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Full Length Research Paper

Effects of humidity level and IBA dose application on the softwood top cuttings of white mulberry (*Morus alba* L.) and black mulberry (*Morus nigra* L.) types

I. H. Kalyoncu[1], N. Ersoy[1]*, M. Yılmaz[2] and M. Aydın[2]

[1]Department of Horticultural Science, Faculty of Agriculture, University of Selcuk, 42031, Konya, Turkey.
[2]Sarayönü Vocational High School, University of Selcuk, 42420, Sarayönü, Konya, Turkey.

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In this research, the effects of 85-90% relative humidity and ındol-3-butyric acid (IBA) doses on softwood top cuttings of two black mulberry (Types 1 and 2) and one white mulberry (Type 3) types were studied. Cuttings were taken from early June (14 Haziran) and applied to the different IBA doses (0, 1000, 2000, 3000 and 4000 ppm). Cuttings were planted in pumice medium under misting system in the greenhouse for 48 days in order to root. The highest rooting percentage was determined from Type 1 (black mulberry) in 2000 and 3000 ppm IBA doses application (100%). The lowest one was control group from Type 2 (black mulberry) which was not rooted. Acording to increase liveliness of the cuttings, rooting percentage increased. Nearly all of the living cuttings were rooted. The highest ratio of cutting callus formation was found to be 2000 and 3000 ppm IBA doses (100%) from Type 1; the lowest one was determined control group of Types 2 and 3 (0.00%). The highest rooting area lenght was found from Type 3 (2.00 cm) and Type 1 (1.92 cm); the lowest one was control group of Type 2 (0.00 cm). With respect to root numbers, the highest value was found from Type 3 (21.73 number/cutting) and Type1 (16.42 number/cutting); the lowest one was control group of Type 2 (0.00 number/cutting). The longest root was determined from 3000 ppm IBA dose of Type 1 (11.23 cm); the highest root branching value was found from Type 3 in 3000 ppm IBA dose (16.20 number/cutting) application.

Key words: Mulberry, sooftwood top cutting, misting system, humidity, hormone, rooting.

INTRODUCTION

Mulberry (*Morus* sp.) has been domesticated over thousands of years and has been adapted to a wide area of tropical, subtropical, and temperate zones of Asia, Europe, North and South America, and Africa (Özgen et al., 2009). There are approximately 68 mulberry species (*Morus*) in the world and the most common types are *Morus alba* and *Morus indica* (Datta, 2000). The world's most common mulberry application is the use of its leaves in the cultivation of the silkworm, and the most important countries in this respect are China and India. On the other hand, Central Asia and the Middle East consume mulberry fruit (Sanchez, 2000). The main species are *Morus nigra, M. alba, Morus rubra, Morus australis, Morus latifolia* and *Morus multicaulis* (Yaşin et all. 2003).

Mulberry' s homeland is known to be China, India, Turkey, Russia and Middle Eastern countries (İslam et al., 2003). Mulberry has been cultivated almost throughout Turkey, for sericulture (Karadeniz and Şişman, 2003). In Turkey, the most common ones are *M. alba* (white mulberry), *M. nigra* (black mulberry) and *M. rubra* (red mulberry) species (Davis, 1982) and in particular, they have been cultivated for fruit. Although the amount of production of these types are not included in the individual statistics, it is known that the amount of white mulberry produced is in the first row while the black mulberry is also grown in significant quantities. In recent years, antioxidant substances and human health benefits of phenolic compounds have been understood, and thus the interest in mulberry has increased. Even though in Turkey, mulberry has significant genetic potentials, it has not been evaluated sufficiently. Mulberry fruit is desirable material for syrup, dried fruit pulp, cakes, marmalade and

*Corresponding author. E-mail: nersoy@selcuk.edu.tr.

ice cream industry. Therefore, it must be integrated to the economy (İslam et al., 2003). The different organs of mulberry (leaves, shells, root ect.) have been used in folk medicine since ancient times (Güneş and Çekiç 2003a) too.

