STUDIES ON VEGETATIVE PROPAGATION OF MULBERRY (*MORUS SP.*) by hardwood cutting

BY

Mohamed A. Hussein[1], Emad Eldin H. Abd-Elall[1], Esraa, M.E. Hussein[1]
And Fayza W. Sbralla[2]

Abstract:

The technique of breeding, multiplying and perpetuating plants is as ancient as human civilization itself. The success of any vegetative propagated culture depends primarily on the rooting capacity and growth rate of the plant. A high rooting rate contributes to uniformity and improved crop establishment and significantly reduces initial expenses. Mulberry is reproduced in Egypt using tissue culture due to the difficulties of establishing roots on cuttings due to a problem with spreading growth regulators inside the cuttings; however, this process is highly expensive and takes a long time. We used varied doses of growth regulators to induce cuttings to root in this study, which is a low-cost technique that produces dense plants in a short amount of time. The experiment was carried out in a greenhouse with a spray irrigation system, and cuttings were gathered and planted the same day after being hormone-treated. The data was collected three months after the plants were planted. The results revealed that planting cuttings on February 1st resulted in the highest proportion of rooted seedling survival (79.46 %), compared to planting cuttings on March 1st (71.36 %).. Furthermore, the combined effect of the previous factors had positive effects on the studied characters; the highest values of success rate of rooting (100 %) came from cuttings taken on Feb. 1st and immersed in 1000 ppm of IBA solution with *M. Alba* To improve cutting survival % and seedling quality, the results suggest collecting cuttings on Feb. 1st and applying 1000 ppm of IBA right before planting.

Keywords: (cutting, root percentage, growth regulator).

[1] - Hort. Dept. Fac. of Agric. Sohag Univ. Egypt.
2 - Agriculture engineer. Email: fayzaatmaan@gmail.com.

STUDIES ON VEGETATIVE PROPAGATION OF MULBERRY (*MORUS SP.*) by hardwood cutting

Mohamed A. Hussein, Emad Eldin H. Abd-Elall, Esraa, M.E. Hussein, and Fayza W. Sbralla

INTRODUCTION:

Mulberry plants may be propagated with seeds or cuttings of softwood cuttings or deciduous cuttings Grafts or seeds may also be used to propagate such trees. Further cutting is advantageous to get desired characters like maintenance of particular characters of the plant, speed in raising many saplings, adaptability to a particular habitat, resistance to pests and diseases, and produce viable seeds. Different methods of vegetative propagation are dependent in other countries according to the environmental conditions and soil nature **(Gilman and Watson, 1994).**

Propagation through stem cuttings is the easiest, cheapest, and quickest method compared to grafting, particularly in tropical regions, to find out the rooting potential of mulberry genotypes **(Susheelamma et al., 1990 and 1992 and Sujathama and Dandin, 1998).**

The rooting behavior of a variety is purely a genetic character and is considered one of the essential parameters for deciding L the suitability of genotypes for a particular area **(Baksh et al., 2000).**

(Harrison, 1991) discovered that the seasonal timing in which cuttings are taken could play an essential role in rooting. Mulberry (*Morus Alba* L.) cuttings cultivated in the open air were compared to those grown in a polyethylene low tunnel. Eight- to six-inch-long cuttings had the highest sprouting percentage, plant height, and number of leaves, and all metrics performed better in the polyethylene tunnel than in the open air**. (Khan et al 2007)**

Rafeeq *et al.* (2020) Studies on the spread of *Morus* species by cuttings show that 100 ppm of IBA concentration was most effective for spreading *Morus Alba* by cuttings. Furthermore, the application of 100 ppm of IBA concentration was found to be most efficient for the maximum characteristics of *Morus Alba* and may be used for mass Propagation in nurseries.

The Mulberry is commercially propagated from hardwood cuttings because of its distinct advantages, such as the rapid multiplication of the basic materials and the maintenance of the desired characteristics of the plants. The time of preparation of cuttings in Mulberry greatly affected the extent and success of root formation. The optimum time of cuttings preparation and planting is related to the plant's physiological and environmental conditions. The timing of collection and rooting varies according to climatic conditions and external temperature. Several factors can affect the rooting potential of stem cuttings, including species and specific cultivar needs; the source, position, and type of cutting taken, juvenility and condition of the stock plant; wounding or leaf removal; stock plant wilting and girdling; cutting date. It is also influenced by growing conditions such as environments, fog, bottom heat, use of hormones, fertilizer and extra lighting **(Hartmann et al., 2002).**

Ezekiel (2010) Low-cost vegetative propagation can be accomplished by considering factors helpful in improving process performance and better resource utilization. So, this study reports on the propagation of white mulberry *Morus Alba* and *morus nigra*. with

cuttings to determine the best seasonal time for taking cuttings and the optimal IBA and NAA concentration, for successful root formation.

Mulberry is one of the trees that have great economic importance, but in the production of plants, it depends on the method of tissue cultivation, which is an economically costly method that requires a specialist and a large time.

In this study, we resort to the production of plants by cuttings, which is an economical method that produces plants with a high density in a short time, but it is difficult to form roots, so we resort in this research to treating cuttings with different concentrations of growth regulators and different collection times to obtain the most percentage of plants.

Materials and Methods:

The present investigation on studies on Vegetative propagation of mulberry (Morus sp.) cuttings at the experimental farm of the Department of Horticulture in El kawamil, during 2020-2021 the varieties of mulberry used for investigation were White mulberry (Morus Alba) and Black mulberry (Morus nigra).

One-year-old cuttings of Mulberry White Mulberry (Morus Alba L) and Blak Mulberry (Morus nigra) were obtained with the help of a sterilized woodcutter from mature and healthy trees in the experimental farm of the Department of Horticulture in Al Kawthar. Stem cuttings were 25 cm in length and 1-1.5 cm in diameter, the top of cutting was slanted, which 1cm from the top node and the lower part was perpendicular, which located strictly under the lower node. The cuttings were maintained and watered regularly under the natural shaded conditions of the nursery. Cuttings were planted in 15×25 cm polyethylene bags, with river sand, perlite and pettmus at the rate of (1:1:1) rooting medium. To research the effect of some growth regulators/hormones on the rooting of mulberry cuttings and to decide the appropriate time to plant cuttings of test mulberry varieties.

