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Studies on propagation of Eugenia (*Eugenia myrtifolia*)

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Abstract
The experiment was conducted during January to July 2022 in the mist house of Department of Floriculture and Landscape Architecture, Kittur Rani Channamma College of horticulture, Arabhavi. The experiment was laid out in Factorial Completely Randomized Design (FCRD) concept 12 treatment combination consisting of different types of cutting and growth regulator levels with three replications. Types of cutting and growth regulator levels had significant effect on shoot root parameters. Minimum number of days taken for sprouting (75.60 days), more number of shoots (2.87, 3.40 and 3.47 at 120, 135 and 150 days after planting), Minimum number of days required for root initiation (68.07 days), more number of roots per cuttings (10.60) and percentage of rooted cuttings (71.67%) were recorded in semi-hard wood cuttings treated with IBA @ 2000 ppm.

Keywords: Eugenia, IBA treatments, Number of days taken for sprouting and rooting, number of shoots and roots and rooting percentage

1. Introduction

Eugenia (*Eugenia myrtifolia* L.) is a worldwide plant considered as versatile evergreen shrub or tree. It is native to temperate and tropical rainforests of Australia. It belongs to family Myrtaceae. It is known for its attractive glossy foliage especially when its branches were regularly trimmed. Nowadays, it is a highly in demand ornamental plant by many landscapers and household ornamental enthusiasts not only because of its attractive bushy type foliage but also because of its foliage which is easily transformed into different shapes or made into topiaries. Its youn g shoots are red in colour and later they turn in to pale green to dark green. So it brings mobility in the garden. It is commonly propagated by stem cuttings because of its irregular seed production (Toussaint *et al*., 1991) [18]. Per cent regeneration of *Eugenia* stem cuttings is generally low and often cuttings require longer time to form adventitious roots compared to other plant species (Mcmullen, 2011) [8].

The purpose of usage of plant growth regulators in propagating plants through cutting is to hasten root and shoot initiation, increase roots number and thereby increase the uniformity in the rooted cuttings. Use of proper concentration is also a major thing, as its' over concentration may be injurious or a small quantity may be of no use in root induction.

In this context, the effect of IBA in inducing or hastening rooting varies with the crop species, types of cutting and concentration used as well. Therefore, keeping the above points in view, *Eugenia* being a hard-to-root type present research was carried out at in the mist house of Department of Floriculture and Landscape Architecture, Kittur Rani Channamma College of Horticulture, Arabhavi to studies effect of types of cutting and different growth regulator levels on propagation of *Eugenia myrtifolia*.

2. Material and Methods

2.1 Experimental details: The research was carried out in the mist house of Department of Floriculture and Landscape Architecture, Kittur Rani Channamma College of Horticulture, Arabhavi. The planting material was obtained from uniformly grown shrubs of *Eugenia myrtifolia* from Kittur Rani Channamma College of Horticulture, Arabhavi. Tip cuttings with 3 to 4 nodes or of length 10 to 15 cm retained with two to three pairs of leaves and one or two pairs of leaves in partially lignified semi-hard wood cuttings were used for the experiment. The two types of cuttings were treated with different concentrations of IBA with twenty cuttings in each treatment. Cuttings were treated for 10 minutes and planted in the media made up of cocopeat and sand in 3:1 ratio. The experiment was laid out in Factorial Completely Randomized Design (FCRD) concept with three replications.

2.2 Treatment details
Factor I: Types of cutting g (C)
C_1: Tip cutting
C_2: Semi hard wood cutting

Factor II: Growth regulator levels (G)

G_1	Control	G_4	IBA- 1500 ppm
G_2	IBA- 500 ppm	G_5	IBA- 2000 ppm
G_3	IBA- 1000 ppm	G_6	IBA- 2500 ppm

3. Results and Discussion
3.1 Number of days taken for sprouting
The data noted on number of days taken for sprouting showed significant difference between two types of cuttings. Early shoot initiation was recorded in semi-hard wood cuttings (85.15 days) in comparison to tip cuttings (92.48 days). It might be because of utilization of readily available sugars in addition to the stored carbohydrates and nitrogen present in semi-hardwood cuttings. Higher nitrogen content in partially matured cuttings might be utilized for cell division and differentiation and resulted in early sprouting of semi-hard wood cuttings (Parmar, 2015) [12]. Similarly, better results of semi hardwood cuttings were given by Tiwari *et al.* (2016) [17] in *Dillenia pentagyna*, Wazir (2014) in *Camellia japonica* and Neelima *et al*. (2018) [11] in jasmine.

