PROPAGATION OF SUB-HIMALAYAN MAPLE (*ACER OBLONGUM*) THROUGH STEM CUTTINGS UNDER MIST CHAMBER UNIT

D. R. Bhardwaj* & V. K. Mishra

Department of Silviculture and Agroforestry, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni-Solan (H.P.) - 173 230, India

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BHARDWAJ, D. R. & MISHRA, V. K. 2002. Propagation of sub-Himalayan maple (*Acer oblongum*) through stem cuttings under mist chamber unit. *Acer oblongum* was used to investigate the effect of chemical treatment, time of cutting collection, donor plant and positional effect of the shoot on the rooting behaviour under mist unit. The per cent rooting, primary root number and root length were enhanced markedly after application of chemical treatments. Maximum per cent rooting was observed after treatment with 0.6% IBA + 0.2% p-HBA + 5% sucrose + 5% captan. Irrespective of chemical treatment, donor plant and position of the shoot, the cuttings planted in the rainy season resulted in the regeneration of more roots than those planted in spring. Also, the cuttings of seedling origin showed significantly higher rooting, primary root number and root length than tree cuttings. Maximum rooting (about 50%) was recorded in the treatment combination involving seedling cuttings collected in rainy season from lower or upper position of the shoot. The tree cuttings gave best response (27%) when collected in the rainy season from the upper portion of the shoot. The cuttings which gave higher rooting percentage also had higher sugar and C/N ratio but low N.

Key words : Rooting response - donor plant - seasonal periodicity - position effect

BHARDWAJ, D. R. & MISHRA, V. K. 2002. Pembiakan pokok mapel (*Acer oblongum*) sub-Himalaya melalui keratan batang di bawah unit kebuk berkabus. *Acer oblongum* digunakan untuk mengkaji kesan rawatan kimia, masa kutipan keratan, pokok penderma dan kesan kedudukan pucuk terhadap tabiat pengakaran di bawah kebuk berkabus. Peratus pengakaran, bilangan akar utama dan panjang akar meningkat dengan ketara selepas diberi rawatan kimia. Peratus pengakaran maksimum dicerap selepas rawatan dengan 0.6% IBA +0.2% p-HBA + 5% sukrosa dan 5% kaptan. Tanpa mengira rawatan kimia, pokok penderma ataupun kedudukan pucuk, keratan yang ditanam pada musim hujan menghasilkan pengeluaran semula akar yang lebih banyak berbanding dengan keratan yang ditanam pada musim bunga. Keratan daripada anak benih menunjukkan pengakaran, bilangan akar utama dan panjang akar yang lebih tinggi dengan bererti berbanding keratan pokok. Pengakaran maksimum (kira-kira 50%) dicatatkan dalam kombinasi rawatan yang melibatkan keratan anak benih yang dikutip pada musim hujan daripada bahagian bawah atau bahagian atas pucuk. Keratan pokok memberikan tindak balas terbaik (27%) apabila dikutip pada musim hujan daripada bahagian atas pucuk. Keratan yang memberikan peratus pengakaran yang lebih tinggi juga mempunyai gula dan kadar C/N yang lebih tinggi tetapi kadar N yang rendah.

**E-mail: bhardwajdr_uhf@rediffmail.com*

Introduction

Acer oblongum (maple), a moderate-size tree of the sub-Himalayan region, is an evergreen to subdeciduous tree species. It is highly valued for its prized timber, fodder, fuel and ornamental foliage in the states of Himachal and Uttar Pradesh in India. Its large scale nursery production is, however, markedly impaired due to low seed viability and poor germination. It is, therefore, important to explore alternative means of propagation to overcome the problem of seedling production.

Propagation through stem cuttings offers a fast and simple approach for mass multiplication of planting stock. Root regeneration is, however, often related to indigenous auxin regulators (Gurumurti *et al.* 1974, Nautiyal *et al.* 1991), shoot position (Schroedar & Walker 1991), age of donor plant (Jonson & Weislinska 1982) and time of cutting collection (Johnson & Zak 1975).

The present paper explores the effect of chemical treatment, donor plant, time of cutting collection and position of the shoot on the rooting behaviour of *A. oblongum* stem cuttings under mist conditions.