Experimental Work:

This study involved three factors (A & B & C). The first factor (A) consisted of two Varieties: a1) *Morus Alba* and a2) *Morus nigra*. The second factor (B) included the following two treatments of date- of planting cuttings: b1) planting cutting on Feb. 1st. b3) planting cutting on first March 1st.

The third factor (C) contained seven concentrations of Growth regulators/hormones, namely c_1) Control c_2) Indole-3- butyric acid at 500 ppm. c_3) Indole-3- butyric acid at 1000 ppm.

c_4) Indole-3- butyric acid at 1500 ppm. c_5) 1-Naphthalene acetic acid at 2000 ppm. c_6) 1-Naphthalene acetic acid at 3000 ppm. c_7) 1-Naphthalene acetic acid at 4000 ppm.

Therefore, the experiment involved twenty-eight treatments. Each treatment was replicated three times.

The investigation was conducted under a polyhouse at the experimental farm of the Division.

Preparation and method of growth regulator/hormone application :

Two growth regulators Indole-3 butyric acid at three concentrations of 500, 1000, 1500 ppm and 1-Naphthalene acetic acid at three concentrations of 2000, 3000 and 4000 ppm, each concentration was prepared by dissolving of required hormone growth regulator in

50ml each of 100°/o ethanol in a 1-litre volumetric flask and finally, the volume was made up to 1 litre with distilled water. The ethanol in each case was allowed to evaporate. Bundles of cuttings each treatment were dipped in respective treatment solution to a depth of 2.5 cm for 15 seconds. Excess solution was drained off the cuttings in the shade before plantation in the polythene bags.
In addition, the temperature of 25-28 ° c and relative humidity of 80-90 % in polyhouse was controlled in the form of mist by sprinkling water with spray pumps on empty spaces.

Experimental Design:

A complete randomized block design in a split-split plot arrangement was followed. The two Varieties occupied the main plots, two treatments of time- of planting of cuttings ranked the sub-plots and the seven concentrations of Growth regulators/hormones allocated the sub-sub–plots. Each treatment had 21 cuttings and a single stem cutting was planted per each pot.

Various measurements:

Rooting percentage

The cuttings were carefully uprooted ninety days after planting and washed in clean water without damaging the root section. The rooting percentage data was determined based on the overall number of cuttings planted with each procedure and the effective survival of the number of cuttings.

Average number of primary roots

In all the experiments, the number of primary roots originating from the base of the nodes was reported and then the average was determined.

Average length of primary roots

In all the experiments, the length of the primary roots per cutting was determined with the aid of a scale from the base to the tip and then the mean length of the primary root (cm) was estimated.

Average number of branches

The number of branches per cuttings in various treatments has been calculated the average was then estimated and reported.

Average length of branches

The length of branches per cuttings in all the treatments was measured with the help of scale from the base to the tip, and the average length of branches (cm) was then calculated.

Average diameter of branches

The Diameter of branches of rooted cuttings in all the treatments was measured with the average Diameter of branches (mm) was then calculated.

Average number of leaves

The number of leaves of rooted cuttings in different treatments was recorded and the average was then calculated.

Statistical Analysis

All the obtained data were tabulated and statistically analyzed according to **Mead et *al.* (1993)** and averages of treatments were compared by using new L.S.D. test at 5% (according to **Steel and Torrie, 1984**).

Results

Rooting percentage

The studied interactions between variates as well as different collection times of cuttings and different concentrations of IBA and NAA had an announced effect on rooting percentage. The best treatment combination in respect of rooting percentage was observed with White mulberry (M. Alba) cuttings treated with (1000 IBA and 3000 NAA) that planted in Feb. 1st (100.0%), followed by black mulberry (M. nigra) cutting treated with (1500 IBA and 4000 NAA) that planted first February (95,100%). The cuttings planted on the first march with Black mulberry (M. Nigra) cutting untreated with (IBA and NAA) that planted first March recorded a lesser rooting percentage in both seasons.

The most rooting was found in White mulberry (M. Alba), which had 79.6 percent, followed by black mulberry (M. nigra), which had a percentage of 76.77 percent.

Table (1) Effects of cutting collection time, growth regulators applications on the hardwood cuttings of white and black mulberry types on rooting percentage.

Treatments		2020			2021		
		Verities (A)			Verities (A)		
Planting Date(B)	Growth regulator Concentration (C)	M. Alba a1	M. nigra a2	Mean BC	M. Alba a1	M. nigra a2	Mean BC
b1 (1 Feb.)	c_1 (control)	42.0	40.0	41.0	32.0	28.6	30.3
	c_2 (500 ppm IBA)	76.4	71.4	73.5	73.4	71.4	72.4
	c_3 (1000 ppm IBA)	100.0	95.0	97.5.0	100.0	91.0	94.5
	c_4 (1500 ppm IBA)	85.7	85.7	85.7	85.7	85.7	85.7
	c_5 (2000 ppm NAA)	77.4	71.4	71.4	81.4	75.4	71.4
	c_6 (3000 ppm NAA)	100.0	100.0	100.0	100.0	100.0	100.0
	c_7 (4000 ppm NAA)	85.7	85.7	85.7	85.7	84.3	80.7
Mean (A X B)		81.02	78.46		79.74	67.62	

Mean (B)		79.25			76.42		
b2 (1 March)	c_1 (control)	28.4	28.7	28.55	42	28.4	35.2
	c_2 (500 ppm IBA)	61.4	55.4	58.4	59.8	51.4	55.6
	c_3 (1000 ppm IBA)	90	89	89.5	85.4	74.8	80.1
	c_4 (1500 ppm IBA)	75.7	74.7	75.2	70.2	65.7	67.95
	c_5 (2000 ppm NAA)	61	60.4	60.7	51.4	51.4	51.4
	c_6 (3000 ppm NAA)	90	89	89.5	75.7	75.5	75.6
	c_7 (4000 ppm NAA)	75.7	74.7	75.2	70.7	70.7	70.7
Mean (A X B)		68.88	67.41		65.02	59.7	
Mean (B)		68.15			62.36		
				Mean (C)			Mean (C)
Mean (A XC)	c_1 (control)	35.2	34.35	34.77	37	26.45	31.72
	c_2 (500 ppm IBA)	68.9	63.4	66.15	72.4	71.4	71.9
	c_3 (1000 ppm IBA)	95	92	93.5	100	95.5	97.75
	c_4 (1500 ppm IBA)	80.7	80.2	80.45	85.7	85.7	85.7
	c_5 (2000 ppm NAA)	69.2	65.9	67.55	76.4	73.4	74.9
	c_6 (3000 ppm NAA)	95	94.5	94.75	95	94.5	94.75
	c_7 (4000 ppm NAA)	80.7	80.2	80.45	85.7	85	85.35
Mean (A)		74.95	72.93		79.6	76.77	