The data related to number of days taken for sprouting indicated that there was significant effect due to the application of auxin at different concentrations on cuttings. Among different levels of IBA, cuttings treated with IBA @ 2000 ppm (G_5) took minimum days for sprouting (78.20 days) whereas, maximum number of days taken for sprouting was recorded in the cutting without IBA treatment (G_1) (99.10 days). Due to the vigorous root system developed as a result of higher concentration of IBA had increased the nutrient uptake, which in turn affected the cell division in the vascular cambium and differentiation into different types of functional cells and resulted in early shoot in itiation (Devi *et al*., 2016) [4]. Similar results were reported by Sahariya *et al.* (2013) [13] in bougainvillea var. Thimma and Thakor *et al*. (2017) [16] in *Jasminum sambac*.

The interaction effect was significant between types of cuttings and auxin levels with respect to number of days taken for sprouting. Minimum days was recorded in semi-hard wood cuttings treated with IBA @ 2000 ppm (C_2G_5) (73.50 days) whereas, tip cuttings without IBA treatment (C_1G_1) took maximum days for sprouting (102.00 days). Exogenous application of IBA might have converted in to IAA, enhanced the rate of synthesis of endogenous IAA or increased the tissue sensitivity to IAA, which favored mobilization and utilization of the stored carbohydrates, nitrogenous substances in the semi-hardwood cuttings, which resulted in early initiation of shoot (Severino *et al*., 2011) [14]. These results were in accordance with Shabha and Alshammary (2013) [15] in *Hamelia patens and Bougainvillea peruviana* cv. Shubra and Asl *et al.* (2012) [1] in bougainvillea.

Table 1: Number of days taken for sprouting and number of shoots per cutting as influenced by types of cuttings and growth regulator levels and their interaction effect in *Eugenia myrtifolia*

Treatments	Number of Days taken for sprouting	Number of shoots/ cutting		
		120 (DAP)	135 (DAP)	150 (DAP)
Factor A (C-Types of cutting)				
C_1: Tip cuttings	92.48	1.97	2.44	2.73
C_2 : Semi-hardwood cuttings	85.15	2.23	2.76	2.92
S.Em±	0.30	0.02	0.04	0.04
C.D (5%)	0.87	0.06	0.11	0.12
Factor B (G- Growth regulator)				
G_1: Control	99.10	1.33	1.62	1.90
G_2: IBA @ 500 ppm	85.05	2.40	2.98	3.20
G_3: IBA @ 1000 ppm	96.05	1.72	2.15	2.33
G_4: IBA @ 1500 ppm	86.85	2.13	2.60	2.93
G_5: IBA @ 2000 ppm	78.20	2.65	3.23	3.33
G_6: IBA @ 2500 ppm	87.65	2.35	3.00	3.25
S.Em±	0.51	0.04	0.06	0.07
C.D (5%)	1.50	0.11	0.18	0.21
Factor A x B (C X G)				
C_1G_1	102.00	1.27	1.50	1.73
C_1G_2	83.40	2.50	3.07	3.33
C_1G_3	101.00	1.83	2.13	2.33
C_1G_4	91.10	1.67	2.07	2.67
C_1G_5	82.90	2.43	3.07	3.20
C_1G_6	94.50	2.10	2.80	3.10
C_2G_1	96.20	1.40	1.73	2.07
C_2G_2	86.70	2.30	2.90	3.07
C_2G_3	91.10	1.60	2.17	2.33
C_2G_4	82.60	2.60	3.13	3.20
C_2G_5	73.50	2.87	3.40	3.47
C_2G_6	80.80	2.60	3.20	3.40
S.Em±	0.73	0.05	0.09	0.10
C.D (5%)	2.12	0.16	0.26	0.29

DAP: Days After Planting

3.2 Number of shoots per cuttings

Types of cuttings had significant effect on number of shoots per cuttings at 120, 135 and 150 DAP. More number of shoots was recorded in semi-hard wood cuttings (2.23, 2.76 and 2.92 at 120, 135 and 150 DAP, respectively) as compared to tip cuttings (1.97, 2.44 and 2.73 at 120, 135 and 150 DAP, respectively). It might be because of higher nitrogen content in partially matured cuttings might be utilized for cell division and differentiation and resulted more number of shoots in semi-hard wood cuttings (Parmar, 2015) [12].

