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ROOTABILITY OF HARDWOOD CUTTINGS OF MULBERRY (*MORUS ALBA* L.) INFLUENCED BY PLANTING TIME AND GROWING CONDITIONS UNDER VALLEY CONDITION OF GARHWAL HIMALAYAS

K. K. Singh*, Dev Kishan Jat and S. K. Mehta

Department of Horticulture, Chauras Campus, H.N.B. Garhwal University, Srinagar (Garhwal)-246 174 (U.K.), India.

Abstract

An experiment was conducted at the Horticultural Research Centre, HNB Garhwal University, Srinagar Garhwal (U.K.), Uttarakhand, India; to investigate Rootability of Hardwood Cuttings of Mulberry (*Morus alba* L.) influenced by planting time and growing conditions under Valley Condition of Garhwal Himalayas. Stem cuttings of the plant were subjected to different treatments; planting time (July, August and September), growing conditions (mist chamber, open condition and partial shade) and 5000ppm IBA concentration. The experiment was laid out in factorial randomized block design and replicated thrice. For preparing the rooting media, soil, sand and farm yard manure (FYM) in ratio of 1:1:1 by v/v were mixed thoroughly, cleaned for stones and grasses, then the mixture was filled in root trainers. The mist house growing condition was found effective in increasing the success rate of the cuttings. The cuttings planted in August, performed the best in all aspects, number of sprouted cutting, average number of sprouts, length of longest sprout, diameter of thickest sprout, number of leaves on new shoots, shoot percentage, fresh and dry weight of shoot, root percentage, number of primary root, secondary root, length of longest root, fresh and weight of root.

Key words : Mulberry, growing condition, planting time, rooting.

Introduction

Morus alba L. belong to Moraceae family. It is cultivated largely in Asian countries for its foliage and considered as the main food for silkworm (*Bombyx mori*). There are more than 100 species under the genus *Morus*. Most of the Indian varieties of mulberry belong to *M. indica*. The most important use of mulberry leaf is rearing of the silk worms for production of silk. The silk producers have traditionally fed mulberry refusals and leftovers from silkworm feeding to farm animal and to herbivorous carp in poly-culture fish ponds. It is also used for timber purpose such as making of table, chair, sports item as well as agricultural implements and the bark is also used for making good quality paper (Dinesh *et al*. 2006). 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. The ripe fruit of mulberry is highly appreciated for its delicious fruit which is consumed fresh or for extraction of juice. The ripe fruit of mulberry contains 8-9% sugar and 1% acidity.

***Author for correspondence:** E-mail: forekrishna@gmail.com

Mulberry is commercially propagated from hard wood cuttings because of distinct advantages like speedy multiplication of parent materials and maintenance of the desired characters 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 physiological condition of the plant and environmental conditions. Both time of cutting collection and rooting success varies with the climatic condition and prevailing outdoor temperature. There are several factors that 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 stock plant; wounding or leaf removal; stock plant etiolation and girdling; cutting date; or is influenced by growing 9 conditions such as media, mist, bottom heat, use of hormones, fertilizer, and supplemental lighting (Hartmann *et al*., 2002). Harrison-Murraya (1991) observed that the seasonal timing, or the period of the year in which cuttings are taken, can play an important role in rooting. In plant propagation, the

