2R_{10} during both the seasons. Vegetative or generative organs in ornamental plant production can be manipulated by removing of apical buds for controlling growth parameters and to increase branching production. Heuvelink and Buiskool (1995) and Jovicich *et al.,* (1999) postulated that after removal of apical bud the sink-source ratio is influenced which alters the growth parameters and enhances branching pattern in plants. Influence of pinching on vegetative growth has been similar in carnation (Dalal *et al.,* 2006) and chrysanthemum (Singh and Baboo, 2003). Further, suppression of apical dominance induces the lateral vegetative bud growth (Cathey and Stuart, 1961) which leads to increase number of branches and ultimately in the plant spread.

Part – 2: Effect of IBA and media on rooting of semi hardwood cuttings of *Euphorbia milii*

Cuttings stumped in M_2 media *i.e.* cocopeat showed highest percentage of sprouted cuttings (88.51 and 83.77 %) with longest shoots (12.38 and 12.18 cm) and early sprouting (27.94 and 27.66 days) which was followed by sand media *i.e.* M_1 during first and second year respectively. Further, treatment of 750 mg/l IBA (I_4) showed maximum sprouting percentage (88.67 and 82.58 %) with longest shoots (12.38 cm and 12.18 cm) which took minimum days for new sprouts (28.46 and 26.58 days) which was statistically at par with 500 mg/l (I_3) and 250 mg/l IBA (I_2) concentration during both the years. Lowest percentage of sprouted cutting with delay in sprouting was noted in untreated cuttings (I_1) during experiment. However, interaction effect of rooting media and IBA concentration was found non-significant. Minimum days for sprouting with highest percentage of sprouted cuttings was a result of good drainage in cocopeat media as well as in sand media, which kept media free from microbial action in periphery of rooting region of cuttings. An appropriate rooting medium generally has to have an optimal volume of gas filled pore space and oxygen diffusion rate adequate for the needs of respiration (Fonteno and Nelson, 1990). Maximum growth of cutting and biomass was probably due to the suitable combination of physical condition comprising of water holding condition and porosity of the cocopeat and sand media. Application of IBA at different concentrations had significant effect on shoot parameters. The stored food material present in the cutting is mobilized with the aid of growth regulators, which

hastens sprouting. Early sprouting of shoots with more number of leaves and shoots with auxin treatments was also observed in bougainvillea (Seyedi *et al.*, 2014) and in pink mussanda (Patel, 2009).

Cuttings grown in cocopeat media (M_2) showed significantly higher number of roots (12.68 and 13.10) and longest roots (6.86 and 7.40 cm) during first and second year, respectively. Whereas minimum number of shortest roots were noted in the cuttings grown in media M_3 *i.e.* mixture of cocopeat and banana pseudostem fibers during the experiment. In case of IBA application, cuttings treated with 750 mg/l IBA recorded maximum number of roots (13.13 and 13.32) and longest roots (6.66 and 7.39 cm) during both the seasons, respectively. Untreated cuttings (I_1) exhibited minimum number of roots per cuttings and root length during the experiment. In addition, treatment combination M_2I_4 *i.e.* application of 750 mg/l IBA with cocopeat media resulted in longest root per cutting during first year (7.98 cm) and second year (9.27 cm) which was significantly at par with M_2I_3 treatment combination. Ofori-Gyamfi (1998) reported that rooting performance depends on the type of medium and its physical properties used in the propagating structure. The beneficial effect of root formation in stem-cuttings may be affected by physical and chemical characteristics of rooting substrates *viz.* media texture, structure, bulk density, porosity, water-holding capacity, pH, temperature and oxygen *etc.* (Kester *et al.,* 1990 and Larsen and Guse, 1997) which allows promotion or inhibition of root growth (Hartmann *et al.*, 1997). The differences in rooting ability of various species propagated in different rooting media could be explained by xeromorphic or hydromorphic status of media (Loach, 1992) and the effects of this status on the water relations of the cuttings (Mensen *et al.,* 1997). Improvement of the formation and growth of roots of *Euphorbia* cuttings in cocopeat subtract could be linked to a likely increase of air content and oxygen diffusion rate than in sand media as also reported by Gislerod (1983) for Poinsettia cuttings.

Individual effect of rooting media and IBA concentrations significantly influenced survival rate of *Euphorbia milii* cuttings during both the seasons. In case of combined effect of rooting media and IBA concentrations, maximum survival percentage was recorded in (91.52 and 89.03 %) in the cuttings grown in cocopeat media with treatment of 750 mg/l IBA (M_2I_4) which was followed by M_2I_3 treatment combination during first and second year. However, minimum survival percentage recorded in untreated cuttings grown in mixture of cocopeat + banana pseudostem fiber *i.e.* M_3I_1 (Table 6 and 7). According to Davis and Hassig (1990), the production of adventitious roots in plants through cell division, multiplication and specialization is also controlled by plant growth substances especially auxins. Auxin has been well known to promote adventitious root formation and accelerate root initiation (Lee *et al.,* 2000; Ibàñez-Torres, 2004) and increase the number and percentage of rooted cuttings as well as quality of roots produced per cutting (Leonardi *et al.,* 2001). Enhanced rooting of the *Euphorbia* stem cuttings treated with 750 mg/l IBA concentration is concordant with the findings by Aminah *et al.,* (2006) in which application of 0.8% IBA recorded the highest rooting percentage in stem cuttings of *Shorea parvifolia* and *Shorea macroptera.* Further, better root initiation and root growth lead to higher survival percentage with decrease in mortality rate by rotting of *Euphorbia* cuttings as also reported by Jo (1990). Auxins at different concentrations have been reported to differentially influence adventitious rooting and establishment rate in *Poinsettia pulcherrima* (Shirol *et al.,* 1992 and Sochacki and Chmiel, 1994) and in Bougainvillea (Sahariya *et al.,* (2013).

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