Average number of primary roots

As related to the Average Number of roots per cut, data revealed significant treatments compared to control. The studied interactions between variates as well as times cutting planting and different concentrations of IBA and NAA had an announced effect on the Average Number of roots per cut. The best treatment combination in respect of the Average Number of roots per cut was observed with White mulberry (M. Alba) cuttings treated with (1000 IBA and 3000 NAA) (7.1, 7.7))that planted in first February, followed by Black mulberry (M. nigra) cutting treated with (1000 IBA,3000 NAA) that planted the first February(8.0, 7.3) in contracts, untreated cutting with growth regulators of white mulberry (M. Alba) and black mulberry (M. nigra) produced the lowest value on the Average Number of roots per cut in both seasons, respectively table2.

Table (2) Effects of cutting collection time, growth regulators applications on the hardwood cuttings of white and black mulberry types in the average number of primary roots.

Treatments		2020			2021		
		Verities (A)			Verities (A)		
Planting Date(B)	Growth regulator Concentration (C)	M. Alba a1	M. nigra a2	Mean (B XC)	M. Alba a1	M. nigra a2	Mean (B XC)
B1 (1 Feb.)	c_1 (control)	0.6	0.9	0.75	0.9	3.9	2.4
	c_2 (500 ppm IBA)	1.6	2.7	2.15	2.4	2.0	2.2
	c_3 (1000 ppm IBA)	7.1	7.3	7.2	8.4	7.3	7.9
	c_4 (1500 ppm IBA)	3.6	4.7	4.15	3.7	3.0	3.4
	c_5 (2000 ppm NAA)	2.3	3.1	2.7	5.3	1.7	3.7
	c_6 (3000 ppm NAA)	7.7	8.0	7.85	5.7	6.0	5.7
	c_7 (4000 ppm NAA)	4.3	4.3	4.3	4.0	3.7	3.9
Mean (A X B)		4.14	4.05		4.08	3.6	
Mean (B)		4.28			3.87		
B2 (1 March)	c_1 (control)	0.7	0.4	0.55	1.7	1.9	1.8
	c_2 (500 ppm IBA)	3.0	0.4	1.7	1.9	1.9	1.9
	c_3 (1000 ppm IBA)	11.4	2.9	7.15	7.3	5.4	5.9
	c_4 (1500 ppm IBA)	4.0	2.3	3.15	3.4	2.7	3.1
	c_5 (2000 ppm NAA)	5.7	2.7	4.2	4.9	2.3	3.6
	c_6 (3000 ppm NAA)	8.6	2.8	5.7	6.7	4.6	5.2
	c_7 (4000 ppm NAA)	6.4	2.7	4.55	2.9	2.9	2.9
Mean (A X B)		5.25	2.02		3.82	3.1	
Mean (B)		3.635			3.48		
				Mean (C)			Mean (C)
A XC	c_1 (control)	0.65	0.65	0.65	1.3	2.9	2.1
	c_2 (500 ppm IBA)	2.3	1.55	1.925	2.15	1.95	2.0
	c_3 (1000 ppm IBA)	9.25	5.1	7.175	7.85	6.35	7.2
	c_4 (1500 ppm IBA)	3.8	3.5	3.65	3.55	2.85	3.3
	c_5 (2000 ppm NAA)	4.45	2.9	3.675	5.1	2	3.7
	c_6 (3000 ppm NAA)	8.06	5.4	6.73	6.2	5.3	5.4
	c_7 (4000 ppm NAA)	5.4	3.5	4.45	3.45	3.3	3.4
Mean (A)		4.14	3.22		4.22	3.52	

New LSD 5% 2020		New LSD 5% 2021	
A	0.3	A	0.2
B	0.3	B	0.2
C	0.8	C	0.5
AB	0.5	AB	0.4
AC	1.6	AC	1.1
BC	1.6	BC	1.1
ABC	3.1	ABC	2.1

Average length of primary roots

Most combinations in this study had an announced effect on The Average length of primary roots per cut. The best treatment combination in respect of the Average length of primary roots per cut was observed with White mulberry (M. Alba) cuttings treated with 1000 IBA and 3000NAA that planted in first February(8.9 and 11.4 cm), the lowest Average length of primary roots per cut was registered with the untreated cutting of White mulberry (M. Alba) planted in March 1st (0.8,1.0 cm) untreated cutting of white mulberry (M. Alba) planted in February 1st 0.8 cm), respectively.table3.

Table (3) Effects of cutting collection time, growth regulators applications on the hardwood cuttings of white and black mulberry types in Average length of primary roots.

Treatments			2020			2021	
			Verities (A)			Verities (A)	
Planting Date(B)	Growth regulator Concentration (C)	M. Alba a1	M. nigra a2	Mean (B XC)	M. Alba a1	M. nigra a2	Mean (B XC)
B1 (1 Feb.)	c_1 (control)	1.4	3.0	2.2	0.7	0.9	0.8
	c_2 (500 ppm IBA)	3.2	2.4	2.8	1.9	1.6	1.75
	c_3 (1000 ppm IBA)	8.9	3.2	6.05	7.3	4.3	5.8
	c_4 (1500 ppm IBA)	2.6	2.4	2.5	3.1	3.1	3.1
	c_5 (2000 ppm NAA)	4.7	2.5	3.6	2.1	2.0	2.05
	c_6 (3000 ppm NAA)	11.4	4.1	7.75	8.1	4.7	6.4
	c_7 (4000 ppm NAA)	3.5	1.2	2.35	3.4	2.7	3.05