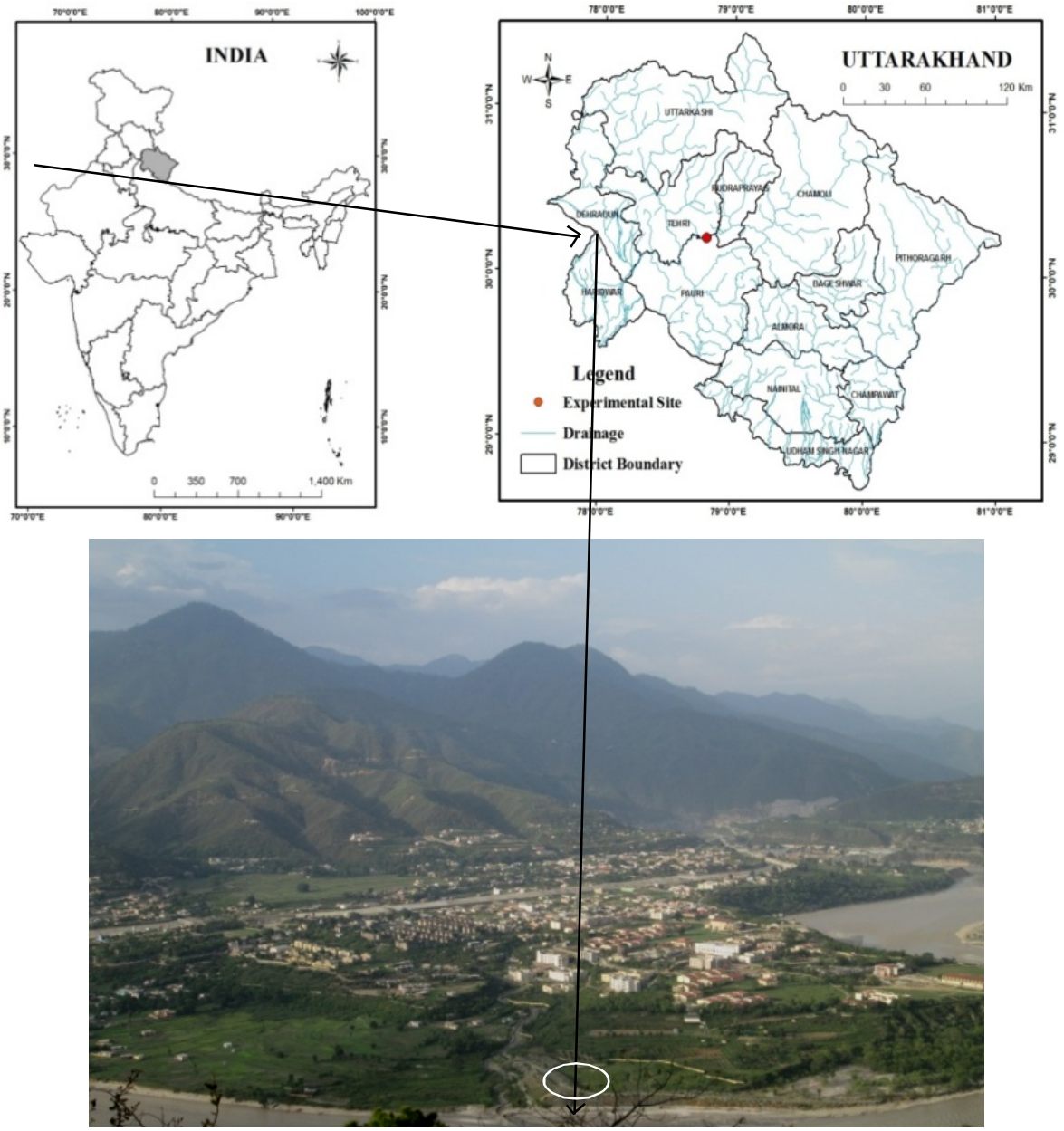

Plate 1 : Experimental site.

different environment *viz.*, glass house, net house, poly-house and mist chamber have been widely used for rooting of different types of cutting. Development of mist chamber is a major breakthrough in propagation of plants. Khan *et al*. (2007) reported that the mulberry (*Morus alba* L.) performance of cutting in open air and in polythene low tunnel. Sprouting percentage and number of leaves were found maximum in eight inch long cutting and height of plants was maximum in six inch long cuttings. These parameters performed well in polythene tunnel as compared to open air. Kalyoncu *et al*. (2009) studied the highest rooting percentage was determined from black mulberry in 2000 and 3000ppm IBA doses application (100%). Among all the treatments, numbers of sprouted cuttings, length of the roots, percentage of rooted cutting, lengths of longest sprouts of root were higher in IBA 2000 mg.L^{-1} (Singh *et al*., 2014).

Materials and Methods

Study area

The experiment was conducted at Horticulture Research Centre, Chauras Campus. Geographically Srinagar valley is spread between latitude 30^0, 12’ 0” to 30^0 13’ 4” North and longitude 78^0 0’ 45” to 78^0 0’ 50”

East. The valley is about 6 km long and 1 to 1.2 km wide located on both side of famous Alaknanda river at an elevation 540 m above MSL and about 127 km from Haridwar in Himalayan region. The valley shows a semi-arid and sub-tropical climate. Except during rainy season rest of months are usually dry with exception occasional showers during winter or early spring. The average minimum and maximum temperature, relative humidity and rainfall vary from 7.32^{0}C to 36.3^{0}C, 54.24% and 2.70 to 245.26 mm, respectively.