In recent years, an interest in mulberry saplings especially in black mulberry is increasing (Güneş and Çekiç, 2003b). 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). On grafting propagation, grafting success is prevented because the emergence of the milk secretion and the space under the bud tissue emerge (Ünal et al.,1992).

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 (Konarlı et al., 1977; Ayfer et al., 1986; Baksh et al., 2000; Ünal et al., 1992; Özkan and Arslan, 1996; Soylu et al., 1997; Yıldız and Koyuncu, 2000; Koyuncu and Şenel, 2003; Koyuncu et al., 2004; Karadeniz and Şişman, 2004; Erdoğan and Aygün, 2006). In these researches, while the success rate is up to 100% of the white mulberry, this ratio can be obtained to be 89.3% in black mulberry. Some researchers could not obtain any rootings in black mulberry softwood cuttings, while the others could succeed with high rate of rooting (Ayfer et al., 1986; Koyuncu et al., 2004; Erdoğan and Aygün, 2006; Özkan and Arslan, 1996).

In this research, the effects of humidity level and different IBA concentrations on rooting of softwood top cuttings of three mulberry types were investigated.

MATERIALS AND METHODS

Material

In the research, the softwood top cuttings of two type black mulberry (*M. nigra* L.) (Types 1 and 2) and one type (Type 3) white mulberry (*M. alba* L.) trees grown in home gardens of Konya Province Center were taken from one-year old shoots in early June (June 14). 85-90% air humidity level, perlite media (0.0-5.0 mm) and indole-3-Butirik Asit (IBA) in different doses [0 (control), 1000, 2000, 3000 ppm and 4000 ppm] were used.

Methods

The research was carried out in the "Mist Propagation Unit" of Research and Practice greenhouse of Selcuk University, Faculty of Agriculture, Department of Horticulture. Softwood top cutings were taken to be 15-30 cm length, 3-6 mm diameter and pinched of the leaves below the point where one or two leaves are attached at the stem and then planted into the rooting media (Kalyoncu, 1996).

In the research, 0 ppm (control), 1000, 2000, 3000, 4000 ppm ındole-3-butyric acid (IBA) doses were applied. In practice, in the form of sheaves of cutting, 1-2 cm of the bottom parts were dipped in IBA solution for a period of five seconds and we waited for a short period of time for the alcohol to release. Then cuttings were planted in a rooting media (buried about 2/3 their height) by 10 x 10 row and plant spacing (Kalyoncu, 1996). The relative humidity level, rooting area temperature and ambient temperature in the mist propagation unit were 85-90%, 18-20, 29-31℃, respectively. This experiment was carried out in a randomized block factorial designs, with 3 replicates, each replicate consisting of 5 cuttings. After mulberry softwood cuttings, for a period of 48 days, were subjected to root mist propagation system, they were investigated in the way of cutting vitality (number), cutting length (cm), callus status (%), rooting ratio (%), cutting diameter (cm), rooting surface area length (cm), root number (number/cutting), the longest root length (cm), the shortest root length (cm), root branching (number/cutting), and root diameter (cm). Reviewed in terms of these properties, measurement and counting were done according to Kalyoncu (1996). "MINITAB" computer package program was used in the statistical analysis. The differences between averages were controlled by Duncan test (Düzgüneş et al., 1987).

RESULTS AND DISCUSSION

Cutting propagations of mulberry have been mostly carried out by wood cuttings. Black and white mulberry softwood cutting propagation is made in this study and up to 100% rate of the roots have been obtained by humidity environment and some applications of IBA hormone doses. Some properties of the cuttings, cutting vitality (number), cutting length (cm), callus status (%), rooting ratio (%), cutting diameter (cm), rooting surface area length (cm), root number (number/cutting), the longest root length (cm), the shortest root length (cm), root branching (number/cutting), root diameter (cm) were determined statistically (Kalyoncu, 1996) and results of Duncan test were given in Table 1.