The data related to number of shoots per cuttings at 120, 135 and 150 DAP showed significant difference between different levels of auxin. Among different concentrations of IBA, cuttings treated with IBA @ 2000 ppm (G_5) resulted in more number of shoots (2.65, 3.23 and 3.33 at 120, 135 and 150 DAP, respectively. However, minimum number of shoots (1.33, 1.62 and 1.90 at 120, 135 and 150 DAP, respectively) was recorded in the cuttings which were not treated with IBA (G_1). It might be because of higher concentration of IBA resulted in early shoot initiation, hence more number of shoots were recorded.

The interaction effect was significant between types of cuttings and auxin levels with respect to number of sh oots per cuttings at 120, 135 and 150 DAP. Semi-hard wood cuttings treated with IBA @ 2000 ppm (C_2G_5) resulted in more number of shoots (2.87, 3.40 and 3.47 at 120, 135 and 150 DAP, respectively). Minimum number of shoots (1.27, 1.50 and 1.73, at 120, 135 and 150 DAP, respectively) was observed in tip cuttings without IBA treatment (C_1G_1).

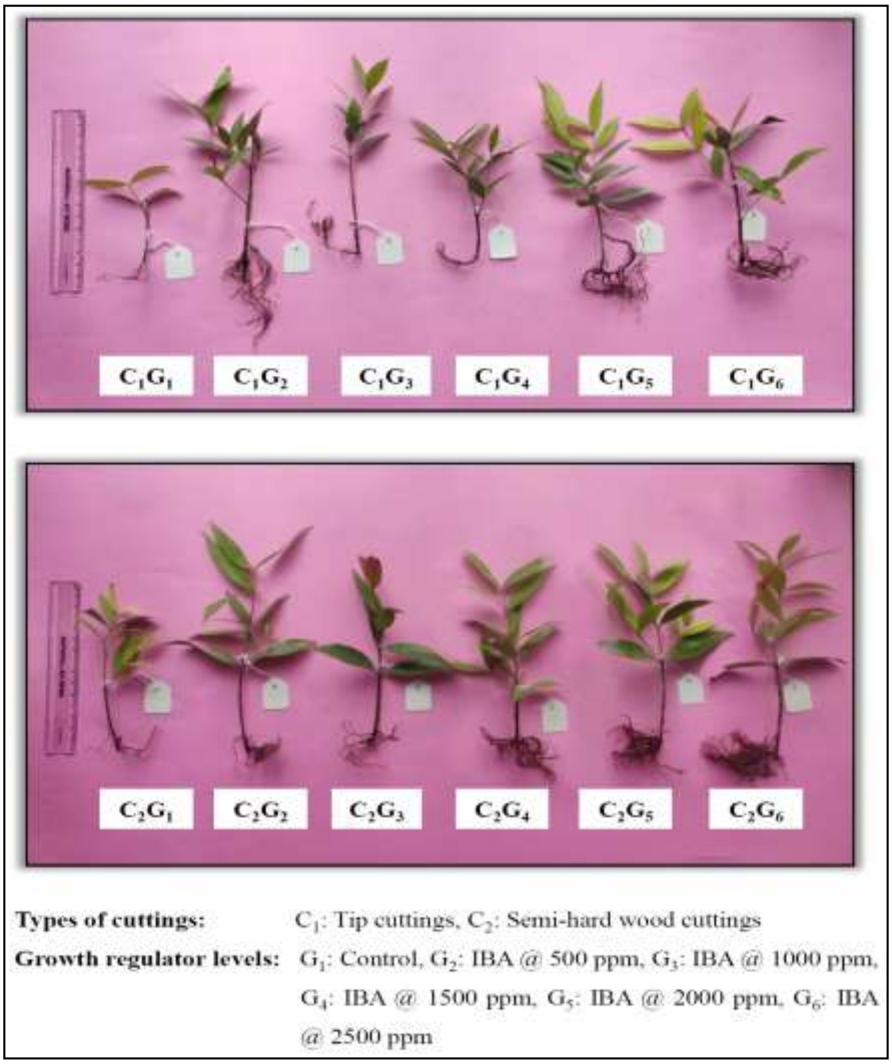

Fig 1: Rooting of cuttings as influenced by types of cuttings and growth regulator levels in *Eugenia myrtifolia.*

