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Effect of auxins and rooting media on rooting in stem cutting of mulberry (*Morus nigra* L.)

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Abstract
This research was conducted to Effect of Auxins and Rooting Media on Rooting in Stem Cutting of Mulberry (*Morus nigra* L.) at Horticultural Research Centre, Chauras Campus. H.N.B. Garhwal University Srinagar, Garhwal Uttarakhand, India. Stem cuttings of the plant were subjected to different treatments; IBA concentration (1000ppm, 2000ppm and 0ppm) and rooting media (Sand+FYM, Vermicompost and Cocopeat). The experiment was laid out in Factorial randomized block design and replicated thrice. In case of IBA concentration, the maximum number of sprouted cutting (7.11), average number of sprouts per cutting (5.77), length of longest sprout (8.90 cm), diameter of thickest sprout (0.71 cm), number of leaves on new shoots (8.55), survival percentage (71.11 %), rooting percentage (70.00), number of primary root (10.77), length of longest root (10.22 cm) was recorded under 2000ppm concentration of IBA. In case of rooting media, the maximum number of sprouted cutting (7.11), diameter of thickest sprout (0.54 cm), number of leaves on new shoots (8.11), survival percentage (71.11%), rooting percentage (70.00), number of primary root (8.55), length of longest root (9.11cm) was observed under vermicompost rooting media.

Keywords: Mulberry, IBA, rooting media, cutting, rooting

Introduction
Morus alba L. belong to Moraceae family. Most of the Indian varieties of mulberry belong to *M. indica*. Fruits of mulberry have some medicinal property, i.e. laxative, refrigerant in fevers, and used locally as a remedy for sore throat, dyspepsia, and melancholia. Mulberry, cultivated for fruit, should be propagated as clone. Unlike propagation of tissue culture and layering system for plant production, usually grafting and cutting propagation methods are used (Hartmann *et al*., 1990 and Guo *et al*., 2007) [9, 26]. The use of hardwood cuttings is one of the least expensive and easiest method of vegetative propagation. In recent time auxin treatments promoting roots formation of cuttings. (Fourrier 1984) [8]. There are main factors that can affect the rooting potential of stem cuttings including species and specific cultivar needs; the source and type of cutting taken; wounding or leaf removal; stock plant etiolation and Planting time; or is influenced by growing 9 conditions such as media, mist, bottom heat, use of hormones, fertilizer, and supplemental lighting (Hartmann *et al*., 2002) [10]. In mulberry, a great number of studies primarily on wood cutting have been conducted on a large scale whereas studies on the softwood cutting have been limited. Hence, their results were quite different from each other (Baksh *et al*., 2000; Soylu *et al*., 1997; Yıldız and Koyuncu, 2000; Koyuncu *et al*., 2004; Erdoan and Aygün, 2006) [4, 24, 25, 14, 6, 7]. Indole-3-butyric acid (IBA) is the most widely used root promoting chemical in the nursery trade, along with 1-naphthaleneacetic acid (NAA), because it is nontoxic over a wide range of concentrations (Ruppert, 1974) [16]. The most successful results have been obtained from IBA treatments including auxin hormone group. IBA has been found to be critical for both softwood and hardwood cuttings (Erdoan and Aygun, 2006) [6, 7]. Maximum numbers of sprouted cuttings, length of the roots, percentage of rooted cutting, lengths of longest sprouts of root were recorded under 2000 ppm concentration of IBA (Singh *et al*., 2014) [20]. Kalyoncu *et al*. (2009) [12] reported that the maximum rooting percentage was observed under 2000 and 3000ppm concentration IBA.

Rooting medium also play an very important role in the root proliferation and further growth in plants raised by stem cutting. Rooting media should be considered an integral part of the propagation system. Albouyeh (2007) [2] for citrus cuttings recommends only peat or mixture of peat, perlite and cocopeat with 2:2:1 ratio for plant height and leaf number increasing. Mixtures such as perlite plus peat, coconut fiber or vermiculite have also given good results.

Mixtures of perlite and vermiculite have traditionally been used in Californian nurseries (Sardoei, 2014) [3]. Kako Al-Zebari and Ali M. Al-Brifkany. (2015) [11]. observed that the Media (1 part peat moss + 2 parts sand) to increase rooting percentage in the stem cuttings of (*Citrus medica* Linnaeus) Corsian cultivar.

Methods and Materials

Hardwood stem cuttings of Mulberry (*Morus alba* L.) were collected from 5 to 7 year old plants and 15 cm long stem cuttings with basal portion were prepared. The basal ends of the cuttings were dipped in dilute solutions, 1000ppm, 2000ppm, 0ppm of Indole-3-Butyric Acid by quick dip method for 10 seconds before planting in the various rooting medium (Sand+ FYM, Vermicompost and Cocopeat). After the treatment, the cutting were immediately planted in root trainers and inserted 7.5 cm deep in the rooting media. The experiment was replicated thrice with 30 cuttings in each treatment and a total of 270 cuttings were planted in mist chamber. The number of sprouted cutting, average number of sprouts per, length of longest sprout, diameter of thickest sprout, number of leaves, survival percentage, fresh and dry weight of shoot, rooting percentage, number of primary root, secondary root, length of longest root, fresh and weight of root were recorded after three months. The data recorded were subjected to statistical analysis by using Factorial Randomized Block Design (FRBD) as described by Cochran and Cox (1992) [5].