Semi-woody cuttings from the middle portion of branches of mulberry (*M. alba*) were collected by Pio et al. (2006) and prepared with different lengths (5, 10, 15 and 20 cm) and put in plastic sacks (0.65 dm^3) filled with soil+sand (as substrate) at 2:1 (v/v). They were then placed in 2 different ambient conditions (in a greenhouse with temperature of 27℃, relative humidity of 85-90% and 50% brightness). After 60 days, the rooting and sprouting percentages, number of sprouts and leaves, root and sprout lengths, as well as root dry matter were evaluated. They reported that a stake of 15 cm was the ideal for propagation through cuttings of mulberry; there was superiority of the cuttings conditioned in the greenhouse. Boschini and Rodriguez (2002), reported that the asexual mulberry (*Morus alba*) seed was extracted from an established plantation that was harvested during four years with pruning intervals of 56-112 days. The selected branches were divided into three cuttings, 40 cm long with at least three buds in the basal, medial and apical parts of each branch. The highest percentage of rooting and sprouting in a 35-day period was observed in the 112 day-old cuttings: 9% sprouts, 12% roots and 31% with both sprouts and roots. The optimum age of the branch to obtain maximum sprouting and rooting was estimated at 117 days. The cuttings taken from the basal and medial

Table 1. Effets of moisture level and hormone dose applications in the softwood top cuttings of white and black mulberry types in 85-90% humidity level.

Cutting properties	Rootstock Types	IBA Hormone Doses(ppm)					Averages of type
		0 (control)	1000	2000	3000	4000	
Alive Cutting (%)	Type 1	100 (0.000)	100 (0.000)	100 (0.000)	100 (0.000)	42 (0.144)	88a (24.700)
	Type 2	13 (23.000)	47 (50.300)	75 (25.000)	83 (28.800)	17 (28.800)	47b (40.600)
	Type 3	08 (14.400)	08 (14.400)	08 (14.400)	47 (50.300)	17 (28.800)	18 (28.400)
Averages of Hormones		41bc(0.466)	52ab (0.476)	61ab (0.435)	77a (0.374)	25c (0.250)	51 (0.428)
Cutting Lenght (cm)	Type 1	26.83a (0.946)	24.63b (1.654)	23.96b (0.711)	24.71b (1.507)	20.42c (0.473)	24.11a (2.366)
	Type 2	18.73a (0.987)	17.79a (0.970)	17.88a (0.125)	17.00a (1.205)	17.92a (0.144)	17.86b (0.900)
	Type 3	16.50a (0.661)	16.92a (1.134)	17.42a (0.764)	17.67a (0.321)	17.54a (1.337)	17.21b (0.896)
Averages of Hormones		29.69a (4.770)	19.78a (3.821)	19.75a (3.206)	19.79a (3.826)	18.63b (1.530)	19.73 (3.491)
Callus status (%)	Type 1	92a (14.400)	83a (28.800)	100a (0.000)	100a (0.000)	25b (25.000)	80a (33.000)
	Type 2	0.00c (0.000)	25bc (25.000)	67a (38.100)	58ab (14.400)	08c (14.400)	32b (33.300)
	Type 3	0.00 (0.00)	08 (14.400)	08 (14.400)	47 (50.300)	17 (28.800)	16 (28.600)
Averages of Hormones		31 (0.463)	39 (0.397)	58 (0.450)	68 (0.357)	17 (0.216)	43 (0.414)
Rooting Ratio (%)	Type 1	50 (25.000)	67 (28.800)	100 (0.000)	100 (0.000)	17 (28.800)	67a (37.400)
	Type 2	0.00 (0.000)	17 (28.800)	42 (14.400)	42 (14.400)	08 (14.400)	22b (22.800)
	Type 3	08 (14.400)	08 (14.400)	08 (14.400)	47 (50.300)	17 (28.800)	18 (28.400)
Averages of Hormones		19c (27.300)	31bc (34.800)	50ab (41.400)	63a (38.300)	14c (22.000)	35 (37.000)
Rooting Area Lenght (cm)	Type 1	0.25 (0.125)	0.46 (0.260)	1.75 (0.375)	1.92 (1.751)	0.79 (1.371)	1.03a (1.109)
	Type 2	0.00 (0.000)	0.13 (0.216)	0.33 (0.190)	0.21 (0.072)	0.13 (0.216)	0.16b (0.179)
	Type 3	0.04 (0.072)	0.29 (0.505)	0.04 (0.072)	2.00 (2.291)	0.42 (0.721)	0.56ab (1.200)
Averages of Hormones		0.10b (0.136)	0.29b (0.336)	0.71ab (0.819)	1.38a (1.687)	0.44b (0.834)	0.58 (0.995)
Root Number (unit/cutting)	Type 1	1.42 (1.010)	4.83 (1.607)	13.17 (2.602)	16.42 (15.290)	4.75 (8.227)	8.12 (8.896)
	Type 2	0.00 (0.000)	0.33 (0.577)	2.00 (1.803)	3.17 (1.010)	0.75 (1.299)	1.25 (1.541)
	Type 3	0.08 (0.144)	4.25 (7.361)	0.08 (0.144)	21.73 (27.318)	3.42 (5.918)	5.91 (13.765)
Averages of Hormones		0.50b (0.857)	3.14b (4.332)	5.08b (6.321)	13.77a (17.716)	2.97b (5.405)	5.09 (9.727)
The Longest Root (cm)	Type 1	2.42 (1.448)	6.09 (5.660)	10.38 (3.672)	11.23 (2.187)	2.54 (4.402)	6.53a (5.025)
	Type 2	0.00 (0.000)	0.16 (0.274)	2.02 (1.900)	4.13 (1.772)	0.73 (1.255)	1.41b (1.929)
	Type 3	0.21 (0.360)	1.17 (2.020)	0.08 (0.129)	6.40 (7.015)	1.79 (3.103)	1.93b (3.864)
Averages of Hormones		0.88c (1.379)	2.47bc (4.075)	4.16b (5.175)	7.25a (4.916)	1.69bc (2.876)	3.29 (4.399)
The Shortest Root (cm)	Type 1	0.98 (0.195)	0.63 (0.343)	1.39 (0.830)	0.95 (0.352)	0.08 (0.129)	0.80a (0.588)
	Type 2	0.00 (0.000)	0.10 (0.173)	0.36 (0.203)	0.62 (0.137)	0.08 (0.129)	0.23b (0.266)
	Type 3	0.21 (0.360)	0.18 (0.303)	0.08 (0.129)	0.83 (0.850)	0.27 (0.461)	0.31b (0.494)