Mean (A X B)		5.1	2.68		3.8	2.75	
Mean (B)			3.89			3.27	
B2 (1 March)	c_1 (control)	1.8	1.3	1.55	0.8	1.0	0.9
	c_2 (500 ppm IBA)	1.7	0.8	1.25	1.7	1.1	1.4
	c_3 (1000 ppm IBA)	4.0	2.2	3.1	6.6	3.6	5.1
	c_4 (1500 ppm IBA)	1.0	0.9	0.95	3.0	2.0	2.5
	c_5 (2000 ppm NAA)	3.0	1.5	2.25	2.0	1.4	1.7
	c_6 (3000 ppm NAA)	4.1	3.4	3.75	5.3	3.3	4.3
	c_7 (4000 ppm NAA)	3.4	0.9	2.15	3.6	2.4	3
Mean (A X B)		2.71	1.57		3.28	2.11	
Mean (B)			2.14			2.7	
				Mean(C)			Mean(C)
Mean (A XC)	c_1 (control)	1.6	2.15	1.875	0.75	0.95	0.85
	c_2 (500 ppm IBA)	2.45	1.6	2.025	1.8	1.35	1.575
	c_3 (1000 ppm IBA)	6.45	2.7	4.575	6.95	3.95	5.45
	c_4 (1500 ppm IBA)	1.8	1.65	1.725	3.05	2.55	2.8
	c_5 (2000 ppm NAA)	3.85	2	2.925	2.05	1.7	1.875
	c_6 (3000 ppm NAA)	7.75	3.75	5.75	6.7	4	5.35
	c_7 (4000 ppm NAA)	3.45	1.05	2.25	3.5	2.55	3.025
Mean (A)		3.90	2.12		3.54	2.43	

New LSD 5% 2020		**New LSD 5% 2021**	
A	0.2	A	0.1
B	0.2	B	0.1
C	0.6	C	0.4
AB	0.4	AB	0.4
AC	1.1	AC	0.8
BC	1.1	BC	0.8
ABC	2.2	ABC	1.7

Average number of branches

Most combinations in this study had an announced effect on the average number of branch roots per cut. The best treatment combination in respect of the average number of branches per cut (6.70 and 6.90) was observed with White mulberry (M. Alba) cuttings treated with 1000 ppm IBA that planted on February 1s(6.9)t followed by White mulberry (M. Alba) cuttings treated with 3000 ppm NAA that planted on February 1st (5.9), respectively. The lowest average number of branches per cut (1.00 and 1.00) was registered with Black mulberry (M. nigra) untreated cuttings on March 1st in both seasons, respectively.

Table (4) Effects of cutting collection time, growth regulators applications on the hardwood cuttings of white and black mulberry types in Average Number of branches.

Treatments		2020			2021		
		Verities (A)			Verities (A)		
Planting Date(B)	Growth regulator Concentration (C)	M. Alba a1	M. nigra a2	Mean (B XC)	M. Alba a1	M. nigra a2	Mean (B XC)
B1 (1 Feb.)	c_1 (control)	2.1	1.7	1.9	2.0	2.0	2.0
	c_2 (500 ppm IBA)	3.7	1.9	2.8	1.7	2.0	1.9
	c_3 (1000 ppm IBA)	6.7	6.4	6.6	6.9	4.4	5.7
	c_4 (1500 ppm IBA)	3.1	2.3	2.7	3.7	2.3	3.0
	c_5 (2000 ppm NAA)	2.3	2.0	2.2	1.9	2.1	2.0
	c_6 (3000 ppm NAA)	5.4	3.7	4.6	5.9	4.6	5.3
	c_7 (4000 ppm NAA)	3.3	2.0	2.7	2.4	2.4	2.4
Mean (A X B)		3.8	2.85		3.5	2.82	
Mean (B)			3.35			3.18	
B2 (1 March)	c_1 (control)	1.7	1.0	1.4	1.0	1.0	1.0
	c_2 (500 ppm IBA)	1.6	1.0	1.3	1.4	2.0	1.7
	c_3 (1000 ppm IBA)	4.1	3.1	3.6	4.3	3.2	3.8
	c_4 (1500 ppm IBA)	1.4	1.6	1.5	2.4	2.9	2.7
	c_5 (2000 ppm NAA)	2.1	1.4	1.8	1.7	1.4	1.6
	c_6 (3000 ppm NAA)	4.4	3.6	4.0	3.9	3.1	3.5
	c_7 (4000 ppm NAA)	3.9	2.1	3.0	2.4	3.0	2.7
Mean (A X B)		2.74	1.97		2.44	2.37	
Mean (B)			2.37			2.42	
				Mean(C)			Mean(C)
	c_1 (control)	1.9	1.35	1.65	1.5	1.5	1.5

Mean (A XC)	c_2 (500 ppm IBA)	2.65	1.45	2.05	1.55	2	1.8
	c_3 (1000 ppm IBA)	5.4	4.75	5.1	5.6	3.8	4.75
	c_4 (1500 ppm IBA)	2.25	1.95	2.1	3.05	2.6	2.85
	c_5 (2000 ppm NAA)	2.2	1.7	2	1.8	1.75	1.8
	c_6 (3000 ppm NAA)	4.9	3.65	4.3	4.9	3.85	4.4
	c_7 (4000 ppm NAA)	3.6	2.05	2.85	2.4	2.7	2.55
Mean (A)		3.27	2.41		2.97	2.6	

New LSD 5% 2020		New LSD 5% 2021	
A	0.14	A	0.14
B	0.14	B	0.14
C	0.4	C	0.4
AB	0.3	AB	0.3
AC	0.9	AC	0.9
BC	0.9	BC	0.9
ABC	1.7	ABC	1.7

Average length of branches

Data in table (5), the studied interactions between variates as well as times cutting planting and different concentrations of IBA and NAA had an announced effect on average branch length. The best treatment combination in respect of average branch length was observed with White mulberry (M. Alba) cuttings treated with (1000 IBA and 3000 NAA) that planted in February 1st (9.90 and 10.90 cm) and (8.90 and 11.90 cm) respectively, the lowest average branch length per cut (1.00 and 1.00) was registered with Black mulberry (M. nigra) untreated cuttings on March 1st in both seasons, respectively.