Methodology

Hardwood stem cuttings of mulberry (*Morus alba* L.) were collected from 6 to 8 year old plants and 15 cm long stem cuttings with basal portion were prepared. For rooting media, soil, sand and farm yard manure (FYM) in ratio of 1:1:1 by v/v were mixed thoroughly, cleaned for stones and grasses, then the mixture was filled in root trainers. The basal ends of the cuttings were dipped in dilute solutions, 5000ppm of Indole-3-Butyric Acid by quick dip method for 10 seconds before planting in the rooting medium. 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 10 cuttings in each treatment and a total of 90 cuttings were planted in mist chamber, 90 cuttings were planted in partial shade and 90 cuttings were planted in open condition. The number of sprouted cutting, average number of sprouts per, length of longest sprout, diameter of thickest sprout, number of leaves on new shoots, shoot percentage, fresh and dry weight of shoot, root 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).

Results and Discussion

In case of planting time, significantly the maximum number of sprouted cutting (7.22), average number of sprouts per cutting (4.11), length of longest sprout (9.67cm), diameter of thickest sprout (0.43cm), number of leaves on new shoots (10.67), shoot percentage (67.67%), fresh weight of shoot (38.23gm), dry weight of shoot (9.77gm), root percentage (60.11), number of primary root (10.78), secondary root (42.55), length of longest root (12.00cm), fresh weight of root (9.27gm), dry weight of root (2.48gm) was recorded under August planting time, while the minimum sprouting cutting (6.00),average number of sprouts per cutting (2.89), length of longest sprout (6.38cm), diameter of thickest sprout (0.32cm), number of leaves on new shoots (8.22), shoot percentage (60.22%), fresh weight of shoot (33.15gm), dry weight of shoot (9.07gm), root percentage (51.67%), number of primary root (7.11), secondary root (38.78), length of longest root (11.44cm), fresh weight of root (7.25gm), dry weight of root (2.01gm) was observed under July planting time, during present investigations (tables 1, 2, 3 and 4). Favourable climatic conditions play an important role to increase the number of leaves. The appropriate planting time, application of IBA as well as genetic makeup of genotype use might have played some role in augmenting the number of leaves per cutting (Singh and Singh, 2002). Poor rooting in the cuttings which were planted during cooler time of the season might be due to the fact that these cuttings might have been carrying higher inhibitor to promote ratio or it might be due to higher nitrogen to carbohydrate ratio. Harrison-Murraya (1991) observed that the seasonal timing, or the period of the year in which cuttings are taken, can play an important role in rooting. Blazich (1987) reported that time of year when cuttings are taken is an important factor influencing rooting of woody plants from stem cuttings. According to Singh *et al*. (1961) hardwood cuttings produced a higher rooting percentage with vigorous root system then semi-hardwood cuttings. They also noted that the best time for taking cutting in phalsa was July- August than in September.

In propagating deciduous species, hardwood and semi-hardwood cuttings can be taken during the dormant season when buds are not active and before buds start to force out in the rainy season. There is an optimal period for rooting many species, which is necessary to maximize the rooting process (Hartman *et al*., 1997). Davis (1984) observed a vivid seasonal change in shoot production and rooting. Heavy flushing was also observed during the rainy periods, a time of intense vegetative growth, which may tend to increase rooting percentage. Cuttings do not root normally in the dry season; however, rejuvenated shoots may still have superior root development probably because of higher food reserves and other rooting co-factors. Evans (1992) contended that probably the best time to take cuttings from the field is at the beginning of the rainy season.

In case of growing conditions, significantly the maximum number of sprouted cutting (7.33), average number of sprouts per cutting (4.33), length of longest sprout (8.91cm), diameter of thickest sprout (0.43cm), number of leaves on new shoots (10.56), shoot percentage (68.11%), fresh weight of shoot (48.65gm), dry weight of shoot (10.76gm), root percentage (62.89), number of primary root (10.67), secondary root (48.78), length of

Table 1 : Effect of different growing conditions and various planting time on the shooting performance of mulberry (*Morus alba* L.).