Table 1. Contd.

Averages of Hormones		0.39bc (0.489)	0.30bc (0.347)	0.61ab (0.739)	0.80a (0.487)	0.14c (0.266)	0.45 (0.525)
Root Branching (unit/cutting)	Type 1	0.50 (0.433)	3.00 (2.165)	9.17 (3.413)	10.42 (10.681)	3.58 (6.207)	5.33 (6.299)
	Type 2	0.00 (0.000)	0.00 (0.000)	1.25 (1.561)	1.50 (0.901)	0.33 (0.577)	0.62 (0.972)
	Type 3	0.000 (0.000)	2.92 (5.052)	0.000 (0.000)	16.20 (20.033)	1.67 (2.887)	4.16(10.115)
Averages of Hormones		0.17b (0.331)	1.97b (3.121)	3.47ab (4.696)	9.37a (13045)	1.86b (3.715)	3.37 (7.042)
Root Diameter (mm)	Type 1	0.63 (0.291)	0.96 (0.508)	4.11 (5.244)	1.37 (0.200)	0.22 (0.375)	1.46 (2.459)
	Type 2	0.00 (0.000)	0.23 (0.394)	0.58 (0.349)	0.76 (0.280)	0.12 (0.200)	0.34 (0.381)
	Type 3	0.03 (0.057)	0.12 (0.206)	0.08 (0.134)	0.51 (0.588)	0.19 (0.332)	0.19 (0.324)
Averages of Hormones		0.22 (0.339)	0.44 (0.519)	1.59 (3.246)	0.88 (0.512)	0.18 (0.273)	0.66 (1.527)
Cutting Diameter (cm)	Type 1	4.84a (0.611)	4.10b (0.568)	4.70ab (0.204)	4.48ab (0.100)	4.29ab (0.300)	4.48b (0.444)
	Type 2	5.15b (0.217)	4.83bc (0.264)	5.92a (0.506)	5.98a (0.156)	4.32c (0.413)	5.24a (0.718)
	Type 3	4.00b (0.466)	4.13b (0.563)	4.40ab (0.059)	4.87a (0.394)	4.90a (0.281)	4.46b (0.505)
Averages of Hormones		4.66bc (0.651)	4.35c (0.553)	5.01ab (0.750)	5.11a (0.706)	4.50c (0.415)	4.73 (0.665)