Table (5) Effect of growth regulators, planet date and Varieties in Average length of branches explants of black mulberry (M. nigra) and white mulberry (M. Alba) cvs.

Treatments			2020			2021	
			Verities (A)			Verities (A)	
Planting Date(B)	Growth regulator Concentration (C)	M. Alba a1	M. nigra a2	Mean (B XC)	M. Alba a1	M. nigra a2	Mean (B XC)
B1 (1 Feb.)	c_1 (control)	0.7	1.7	1.2	0.7	1.7	1.2
	c_2 (500 ppm IBA)	1.7	1.8	2.4	4.3	2.7	3.5
	c_3 (1000 ppm IBA)	9.9	6.6	8.3	10.9	6.9	8.9
	c_4 (1500 ppm IBA)	3.6	3.1	3.4	5.7	1.9	3.8

	c_5 (2000 ppm NAA)	2.4	1.9	2.2	5.0	2.3	3.7
	c_6 (3000 ppm NAA)	8.9	6.2	7.6	11.6	4.7	8.2
	c_7 (4000 ppm NAA)	3.7	3.6	3.7	5.4	2.7	4.1
Mean (A X B)		4.41	3.55		6.22	3.27	
Mean (B)			4.11			4.77	
B2 (1 March)	c_1 (control)	0.6	1.0	0.8	0.6	1.0	0.8
	c_2 (500 ppm IBA)	1.5	1.2	1.4	2.1	1.4	1.8
	c_3 (1000 ppm IBA)	6.6	5.7	6.2	5.9	4.0	5.0
	c_4 (1500 ppm IBA)	2.6	3.1	2.9	1.9	2.0	2.0
	c_5 (2000 ppm NAA)	1.5	1.9	1.7	2.7	1.9	2.3
	c_6 (3000 ppm NAA)	6.6	4.4	5.5	5.0	5.1	5.1
	c_7 (4000 ppm NAA)	3.4	3.2	3.3	3.1	2.9	3.0
Mean (A X B)		3.25	2.92		3.04	2.61	
Mean (B)			3.11			2.85	
				Mean(C)			Mean(C)
Mean (A XC)	c_1 (control)	0.6	1.4	1.0	0.6	1.4	1.0
	c_2 (500 ppm IBA)	1.6	1.5	1.6	3.2	2.1	2.7
	c_3 (1000 ppm IBA)	7.8	6.1	7.0	8.4	5.4	6.9
	c_4 (1500 ppm IBA)	3.1	3.1	3.1	3.8	1.9	2.9
	c_5 (2000 ppm NAA)	1.9	0.9	1.4	3.9	3.1	3.5
	c_6 (3000 ppm NAA)	7.8	5.8	6.8	8.3	4.9	6.6
	c_7 (4000 ppm NAA)	3.6	3.4	3.5	4.3	2.8	3.6
Mean (A)		3.77	3.17		4.64	3.08	

New LSD 5% 2020		New LSD 5% 2021	
A	0.2	A	0.2
B	0.2	B	0.2
C	0.6	C	0.6
AB	0.4	AB	0.4
AC	1.2	AC	1.1
BC	1.2	BC	1.1
ABC	2.4	ABC	2.3

Average diameter of branches

The studied interactions between variates as well as times cutting planting and different concentrations of IBA and NAA had an announced effect on average branch diameter. The best treatment combination in respect of average branch diameter was observed with White mulberry (M. Alba) cuttings treated with (1000 IBA and 3000 NAA) that planted in first February (23.80 and 18.4 ml) and (24.7 and 27.3 ml). In contrast, untreated cuttings that planted on March 1st of black mulberry (M. nigra) recorded a lesser average branch diameter (1.7 and 1.9 ml) in both seasons, respectively.

Table (6) Effect of growth regulators, planet date and Varieties in the Average number of leaves explants of Black mulberry (M. nigra) and White mulberry (M. Alba) cvs.

Treatments		2020			2021		
		Verities (A)			Verities (A)		
Planting Date(B)	Growth regulator Concentration (C)	M. Alba a1	M. nigra a2	Mean (B XC)	M. Alba a1	M. nigra a2	Mean (B XC)
B1 (1 Feb.)	c_1 (control)	4.9	3.9	4.4	5.9	3.9	4.9
	c_2 (500 ppm IBA)	23.7	15.3	19.5	18.4	11.1	14.8
	c_3 (1000 ppm IBA)	24.9	16.3	20.6	27.1	14.3	20.7
	c_4 (1500 ppm IBA)	20.3	14.3	17.3	14.3	14.3	14.3
	c_5 (2000 ppm NAA)	18.6	14.6	16.6	19.4	11.4	15.4
	c_6 (3000 ppm NAA)	24.7	16.1	20.4	27.3	15.1	21.2
	c_7 (4000 ppm NAA)	17.7	13.0	15.4	16.9	13.7	15.3
Mean (A X B)		19.25	13.35		18.47	11.97	
Mean (B)			16.31			15.22	
B2 (1 March)	c_1 (control)	1.7	1.9	1.8	1.7	1.9	1.8
	c_2 (500 ppm IBA)	10.0	5.7	7.9	8.6	11.4	10.0
	c_3 (1000 ppm IBA)	20.0	8.6	14.3	20.0	15.7	17.9
	c_4 (1500 ppm IBA)	9.3	10.0	9.7	14.4	14.3	14.4
	c_5 (2000 ppm NAA)	9.3	5.3	7.3	12.9	11.4	12.2
	c_6 (3000 ppm NAA)	15.3	10.0	12.7	18.3	14.3	16.3
	c_7 (4000 ppm NAA)	10.6	10.0	10.3	14.3	14.3	14.3
Mean (A X B)		10.88	7.35		12.88	11.9	
Mean (B)			9.14			12.41	
				Mean(C)			Mean(c)
Mean (A XC)	c_1 (control)	3.3	2.9	3.1	3.8	2.9	3.35

	c_2 (500 ppm IBA)	16.85	10.5	13.7	13.5	11.25	12.4
	c_3 (1000 ppm IBA)	22.45	12.45	17.45	23.55	15	19.3
	c_4 (1500 ppm IBA)	14.8	12.15	13.5	14.35	14.3	14.35
	c_5 (2000 ppm NAA)	13.95	9.95	11.95	16.15	11.4	13.8
	c_6 (3000 ppm NAA)	20	13.05	16.55	22.8	14.7	18.75
	c_7 (4000 ppm NAA)	14.15	11.5	12.85	15.6	14	14.8
Mean (A)		15.07	10.35		15.67	11.93	