Formerly established roots may augment the absorption and translocation of nutrients from the media and which took active part metabolic processes and may be resulted in increased shoot number (Mehraj *et al.*, 2013) [9]. These results were in accordance with Shabha and Alshammary (2013) [15] in *Hamelia patens and Bougainvillea peruviana* cv. Shubra and Asl *et al.* (2012) [1] in bougainvillea.

Table 2: Days required for root initiation, number of primary roots and rooting percentage as influenced by types of cuttings, growth regulator levels and their interaction effect in *Eugenia myrtifolia*

Treatments	Days required for root initiation	Number of primary roots	Percentage of rooted cuttings
Factor A (C-Types of cutting)			
C_1: Tip cuttings	82.36	3.62	50.56
C_2 : Semi-hard wood cuttings	77.18	7.43	57.22
S.Em±	0.33	0.05	0.59
C.D (5%)	0.96	0.14	1.72
Factor B (G- Growth regulator)			
G_1: Control	95.40	3.03	37.50
G_2: IBA @ 500 ppm	76.20	4.90	59.17
G_3: IBA @ 1000 ppm	88.30	3.85	43.33
G_4: IBA @ 1500 ppm	76.05	5.97	56.67
G_5: IBA @ 2000 ppm	70.78	7.70	64.17
G_6: IBA @ 2500 ppm	71.90	7.70	62.50
S.Em±	0.57	0.08	1.02
C.D (5%)	1.67	0.24	2.98
Factor A x B (C X G)			
C_1G_1	96.47	2.13	36.67
C_1G_2	72.40	5.13	66.67
C_1G_3	91.80	2.60	38.33
C_1G_4	80.10	2.13	50.00
C_1G_5	73.50	4.93	56.67
C_1G_6	79.90	4.80	55.00
C_2G_1	94.33	3.93	38.33
C_2G_2	80.00	4.67	51.67
C_2G_3	84.80	5.10	48.33
C_2G_4	72.00	9.80	63.33
C_2G_5	68.07	10.60	71.67
C_2G_6	66.90	10.47	70.00
S.Em±	0.81	0.12	1.44
C.D (5%)	2.36	0.34	4.21

3.3 Days required for root initiation

The data noted on days required for root initiation showed significant difference between two types of cuttings. Early root initiation was recorded in semi-hard wood cuttings (77.18 days) in comparison to tip cuttings (82.36 days). It might be due to the rapid hydrolysis of polysaccharides stored in semi-hard wood cuttings into physiologically active sugars which provide sufficient energy to meristematic tissues and activate the root primordial to initiate roots early in semi-hard wood cuttings (Bhairavi *et al.*, 2019) [2].

Different levels of auxin had significant effect on days required for root initiation in the cuttings. Among different concentrations of IBA, cuttings treated with IBA @ 2000 ppm (G_5) took minimum days for rooting (70.78 days) whereas, maximum days required for root initiation was recorded in the cutting without IBA treatment (G_1) (95.40 days). Higher concentration of IBA might be resulted in increased rate of cambium de-differentiation and accelerated hydrolytic activity, which enhanced callus formation, thus helped in early initiation of roots (Li *et al.* 2009; Gilani *et al.* 2019) [7, 5].