Planting time	Number of sprouted cutting				Average no of sprout per cutting				Length of longest sprout (cm)				Diameter of thickest sprout (cm)			
	G_1 (Mist chamber)	G_3 (Partial Shade)	G_2 (Open condition)	Mean	G_1 (Mist chamber)	G_3 (Partial Shade)	G_2 (Open condition)	Mean	G_1 (Mist chamber)	G_3 (Partial Shade)	G_2 (Open condition)	Mean	G_1 (Mist chamber)	G_3 (Partial Shade)	G_2 (Open condition)	Mean
T_1 (July)	8.33	5.00	4.67	6.00	3.33	3.67	1.67	2.89	6.62	7.90	4.62	6.38	0.37	0.30	0.30	0.32
T_2 (August)	7.33	7.67	6.67	7.22	6.67	4.00	1.67	4.11	14.00	7.87	7.15	9.67	0.45	0.50	0.35	0.43
T_3 (September)	6.33	7.00	7.67	7.00	3.00	2.67	3.67	3.11	6.13	8.34	6.69	7.05	0.47	0.37	0.37	0.40
Mean	7.33	6.55	6.33		4.33	3.44	2.33		8.91	8.03	6.15		0.43	0.39	0.37	
	T	**G**	**T x G**		**T**	**G**	**T x G**		**T**	**G**	**T x G**		**T**	**G**	**T x G**	
Sem	0.328	0.328	0.568		0.339	0.339	0.587		0.732	0.732	1.268		0.022	0.022	0.039	
CD at 0.5%	0.961	0.961	1.665		0.995	0.995	1.724		2.148	2.148	3.720		0.066	0.066	0.114	

Table 2 : Effect of different growing conditions and various planting time on the shooting performance of mulberry (*Morus alba* L.).

Planting time	Number of leaves on new shoot				Shoot percentage				Fresh weight of shoot(gm)				Dry weight of shoot (gm)			
	G_1 (Mist chamber)	G_3 (Partial Shade)	G_2 (Open condition)	Mean	G_1 (Mist chamber)	G_3 (Partial Shade)	G_2 (Open condition)	Mean	G_1 (Mist chamber)	G_3 (Partial Shade)	G_2 (Open condition)	Mean	G_1 (Mist chamber)	G_3 (Partial Shade)	G_2 (Open condition)	Mean
T_1 (July)	8.67	9.33	6.67	8.22	65.00	62.67	53.00	60.22	38.75	30.25	30.46	33.15	9.11	9.42	8.69	9.07
T_2 (August)	14.00	9.00	9.00	10.67	61.67	70.00	71.33	67.67	62.83	26.91	24.97	38.23	13.63	8.43	7.24	9.77
T_3 (September)	9.00	7.33	9.33	8.55	77.67	63.67	53.33	64.89	44.37	36.43	29.39	36.73	9.54	9.33	8.94	9.27
Mean	10.56	8.55	8.33		68.11	65.44	59.22		48.65	31.19	28.27		10.76	9.06	8.29	
	T	**G**	**T x G**		**T**	**G**	**T x G**		**T**	**G**	**T x G**		**T**	**G**	**T x G**	
Sem	0.653	0.653	1.131		1.872	1.872	3.242		2.493	2.493	4.318		0.481	0.481	0.833	
CD at 0.5%	1.916	1.916	3.319		5.491	5.491	9.511		7.313	7.313	12.667		1.411	1.411	2.444	

Table 3 : Effect of different growing conditions and various planting time on the rooting performance of mulberry (*Morus alba* L.).