New LSD 5% 2020		New LSD 5% 2021	
A	0.3	A	0.4
B	0.3	B	0.4
C	1	C	1.1
AB	0.7	AB	0.7
AC	2	AC	2.1
BC	2	BC	2.1
ABC	4.1	ABC	4.2

Average number of leaves

As related to the Number of leaves per cut, data revealed significant all treatments compared to control. The studied interactions between variates and times cutting planting and different concentrations of IBA and NAA had an announced effect on the number of leaves per cut. The best treatment combination in respect of the Number of leaves per cut was observed with White mulberry (M. Alba) cuttings treated with (1000 IBA and 3000 NAA) (24.9and 27.1) and (24.7and 27.3) that planted in Feb. 1st. while, untreated cuttings that planted march 1st of white mulberry (M. Alba) recorded a lesser Number of leaves per cut in both seasons (1.7 and 1.7), respectively.

Table (7) Effect of growth regulators, planet date and Varieties in Average Dimeter of branches s explants of black mulberry (M. nigra) and white mulberry (M. Alba) cvs.

Treatments		2020			2021		
		Verities (A)			Verities (A)		
Planting Date(B)	Growth regulator Concentration (C)	M. Alba a1	M. nigra a2	Mean (B XC)	M. Alba a1	M. nigra a2	Mean (B XC)
B1 (1 Feb.)	c_1 (control)	4.9	3.9	4.4	5.9	3.9	4.9
	c_2 (500 ppm IBA)	23.7	15.3	19.5	18.4	11.1	14.8
	c_3 (1000 ppm IBA)	24.9	16.3	20.6	27.1	14.3	20.7
	c_4 (1500 ppm IBA)	20.3	14.3	17.3	14.3	14.3	14.3
	c_5 (2000 ppm NAA)	18.6	14.6	16.6	19.4	11.4	15.4
	c_6 (3000 ppm NAA)	24.7	16.1	20.4	27.3	15.1	21.2
	c_7 (4000 ppm NAA)	17.7	13.0	15.4	16.9	13.7	15.3
Mean (A X B)		19.25	13.35		18.47	11.97	
Mean (B)			16.31			15.22	
B2 (1 March)	c_1 (control)	1.7	1.9	1.8	1.7	1.9	1.8
	c_2 (500 ppm IBA)	10.0	5.7	7.9	8.6	11.4	10.0
	c_3 (1000 ppm IBA)	20.0	8.6	14.3	20.0	15.7	17.9
	c_4 (1500 ppm IBA)	9.3	10.0	9.7	14.4	14.3	14.4
	c_5 (2000 ppm NAA)	9.3	5.3	7.3	12.9	11.4	12.2
	c_6 (3000 ppm NAA)	15.3	10.0	12.7	18.3	14.3	16.3
	c_7 (4000 ppm NAA)	10.6	10.0	10.3	14.3	14.3	14.3
Mean (A X B)		10.88	7.35		12.88	11.9	
Mean (B)			9.14			12.41	
				Mean(C)			Mean©
Mean (A XC)	c_1 (control)	3.3	2.9	3.1	3.8	2.9	3.35
	c_2 (500 ppm IBA)	16.85	10.5	13.7	13.5	11.25	12.4
	c_3 (1000 ppm IBA)	22.45	12.45	17.45	23.55	15	19.3
	c_4 (1500 ppm IBA)	14.8	12.15	13.5	14.35	14.3	14.35
	c_5 (2000 ppm NAA)	13.95	9.95	11.95	16.15	11.4	13.8
	c_6 (3000 ppm NAA)	20	13.05	16.55	22.8	14.7	18.75
	c_7 (4000 ppm NAA)	14.15	11.5	12.85	15.6	14	14.8
Mean (A)		15.07	10.35		15.67	11.93	

New LSD 5% 2020		New LSD 5% 2021	
A	0.3	A	0.5
B	0.3	B	0.5
C	1	C	1.5
AB	0.7	AB	1
AC	2	AC	3
BC	2	BC	3
ABC	3.9	ABC	6

Discussion

Adventitious root formation on a cutting requires the presence of readily available carbohydrates and nitrogen compounds. For nucleic acid and protein synthesis, the initiation and development of root primogenitors necessitate a higher degree of nitrogen **(Nanda and Kocchar, 1985).** As a result, carbohydrate and nitrogen molecules are more likely to be readily accessible. Differential rooting responses of different mulberry species and varieties to hormonal treatments have also been observed. White mulberry (M. Alba), black mulberry (M. nigra). **Rao and Khan (1963), Fotedar et al. (1991) and Kamili and Shah (1996).**

All hormonal concentrations significantly increased rooting percentage, with 1000 IBA outperforming all other treatments and 3000 NAA coming in second. The increased percentage of cuttings rooting with NAA and IBA treatment may be due to the mobilization of nutritional reserves to the root formation, resulting in increased hydrolyzing enzyme activity **(Nanda and Kocchar, 1985)**. These results are in line with those of **Honda (1970), Shanmugavelu (1975),** and **Mukherjee and Sikdar (1977),** who found that NAA and IBA were more effective at inducing rooting than IAA. Nonetheless, the present results dispute those of **Fotedar et al. (1991),** who concluded that NAA was the least effective compared to IBA. Variations in propagating medium, treatment period, and planting of cuttings in the soil after dipping for a second time in the treatment could explain the inconsistencies in hormone action. Nonetheless **(Stoutemeyer, 1954**).

The difference in stored assimilates and endogenous auxins in cuttings and lateral buds could explain the variable rooting reaction of varieties to plantation time **(Nanda and Kocchar, 1985).** The cuttings planted in February had a slightly higher percentage of rooting than those planted in March Changes in cambial function, endogenous levels of nutrients, and hormonal influences, which are brought on by changes in light temperature and humidity conditions in nature, are attributed to seasonal shifts in rooting reaction **(Nanda and Kocchar 1985)**. As a result, the highest percentage of rooting on February 1st may be attributed to the presence of ideal environmental and dietary factors. **Bindroo et al., 1983 and 1988**, found that cuttings planted in July had a higher percentage of rooting

The largest number of primary roots is found in Morus Alba cuttings, followed by Morus nigra in descending order, with results that backed up **Honda's (1972)** findings in mulberry varieties.