*Data are the means of three replications ± standard error.
Values within column followed by the same letter are not significantly different at *P* = 0.05 (Duncan's Multiple Range test).

portions of the branch had 10% more sprouts and roots than the cuttings taken from the apical part. There were noticeable differences with the application of IBA (P<0.01). Depending on the age of the cutting and the part of the branch it was taken from, the use of IBA caused an 11 to 15% increase increase in total sprouting.

This research is examined in terms of the average cutting vitality. As can be understood from Table 1, significant differences were found among all the applications including the control groups (P<0.01). High vitality ratio was obtained from Type 1 (black mulberry) (88%), while the lowest percentage of cutting vitality was obtained from Type 3 (white mulberry) (18%). When IBA-dose applications were examined, the highest ratio of vitality was obtained from 3000 ppm (76%); the lowest one was 4000 ppm dose application (25%). All the types and doses are reviewed together; the control group, 1000, 2000, 3000 ppm dose applications gave 100% cutting vitality ratio in Type 1. High percentage of cutting vitality is considered due to the care requirement of the Mist Propagation Unit. Indeed, Koyuncu et al. (2003) found the highest rate of cutting vitality as 80% on rooting research on the wood cuttings of black mulberry.

In terms of callus formation, mulberry types (P<0.01), IBA-dose applications (P <0.01), and interactions of mul-berry type x dose of IBA applications were found statistically important (P <0.05). Callus formation status was examined in terms of type. The highest value was obtained from Type 1 (80%) and statistically differences were not found between Types 2 (black mulberry) and 3 (white mulberry). From the significant differences among the doses of IBA, the highest callus formation was in 3000 ppm dose application (68%) and the lowest one was in 4000 ppm dose application (17%). Koyuncu et al. (2003) found that the highest rate of callus formation is 70% in the wood cutting of black mulberry. Kalyoncu and Ecevit (1995) reported that high per-centage of root for-mation was in the cornelian cherry softwood cuttings with 4000 ppm IBA hormon dose application and high humidity levels (98.33%). These authors observed callus formation in the control group, but not in 4000 ppm IBA dose application. Kalyoncu (1996) obtained successful application of different humidity level and hormone doses in the rooting of cornelian cherry softwood cuttings in perlite media and reported that perlite media is ideal for cutting root formation. Hormone applications promote and increases root formation. Also, that callus formation remains with low hormone application, but such low levels encourages root formation instead of callus formation. Kalyoncu and Özer (2000) observed the highest callus formation in control groups of the gilaburu softwood cuttings and they determined that the moisture level of 85-90% gave high callus formation ratio than 95-100% humidity level In the research, examining the rooting of cuttings, statistical differences were determined to be im-portant between the types and the applications (P<0.01). However, there is no significant diffe-rence between the hormone doses and interaction of moisture level x dose in terms of the rooting. Among types, the highest rooting was obtained from Type 1 (67%) and statistical differences were not found between Types 2 and 3. Among the IBA dose applications, the highest percentage of rooting was obtained from 3000 ppm dose appli-cation (63%); the lowest percentages found from 4000 ppm and control group. There were no diffrences among the other applications. Zhang et al. (2004) carried out an experiment with different rootstocks, including *Prunus tomentosa*, CAB, Gisela 5, Gisela 6, and Colt. Long cuttings (15 cm) were collected from healthy maternal rootstock trees in early June. Two or three leaves were left on the upper part of cuttings, all the others were removed. The cutting bed was river sand. Cuttings were dipped for 2 s in a solution of 1000 mg ABT rooting powder/litre, a solution of 400 mg NAA/litre, or a 50 times solution of the root promotor Genwang. Cuttings were cultured in a shed under film. The rooting rates