Results and Discussion

In case of IBA concentration, the maximum number of sprouted cutting (7.11),average number of sprouts per cutting (5.77), length of longest sprout (8.90 cm), diameter of thickest sprout (0.71 cm), number of leaves on new shoots (8.55), shoot percentage (71.11 %), root percentage (70.00), number of primary root (10.77), secondary root (12.77), length of longest root (10.22 cm), fresh weight of root (3.43 gm), dry weight of root (1.88 gm) was recorded under 2000ppm concentration of IBA. while, minimum length of sprout (4.95 cm), diameter of thickest sprout (0.32cm), number of leaves on new shoots (6.22) was recorded under 1000ppm concentration of IBA and the minimum sprouting cutting (5.44),average number of sprouts per cutting (2.33), shoot percentage (54.44%), root percentage (52.22 %), number of primary root (6.11), secondary root (9.77), length of longest root (7.33 cm), fresh weight of root (2.15 gm), dry weight of root (1.21 gm) was observed under 0ppm control during present investigations (Table 1,2).

Singh *et al*. (2016) [18] reported that the maximum success of cuttings in August month planting time and mist chamber growing condition while, IBA 2000 ppm gives most effective success rate of cuttings. The best rooting percentage was obtained from bunch planting for the rooting of black mulberry hardwood cuttings treated with 5 $g.L^{-1}$ IBA (Koyuncu and Senel, 2003) [15]. The maximum rooting percentage was determined from black mulberry in 2000 and 3000ppm IBA doses application (100%) (Kalyoncu *et al*. 2009) [12]. Ahmad *et al*. (2010) [1] reported that the mulberry (*Morus alba* L.) performance of cutting in open air and in polythene low tunnel. Root length, number of root branches, root diameter and fresh and dry weight were found maximum in two inches cutting. Among all the treatments, numbers of sprouted cuttings, length of the roots/cutting, percentage of rooted cutting, lengths of longest sprouts of root were higher in IBA 2000 mg.L-1 (Singh *et al*., 2014) [20]. These finding are agreed with the finding of Singh *et al.* (2013) [21, 23] in *Citrus limon* cv. Pant lemon and Singh *et al*. (2011) [22] in *Bougainvillea glabra*.

In case of rooting media, significantly the maximum number of sprouted cutting (7.11), diameter of thickest sprout (0.54 cm), number of leaves on new shoots (8.11), shoot percentage (71.11%), root percentage (70.00), number of primary root (8.55), secondary root (12.55), length of longest root (9.11cm), fresh weight of root (2.90 gm), dry weight of root (1.60gm) was observed under vermicompost rooting media. and the maximum number of sprouts per cutting (4.00), length of longest sprout (6.67 cm) was recorded under Cocopeat rooting media. The quality of rooting medium is essential in root development of plants. A good rooting medium should hold the cuttings in place during rooting period, provide moisture, permit exchange and provide appropriate light penetration. The minimum sprouting cutting (4.33), length of longest sprout (5.80 cm), diameter of thickest sprout (0.42cm), number of leaves on new shoots (6.44), root percentage (55.55 %) and number of primary root (7.11) was recorded under cocopeat rooting media. minimum number of secondary root (9.77), fresh weight of root (2.67 gm) and dry weight of root (1.31 gm) was observed under Sand+FYM rooting media. minimum average number of sprouts per cutting (5.66), shoot percentage (56.66) and length of longest root (8.44 cm) was recorded under cocopeat rooting media (Table 3,4). Singh *et al*., (2015) [17] showed that the rooting media Soil + Sand + Cocopeat improved rooting percentage, while survival percentage was observed under Soil+ Sand+ FYM. Kamruzzaman and Quadir (1998) [13] observed that the maximum plant survival (51.16 %) and plant height (19.03 cm) was recorded in silt. Similarly, the maximum root length (10.33cm) and root number (9.33) was noted in sand. The maximum plant height (3.50cm) was recorded in sawdust whereas the maximum root length (3.33) and root number (2.66) was recorded in mixture of sand, silt and clay (1:1:1). The present findings are similar to the findings of Singh *et al*. (2013) [21, 23] in *Thuja compecta* and Singh, (2018) [19] in citrus species.

Table 1: Effect of IBA concentration and rotting media on the survival performance of Mulberry (*Morus alba* L.)