Planting time	Root percentage				Number of primary root				Number of secondary				Length of longest root (cm)			
	G_1 (Mist chamber)	G_3 (Partial Shade)	G_2 (Open condition)	Mean	G_1 (Mist chamber)	G_3 (Partial shade)	G_2 (Open condition)	Mean	G_1 (Mist chamber)	G_3 (Partial shade)	G_2 (Open condition)	Mean	G_1 (Mist chamber)	G_3 (Partial shade)	G_2 (Open condition)	Mean
T_1 (July)	76.00	44.00	35.00	51.67	7.00	7.67	6.67	7.11	43.67	41.67	31.00	38.78	14.33	10.33	9.67	11.44
T_2 (August)	54.33	57.67	68.33	60.11	16.33	8.33	7.67	10.78	48.33	39.33	40.00	42.55	15.67	11.33	9.00	12.00
T_3 (September)	58.33	53.00	46.67	52.67	8.67	6.00	7.00	7.22	54.33	43.33	27.33	41.66	13.67	11.67	9.00	11.45
Mean	62.89	51.56	50.00		10.67	7.33	7.11		48.78	41.44	32.78		14.56	11.11	9.22	
	T	G	T x G		T	G	T x G		T	G	T x G		T	G	T x G	
Sem	2.588	2.588	4.483		0.811	0.811	1.405		1.971	1.971	3.414		0.433	0.433	0.750	
CD at 0.5%	7.592	7.592	13.149		2.380	2.380	4.122		5.782	5.782	10.016		1.270	1.270	2.201	

longest root (14.56cm), fresh weight of root (8.98gm), dry weight of root (2.43gm) was observed under mist chamber growing conditions. The minimum sprouting cutting (6.33), average number of sprouts per cutting (2.33), length of longest sprout (6.15cm), diameter of thickest sprout (0.37cm), number of leaves on new shoots (8.33), shoot percentage (59.22), fresh weight of shoot (28.27gm), dry weight of shoot (8.29gm), root percentage (50.00%), number of primary root (7.11), secondary root (32.78), length of longest root (9.22cm), fresh weight of root (7.18gm), dry weight of root (1.91gm) was recorded under open growing conditions (tables 1, 2, 3 and 4). Intermittent mist is often used on cuttings because it reduces the temperature of the leaves, lowers respiration, and increases relative humidity around the leaf surface (Langhans, 1955). Kumar (1973) showed that rooting of cuttings was higher under intermittent mist than under continuous for mist obtained successful rooting of guava cuttings under intermittent mist with IBA at 5000 ppm concentration it has been further established that when the mist propagation was coupled with certain hormonal treatments, the cuttings gave better rooting than with mist alone. Prolings and Therios (1976) showed that creating humid atmosphere by means of artificial mist around the planted cuttings either in concealed pot culture house or in open conditions has proved to enhance the process of rooting.

Auxin application has been found to enhance the histological features like formation of callus and tissue and differentiation of vascular tissue (Mitra and Bose, 1954). Adding a small percentage of certain phenoxy compounds to either IBA or NAA increased rooting and produced root systems better than those obtained when phenoxy compounds are used alone (Davis and Haissig, 1990). Koyuncu and Senel (2003) reported that the best rooting percentage was obtained from bunch planting for the rooting of black mulberry hardwood cuttings treated with 5 $g.l^{-1}$ IBA. Growth regulators are to be used to improve its high rooting ability (Yadav and Rajput, 1969). Shekhawat (1994) claimed best response at 5000 ppm while propagating the ker through cutting. Under mist system of nursery shade net house. Hence, it is possible that optimum use of growth regulators and suitable season would help for rapid multiplication in propagating Mulberry cuttings. Rooting efficiency would be better when it is done in control conditions such as mist chamber.

Conclusion

Reported to the research results, growing conditions and time of planting had a large impact on the success of survival and rooting in cuttings of mulberry (*Morus alba*

Table 4 : Effect of different growing conditions and various planting time on the shooting performance of mulberry (*Morus alba* L.).

Planting time	Fresh weight of root (gm)				Dry weight of root (gm)			
	G_1 (Mist chamber)	G_3 (Partial Shade)	G_2 (Open condition)	Mean	G_1 (Mist chamber)	G_3 (Partial shade)	G_2 (Open condition)	Mean
T_1 (July)	7.73	6.84	7.18	7.25	2.08	2.04	1.93	2.01
T_2 (August)	13.82	7.75	6.24	9.27	3.48	2.12	1.85	2.48
T_3 (September)	5.40	8.98	8.14	7.50	1.75	2.36	1.95	2.02
Mean	8.98	7.85	7.18		2.43	2.17	1.91	
	T	**G**	**T x G**		**T**	**G**	**T x G**	
Sem	0.381	0.381	0.660		0.100	0.100	0.174	
CD at 0.5%	1.117	1.117	1.935		0.295	0.295	0.511	

L.). Time of planting in mid August and growing conditions mist chamber, were the best treatments that are to be considered for the propagation of Mulberry hard wood cutting.

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