of Gisela 5 and Gisela 6 cuttings treated with ABT 1, NAA and Genwang were 65.0-75.0, 56.0-84.0 and 53.8-76.9%, respectively. Dick and Leakey (2006) compared the rooting potential of four types or origins of *Prunus avium* cuttings from the same mature trees (over 20 years-old) using a mist propagation bed during early Summer (June). The cuttings originated from juvenile sucker shoots of the current and previous year and mature crown shoots (current year's lateral 'long-shoots' and multi-year terminal 'short shoots'). The mor-phological differences in inter-node length, stem diameter and leaf area between the four cutting types were highly significant (P = 0.05), leading to large differences in cut-ting volume, which is likely to assimilate reserves. Juve-nile cuttings rooted well (65 and 77% rooting for hard-wood and softwood shoots, respectively), while mature cuttings rooted poorly (4 and 7% for mature hardwood and softwood cuttings, respectively). Leaf abscission was significantly more frequent in mature hardwood cuttings (16 - 78%) than in the other cutting types (1.6 - 9%) at the end of the propagation period. The results in this study are in parallel with the results of Dick and Leakey (2006). In this study, juvenile softwood top cuttings of mullberry rooted easily. Predominantly the work of other researchers support the results of this study. Ünal et al. (1992) obtained low success (14.4%) on rooting of black mulberry and violet mulberry wood cuttings despite hor-mone applications. While Koyuncu et al. (2004) obtained that rooting ratio was 33.3% in black mulberry wood cuttings treated with 5000 ppm IBA. Koyuncu (2000) reported that heating of the below en-courage the rooting success and obtained the 89% rooting percentage with black mulberry wood cuttings. Erdoğan and Aygün (2006) observed that IBA appli-cations increased the rooting of black mullberry sotwood cuttings (14.2%). They indicated that the highest rooting ratio was with 6000 ppm IBA (60.0%); others are 4000 ppm (57.5%), 8000 ppm (52.5%) and control (42.5%). There are different research results about rooting of Black mulberry cuttings. Both Ayfer et al. (1986) in the white mulberry and Koyuncu et al. (2004) in the black mulberry reported that there was no root formation. On the other hand, Özkan and Arslan (1996) obtained 55% rooting from 6000 ppm IBA applications in the wood and softwood cuttings of black mul-berry. In this research, the highest rooting (100%) was obtained from Type 1 (black mulberry) applicated with 2000 and 3000 ppm IBA. The value obtained in our research were higher than the ones obtained by other researchers.

Mulberry softwood cuttings was examined in terms of the root surface length, and the types and doses of IBA were found statistically significant, but the interaction of type x IBA was not found significant (P <0.05).

The types were examined in terms of the length of the root surface. The longest root surface length was Type 1 (1.033 cm) and the lowest one was Type 2 (0.158 cm). The results obtained in similar studies were determined to be parallel with this study results (Kalyoncu and Ecevit, 1995; Kalyoncu, 1996; Özer and Kalyoncu, 2007; Kalyoncu et al., 2007).

Mulberry softwood cuttings were examined in terms of the number of root; only the hormone dosage appli-cations were important statistically (P <0.05). Types and type x IBA dose applications were determined to be not important. The highest number of roots was obtained from 3000 ppm hormone dose application (13,772 units/ cutting); differences between other dose applications and control group were not found. Erdoğan and Aygün (2006) reported that various IBA dose applications increased rooting ratio in the softwood mulberry cuttings. They determined that the difference between 8000 ppm IBA application and control group was important and the highest number of roots were obtained from 8000 ppm IBA dose application (12.95 number of root).

The maximum root number was found to be 7.4 units by Yıldız and Koyuncu (2000), 8 units by Koyuncu and Şenel (2003), 4.34 by Arslan and Özkan (1996), and 12.95 units by Aygün and Erdoğan (2006). The results in this study in terms of the maximum number of roots are in parallel with the results of Aygün and Erdoğan (2006). The values of other researchers were lower than those of ours.