Planting Time	Number of sprouted cutting				Average no of sprout per cutting				Length of longest sprout (cm)			
	G_1 (Sand+ FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean	G_1 (Sand+FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean	G_1 (Sand+FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean
T_1 (IBA 1000ppm)	6.00	6.66	5.66	6.11	2.00	2.66	3.33	2.66	4.90	3.88	6.06	4.95
T_2 (IBA 2000ppm)	7.33	8.33	5.66	7.11	5.66	5.00	6.66	5.77	8.00	10.16	8.53	8.90
T_3 (0ppm)	4.33	6.33	5.66	5.44	2.33	2.66	2.00	2.33	4.50	5.17	5.43	5.03
Mean	5.89	7.11	5.66		3.33	3.44	4.00		5.80	6.40	6.67	
	T	G	T x G		T	G	T x G		T	G	T x G	
Sem	0.245	0.245	0.424		0.221	0.221	0.382		0.331	0.31	0.573	
CD at 0.5%	0.719	0.719	1.246		0.648	0.648	1.123 **NS**		0.971	0.971 **NS**	1.682	

Table 2: Effect of IBA concentration and rotting media on the survival performance of Mulberry (*Morus alba* L.)

Planting Time	Diameter of thickest sprout (cm)				Number of leaves on new shoot				Shoot percentage			
	G_1 (Sand+FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean	G_1 (Sand+FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean	G_1 (Sand+FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean
T_1 (IBA 1000ppm)	0.38	0.36	0.43	0.39	7.00	6.66	5.00	6.22	60.00	66.66	56.66	61.11
T_2 (IBA 2000ppm)	0.53	0.86	0.73	0.71	7.00	10.33	8.33	8.55	73.33	83.33	56.66	71.11
T_3 (0ppm)	0.36	0.40	0.43	0.40	5.33	7.33	8.00	6.89	43.33	63.33	56.66	54.44
Mean	0.42	0.54	0.53		6.44	8.11	7.11		58.89	71.11	56.66	
	T	G	T x G		T	G	T x G		T	G	T x G	
Sem	0.017	0.017	0.030		0.423	0.423	0.732		2.453	2.453	4.249	
CD at 0.5%	0.051	0.051	0.088		1.240	1.240	2.149		7.195	7.195	12.463	

Table3 Effect of IBA concentration and rotting media on the rooting performance of Mulberry (*Morus alba* L.)

Planting Time	Root percentage				Number of primary root				Number of secondary root			
	G_1 (Sand+FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean	G_1 (Sand+FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean	G_1 (Sand+FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean
T_1 (IBA 1000ppm)	60.00	66.66	56.66	61.11	6.33	7.33	7.66	7.11	11.33	10.00	11.66	11.00
T_2 (IBA 2000ppm)	73.33	83.33	53.33	70.00	9.66	12.33	10.33	10.77	10.33	15.33	12.66	12.77
T_3 (0ppm)	40.00	60.00	56.66	52.22	5.33	6.00	7.00	6.11	7.66	12.33	9.33	9.77
Mean	57.78	70.00	55.55		7.11	8.55	8.33		9.77	12.55	11.22	
	T	G	T x G		T	G	T x G		T	G	T x G	
Sem	2.115	2.115	3.664		0.406	0.406	0.703		0.330	0.330	0.571	
CD at 0.5%	6.204	6.204	10.747		1.191	1.191	2.064 **NS**		0.968	0.968	1.677	

Table4 Effect of IBA concentration and rotting media on the rooting performance of Mulberry (*Morus alba* L.)

Planting Time	Length of root (cm)				Fresh weight of root (g)				Dry weight of root (g)			
	G_1 (Sand+FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean	G_1 (Sand+FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean	G_1 (Sand+FYM)	G_3 (Vermicompost)	G_2 (Cocopeat)	Mean
T_1 (IBA 1000ppm)	11.00	7.33	8.00	8.78	2.73	2.23	3.06	2.67	1.26	1.13	1.63	1.34
T_2 (IBA 2000ppm)	9.33	11.66	9.66	10.22	3.46	4.16	2.66	3.43	1.73	2.25	1.66	1.88
T_3 (0ppm)	6.00	8.33	7.66	7.33	1.83	2.30	2.33	2.15	0.93	1.43	1.26	1.21
Mean	8.78	9.11	8.44		2.67	2.90	2.68		1.31	1.60	1.52	
	T	G	T x G		T	G	T x G		T	G	T x G	
Sem	0.293	0.293	0.509		0.164	0.164	0.285		0.136	0.136	0.236	
CD at 0.5%	0.862	0.862 **NS**	1.493		0.483	0.483 **NS**	0.836		0.399	0.3990 **NS**	0.692 **NS**	

Conclusion

Reported to the research results, IBA concentration and rooting media had a large impact on the success of survival and rooting in cuttings of Mulberry (*Morus alba* L.). 2000ppm concentration of IBA and vermicompost rooting media, were the best treatments that are to be considered for the propagation of Mulberry hard wood cutting.

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