3000 ppm treatment of cuttings NAA has the primary roots, led by 1000 ppm IBA, all of which were considerably better than the other therapies, including power. The rise in root number per cutting due to NAA and IBA care may be attributed to their aggregation at the cutting's base to an extent appropriate for root initiation and growth **(Hartmann et al. (1997).**

These findings are consistent with **Shanmugavelu's (1975)** results in Kanva-2**, Konarli et al. (1977)** findings in Ichinose, and Isa et al. (1993) findings in Terminalia arjuna.

The cuttings planted on February 1st produced the most primary roots, followed by those planted on the first march, and they were statistically equal. That may be attributed to the favorable environmental conditions that prevailed from first February to 15 April, resulting in great rooting. **Satpathy et al., 1995**, who registered a higher number of roots in cuttings planted in June under West Bengal conditions, backs up these findings.

A significant difference in primary root length was observed among the test varieties. White mulberry (M. Alba) recorded the most extended primary root length per cutting, closely followed by Black mulberry (M. nigra). These findings are comparable to those of **Mukherjee and Sikdar (1974**), who recorded a similar response to ringing in the SJ46 mulberry cultivar.

The cuttings planted on February 1st had the greatest root volume, followed by those planted on first march The increased length of primary roots may be attributed to improved carbohydrate hydrolysis caused by a favorable basal temperature at planting time.

The largest number of primary roots is found in White mulberry (M. Alba) cuttings, followed by Black mulberry (M. nigra) in descending order, with results that backed up **Honda's (1972)** findings in mulberry varieties.

3000 ppm treatment of cuttings NAA has the primary roots, led by 1000 ppm IBA, all of which were considerably better than the other therapies, including power. The rise in root number per cutting due to NAA and IBA care may be attributed to their aggregation at the cutting's base to an extent appropriate for root initiation and growth **(Hartmann et al., 1997).**

These findings are consistent with **Shanmugavelu's (1975) results in** Kanva-2**, Konarli et al., (1977)** findings in Ichinose, and **Isa et al., (1993)** findings in Termanalia arjuna.

The cuttings planted on February 1st produced the most primary roots, followed by those planted on first march, and they were statistically equal. That may be attributed to the abundance of favorable weather conditions on February 1st, which resulted in abundant rooting. **Satpathy et al., 1995,** who registered a higher number of roots in cuttings planted in June under West Bengal conditions, backs up these findings.

The maximum number of the average number of branches was recorded on White mulberry (M. Alba) cutting being significantly the highest compare to Black mulberry (M. nigra), with findings which corroborated of **Honda (1972)** in mulberry varieties.

Treatment of cuttings with 1000 ppm IBA registered maximum number of branches followed by 3000 ppm NAA, both of the treatments were significantly superior to rest of

The treatments including control. The increase in the number of branches per cutting due to NAA and IBA treatment might be due to their accumulation at the base of cutting to a suitable level for initiation and development of roots **(Hartmann et al., (1997).** These results conform with the findings of **Shanmugavelu, (1975) in Kanva-2, Konarli et al. (1977)** in Ichinose and **Isa et al., (1993)** in Termanalia arjuna.

The cuttings planted during first February recorded the maximum number of branches closely followed by those planted in first march and were statistically at par with each other. This might be due to the prevalence of favorable environmental conditions during first February, which has resulted in profuse rooting. These results are supported by **Satpathy et al., 1995** who reported a more significant number of roots in cuttings planted in June under West Bengal conditions. A significant difference in branches length was observed among the test varieties, White mulberry (M. Alba) recording the most extended branch length per cutting, closely followed by black mulberry (M. nigra). These findings are comparable to those of **Mukherjee and Sikdar (1974),** who recorded a similar response to ringing in the SJ46 mulberry cultivar.

The cuttings planted on February 1st had the most significant root volume, followed by those planted on first march. The increased branch length may be attributed to increased carbohydrate hydrolysis caused by the favorable basal temperature at planting time.

the rise in branch diameter may be due to the presence of a stronger root system, which absorbed more nutrients and moisture **(Sandhu et al., 1991)**. The largest diameter of branches was found in cuttings planted on February 1st, followed by plantation on the first march. The maximum branch diameter in cuttings planted on February 1 may be attributed to the shorter internodal spacing in these saplings. **Mukherjee and Sharma (1971)** found a similar response in cuttings planted in August.

Significant varietal variations in leaf number were found, with White mulberry (M. Alba) having the most, followed by Black mulberry (M. nigra). In addition to all other hormone concentrations and the regulation, 3000 ppm NAA and 1000 ppm IBA produced the highest number of leaves per cutting. Compared to cuttings with a moderate root system, the increased number of leaves may be due to the presence of a stronger root system, which absorbed more nutrients and moisture **(Sandhu et al., 1991).** The findings are consistent with those of findings **Fotedar et al. (1991),** who published similar responses for various mulberry varieties treated with 1000 ppm IBA.

The highest number of leaves is found in cuttings planted on February 1st, closely followed by plantation on March 1st. All of the dates, though, were on par with one another. The highest number of leaves in cuttings planted on February 1st may be attributed to the shorter inter-nodal gap in these saplings. **Mukherjee and Sharma (1971)** found a similar response in cuttings planted in August.

Recommunication

White mulberry (M. Alba) was favorable for imparting maximum rooting and root as well as shoot characters to Black mulberry (M. nigra).
February 1st corresponded to a good time for clonal propagation of mulberry cuttings among the plantation periods studied.

IBA concentration of 1000 ppm was favorable for imparting maximum rooting and root as well as shoot characters in M. Alba and M. nigra in under the influence of 3000 ppm NAA 1000 ppm IBA recorded the best results under polyhouse conditions.
Carrying out Planted White mulberry (M. Alba), cutting on February 1st with treated with 1000 ppm IBA or 3000 ppm NAA was beneficial for obtaining an economic vegetative propagation of cutting cultivars of Mulberry (Morus Alba. Morus Nigra) by hardwood cuttings under mist conditions.