The average longest root formation were examined. Statistical differences were found between the types and the dose applications, but interaction of type x IBA dose applications was not different. The longest root was ob-tained from 3000 ppm dose application in Type 1 (6.533 cm) and the lowest one was control group (0.875 cm). In terms of short-root formation, statistical important dif-ferences were found between the types (P<001) and IBA dose applications (P<0.05). The shortest root value was obtained from Type 1 (0.803 cm); no statistical differences were found among other applications. In terms of the hormone dose applications, the highest value was obtained from 3000 ppm dose application (0.800 cm); the lowest one was 4000 ppm application (0.138 cm). The highest values in terms of root length on wood cutting researches, the longest root was found to be 25 mm by Koyuncu et al. (2004), 23 mm by Koyuncu and Şenel (2003), and 122 mm by Stars and Koyuncu (2000). The values in our study were higher than theirs. The most important reason of this is: the root environment of the air relative humidity level can be high.

In terms of average root branching, IBA hormone doses were statistically significant (P <0.05); others were unimportant. The maximum branching was obtained from 3000 ppm dose application. Kalyoncu and Özer (2000) determined that the highest root branching of softwood gilaboru cuttings were in the control group with the highest moisture level condition. Kalyoncu and Ozer (2000) reported that the root branches were less. Other researchers also support this conclusion (Kalyoncu and Ecevit, 1995; Kalyoncu, 1996; Özer and Kalyoncu, 2007; Kalyoncu et al., 2007).

Cuttings are also examined in terms of average root diameter. The difference among the types was statistically significant (P <0.05); others were insignificant. Types are evaluated. The highest stem diameter was Type 1 (1.457 mm) and the statistical differences were not found among the other types. *M. alba* stem cuttings of different diameters; 3-7, 8-12, 13-17 and 18-22 mm, obtained from 8-10 year old trees in Haryana, were planted in Mohrnal Forest Nursery, Bilaspur, Himachal Pradesh, and observations made on rooting and growth. The study indicated improved survival, rooting and growth performance in the species with branch cutting of 18-22 mm mid-diameter (Dhiman et al.,1992).

Conclusıons

Under high air relative humidity environments in the Mist Propagation System, IBA applications with agricultural perlite (0.0-5.0) in the rooting media, mulberry softwood top cuttings can reach extreme proportions (100%). Therefore, air relative humidity, the hormone dose applications and perlite media have a high impact on rooting of softwood cuttings.

As with most fruit species, reproducing varieties of mulberry without losing its feature is possible by applying vegetative propagation methods. One of these methods is the tissue culture or biotechnology, but it is more expensive and relatively difficult in practice. However, on grafting propagation stemming from the emergence of milk secretion and the space under the bud tissue, grafting success turns out to be problematic. Also, in different well-tried methods of grafting in some studies, success has not been high (Ünal et al., 1992; Miralimov, 1963). The researches on rooting of mulberry cuttings have revealed very different results. Some wood cutting works have not examined the root formation. Besides, others have 80-90% rooting, but when all the results are evaluated, it is seen that root formation is lower on average. In the reproduction via softwood cutting propagation, different results are reported over mulberry. No roots in the black mulberry is expressed and the results have been reported to be around 60%. In our work, black mulberry (Type 1) root formation has been obtained at rates of up to 100%. In cutting propagation study, despite the same kind of hormones and even the same dose used, different results were obtained in the level of the root. This is because of the differences of genotype and rooting conditions. In the rooting medium, especially such as relative humidity, negative effects of fungi and moisture inside the perlite are not uniform. Differences in cutting size, piercing into perlite cause cuttings to root less; other causes being cutting lenght discrepancy, negligence in the propagation period, and the breakage of the roots of rooted cuttings in the removing period.

As a result, black and white mulberry softwood cutting propagation was studied and up to 100% rooting was obtained by humidity environment and some applications of IBA. This propagation method is proposed because it furnishes us with several advantages such as a wider unit area of application, unemployment reduction, evaluation of small-scale land, ease, applicability, positive results, improving socio-economic structure of the farmers, contribution to the country's economy and agriculture for mulberry.

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