The interaction effect was significant between types of cuttings and auxin levels with respect to days required for root initiation. Minimum days required for root initiation was recorded in semi-hard wood cuttings treated with IBA @ 2500 ppm (C_2G_6) (66.90 days). Tip cuttings without IBA treatment (C_1G_1) took maximum days for rooting (96.47 days). IBA at higher concentration might have helped in hydrolysis and translocation of sugars and nitrogenous substances in the semi-hardwood cuttings, which were utilized for cell division and for the increased respiratory activity in the regenerating tissues during the initiation of root primordial (Nanda, 1975) [10]. These results were in parallel with Chinapolaiah *et al.* (2019) [3] in *Adhatoda vasica* and Thakor *et al.* (2017) [16] *in Jasminum sambac.*

3.4 Number of primary roots

The data noted on number of primary roots per cuttings showed significant difference between two types of cuttings. More number of primary roots was recorded in semi-hard wood cuttings (7.43) as compared to tip cuttings (3.62). It might be due to the rapid hydrolysis of polysaccharides stored in semi-hard wood cuttings into physiologically active sugars which provide sufficient energy to meristematic tissues and activate the root primordial to initiate roots with more number and length of roots in semi-hard wood cuttings (Bhairavi *et al.*, 2019) [2].

The data related to number of primary root showed significant difference between different concentrations of auxin. Among different levels of IBA, cuttings treated with IBA @ 2000 ppm (G_5) (7.70) and IBA @ 2500 ppm (G_6) (7.70) resulted in more number of primary roots while, minimum number of primary roots (3.03) was recorded in the cuttings without IBA treatment (G_1). Higher concentration of IBA might be resulted in increased rate of cambium de-differentiation and accelerated hydrolytic activity, which enhanced callus formation, thus helped in enhanced root number (Li *et al.*, 2009; Gilani *et al.*, 2019) [7, 5].

The interaction effect was significant between types of cuttings and auxin levels with respect to number of primary roots per cuttings. Semi-hard wood cuttings treated with IBA @ 2000 ppm (C_2G_6) resulted in more number of primary roots (10.60). Least number of primary roots was observed in tip cuttings treated with IBA @ 1500 ppm (C_1G_4) (2.13) and without IBA treatment (C_1G_1) (2.13). IBA at higher concentration might have helped in hydrolysis and translocation of sugars and nitrogenous substances in the semi-hardwood cuttings, which were utilized for cell division and for the increased respiratory activity in the regenerating tissues during the initiation of root primordial (Nanda, 1975) [10]. Due to early initiation of root, root number and root length might be maximum in this treatment. These results were in parallel with Khatik and Sharma (2013) [6] in apple, Chinapolaiah *et al.* (2019) [3] in *Adhatoda vasica* and Thakor *et al.* (2017) [16] *in Jasminum sambac.*

3.5 Percentage of rooted cuttings
The data recorded on percentage of rooted cuttings showed significant difference between two types of cuttings. Maximum percentage of rooted cuttings was recorded in semi-hard wood cuttings (57.22%) as compared to tip cuttings (50.56%). It might be because of higher amount of stored carbohydrate in semi-hard wood cuttings.

The data pertaining to percentage of rooted cuttings showed significant difference between different concentrations of auxin. Among different levels of IBA, cuttings treated with IBA @ 2000 ppm (G_5) resulted in higher percentage of rooted cuttings (64.17%) while, minimum percentage of rooted cuttings (37.50%) was recorded in the cuttings which were not treated with IBA (G_1). Higher concentration of IBA might be resulted in increased rate of cambium de-differentiation and accelerated hydrolytic activity, which enhanced callus formation, thus helped in early initiation of roots and percentage of rooting (Li *et al.*, 2009; Gilani *et al.*, 2019) [7, 5].

The interaction effect was significant between types of cuttings and auxin levels with respect to percentage of rooted cuttings. Semi-hard wood cuttings treated with IBA @ 2000 ppm (C_2G_5) resulted in maximum percentage of rooted cuttings (71.67%) whereas, tip cuttings without IBA treatment (C_1G_1) had minimum percentage of rooted cutti ngs (36.67%). It may be because of well developed shoot system in the semi-hard wood cuttings treated with IBA @ 2000 ppm. These results were in parallel with Khatik and Sharma (2013) [6] in apple, Chinapolaiah *et al.* (2019) [3] in *Adhatoda vasica* and Thakor *et al.* (2017) [16] *in Jasminum sambac.*

4. Conclusion
Semi-hard wood cuttings of *Eugenia myrtifolia* treated with IBA @ 2000 ppm is the best treatment with respect to number of days taken for sprouting and rooting, number of shoots and roots and rooting percentage. So, this treatment combination can be used for the propagation of *Eugenia myrtifolia*.

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