References:

1. **Baksh, S., Mir, M. R., Darzi, G. M. & Khan, M. A. (2000).** Performance of hardwood stem cuttings of mulberry genotypes under temperate climatic conditions of Kashmir. Indian Journal of Sericulture. 39(1): pp30-32.
2. **Bindroo, B. B., Tiku, A. K& Javid, G. N. (1983).** Studies on the propagation of mulberry under temperate climatic conditions Part-I Propagation through hardwood cuttings. In National Seminar on Silk Research and Development, Bangalore, India. Pp 108.
3. **Bindroo, B. B., Tiku, A. K& Panditt, R. K. (1988).** Response of Japanese mulberry varieties propagated through cuttings under Kashmir ecoclimatic conditions. Geobios, New Report. 7: pp36-39.
4. **Ezekiel, A. (2010).** Viable options and factors in consideration for low-cost vegetative propagation of tropical trees. International Journal of Botany, 6(2), pp187-193.
5. **Fotedar, R. K, Ahsan, M. M, Dhar, K. L. & Dhar, A. (1991).** Screening of mulberry varieties for rooting and induction of rooting by the use of growth regulators. Sericologica. 30(3): pp347-36.
6. **Gilman Edward F; Watson Dennis G 1994** Morus Alba Fruitless Cultivars Forest Service.
7. **Harrison-Murray R S 1991** A leaf-model evaporimeter for estimating potential transpiration in propagation environments J. Hort. Science, 66: 131-139.*7th ed Prentice Hall Upper Saddle River*.
8. **Hartmann H T; Kester D E; Devies F T & Geneve R L (2002)** *plant propagation: Principles and practices*.
9. **Hartmann, H. T., Kester, D. E., Davis Jr, F. T. & Geneve, R. L. (1997)**. Plant propagation-Principles and practices, 6th edition. {Indian Reprint), Prentic-Hall of India Private Limited, New Delhi. pp 673.

10. **Hartmann, H. T, Kester, D. E., Davis Jr, F. T. & Geneve, R. L. (1997)**. Plant propagation-Principles and practices, 6th edition. {Indian Reprint), Prentic-Hall of India Private Limited, New Delhi. pp 673.
11. **Honda T. (1970).** Studies on the propagation of mulberry trees by cuttings. Bull. Seri. Expt. Stn. 24:231-236.
12. **Honda, T. (1970).** Studies on propagation of mulberry trees by cuttings. Bulletin of Sericulture Experimentation Station, Japan. 24(1): pp233-236.
13. **Isa, Md., Srivastava, D. P., Goel, A. K. & thangavelu, K. (1993).** Vegetative propagation of Termanalia Arjuna Bedd. Through auxin treated stem cuttings. Indian Journal of Sericulture. 32(1): pp115-116.
14. **Kamili, A. N. & Shah, A. M. (1996)**. Effect of some grow1h regulators and vitamins on the rooting of two exotic mulbe1Ty cuttings. Oriental Science. 1(2): pp99-104.
15. **Khan G S; Ahmad I &Nawaz M F (2007)** Sprouting percentage and growth behaviour of morus Alba as affected by size of cuttings and polythene tunnel Pak. J. Agri. Sci., 44(2): 328-331.
16. **Konarli, 0. Celebioglu, G. & Ciragil, N. (1977).** Propagation of mulberry cultivars from hardwood cuttings. Yaprak dut cesitlerinin odun celigi ile uretilimesi. Yalova Bahce Kulturleri Arastirma Enstitusu Dergisi. 8(2):35-40. [Cf.: Horticultural Abstracts, 1978, 48(9): 7935].
17. **Mead, A. D., & Drasgow, F. (1993).** Equivalence of computerized and paper-and-pencil cognitive ability tests: A meta-analysis. Psychological bulletin, 114(3), 449.
18. **Mukhe1jee, S. K. & Sikdar, A. K. (1977)**. Effects of auxin, vitamins and their combination on the rooting of mulberry cuttings. *Indian Journal of Sericulture.* 16(1): pp1-9.
19. **Nanda, K. K. & Kochhar, V. K. (1985)**. Vegetative propagation of plants. First edition Kalyani publishers, New Delhi. pp 234.
20. **Prahlada Rao, L. S., & Khan, A. Z. (1963).** Vegetative propagation of Japanese mulberry varieties by use of growth regulators. Indian J. Seri, 1(3), pp 7-21.
21. **Sandhu, A.S, minhas, P.P.S., singh, S.N., kambhoj, J.S. (1991)**. studies in hizogenesis of hardwood cutting of pomegranate .India journal of horticulture .48 (4).302-304.
22. **Satpathy, B., Purohit, K. M, Ghosh, J. K. &Ghosh, P. L. (1995).** Propagation of mulbe1Ty (A1orus Alba L.) through young shoots in West Bengal. *Indian Journal of Sericulture*. 34(1): pp42-45.
23. **Shanmugavelu, K. G. (1975)**. Introduction of rooting of mulberry (Morus Alba L.) in cutting with the aid of plant growth regulators under intermittent mist Indian Journal of Sericulture. 14(1): pp22-26.

24. **Shanmugavelu, K. G. (1975)**. Introduction of rooting of mulberry (Morus Alba L.) in cutting with the aid of plant growth regulators under intermittent mist Indian Journal of Sericulture. 14(1): pp22-26.
25. **Steel, R. G. D., & Torrie, J. H. (1960).** Principles and procedures of statistics. *Principles and procedures of statistics.*
26. **Stoutemeyer, V. T. (1954).** Plugs to change turf. Journal of California Agriculture, 8 (2), 5-6.
27. **Susheelamma, B. N., Jolly, M. S, Giridhar, K. & Sengupta, K. (1990)**. Evaluation of germplasm genotypes for drought resistance in mulberry Sericologia. 30(3): pp327-341.
28. **Susheelamma, B. N., Kumar, J. S., Sikdar, A. K., Dandin, S. B., Jolly M. S. & Sengupia, K. (1992).** Exploitation of promising mulberry genotypes for yield potentiality. Sericologia. 33(2); pp295-300.