Materials and methods

The present investigations were undertaken under mist conditions at the experimental farm of the Department of Silviculture and Agroforestry, University of Horticulture and Forestry, Solan, Himachal Pradesh, India located at 1200 m elevation. Cuttings of the upper and lower portion of the shoot were kept separately. The study was conducted in the rainy season as well as in spring using a randomised block design (RBD). There were 56 treatment combinations comprising two seasons of cutting collection (rainy and spring seasons), two types of donor plant (seedlings of < 2 cm diameter and trees of 10–20 cm diameter at breast height (dbh)), two parts of shoot (lower and upper) and seven chemical treatments, replicated thrice. Each treatment involved 25 cuttings. Cuttings having dimensions of 10–12 cm length, 1–2 cm diameter and with at least 2–3 nodes were selected.

The following powder formulations were prepared by mixing the desired quantity of chemicals in talcum powder as per the methodology of Blazich (1988).

T_1 - Control (talcum powder only)
T_2 - 0.2% p-HBA* + 5% sucrose + 5% captan
T_3 - 0.2% IBA** + 0.2% p-HBA + 5% sucrose + 5% captan
T_4 - 0.4% IBA + 0.2% p-HBA + 5% sucrose + 5% captan
T_5 - 0.6% IBA + 0.2% p-HBA + 5% sucrose + 5% captan
T_6 - 0.8% IBA + 0.2% p-HBA + 5% sucrose + 5% captan
T_7 - 1.0% IBA + 0.2% p-HBA + 5% sucrose + 5% captan

*p-HBA – para hydroxy benzoic acid
**IBA – Indole butyric acid

The rooting media, i.e. river sand, was thoroughly washed and sterilised with formalin solution and then filled in polytubes (12.0 × 7.0 cm). The cuttings were then inserted in the polytubes at a depth of 4–5 cm. Intermittent misting was continued daily between 8.00 a. m. and 6.00 p. m. for 5 seconds per 10 minutes. Rooting response was recorded 75 days after planting of the propagules.

The estimation of biochemical parameters, namely, sugar, total carbohydrate content and nitrogen (N), was carried out at the time of cutting collection and at the root initiation stage. Estimation of sugar and total carbohydrate was made according to Dubois *et al.* (1951). N was estimated by Kjeldahl method (Anonymous 1970). The carbohydrate/nitrogen (C/N) ratio was calculated by dividing the total carbohydrate with N percentage of the same sample.

Results and discussion

The average per cent rooting, primary root number and root length in *A. oblongum* stem cuttings are presented in Table 1 and significant interaction effects in Tables 2–9.

Effect of chemical treatment

The rooting per cent showed positive response to the increase in IBA from T1 to T5 after which it remained almost similar (T_6) or declined (T_7) (Table 1). Root promoting effect of IBA treatment on stem cuttings has been widely observed in several species (Hartmann *et al.* 1990, Monteuuis *et al.* 1995, Alegre *et al.* 1998). Auxins induce hydrolysis and mobilisation of nutritional factors to the site of application, thereby promoting root initiation (Nanda 1970, Haissig 1974, 1982). In addition auxin increased hydrolytic activity causing higher rooting percentage (Haissig 1986). Appropriate levels of nutrition and auxin are essential for the supply of energy necessary for the initiation and development of roots, provided that the cells are in active state of division which in itself is determined by the relative levels of endogenous auxin and inhibitors (Wareing *et al.* 1964, Digby & Wareing 1966). The effect of exogenously applied auxins is determined to a great extent by the morphophysiological status of plant that governs the production of endogenous auxins (Masuda & Yamamoto 1970).

The primary root number and root length showed a significant increase due to chemical treatment over untreated ones (Table 1). Generally, the values for these traits increased with an increase in treatment level. These results are in agreement with the findings of Chauhan and Reddy (1974), Pathak *et al.* (1975) and Avanzato *et al.* (1988).

Table 1 Rooting parameters as affected by chemical treatment, collection time, down plant and portion of shoot in *Acer oblongum* cuttings planted under mist unit

Treatment	Rooting (%)	Primary root number	Primary root length (cm)
Chemical treatment (T)			
T_1	19.26 (10.88)	1.67 (1.81)	4.88
T_2	21.86 (13.86)	1.82 (2.34)	6.21
T_3	28.93 (23.40)	2.14 (3.58)	7.19
T_4	35.94 (34.44)	2.41 (4.80)	7.40
T_5	39.81 (40.99)	2.51 (5.32)	6.67
T_6	39.33 (40.16)	2.69 (6.24)	6.82
T_7	36.43 (35.26)	2.43 (4.90)	6.32
SED	1.66	0.14	0.59
CD 5%	3.28	0.27	1.17
Collection time (S)			
Rainy season (S_1)	34.99 (32.88)	2.35 (4.55)	6.33
Spring season (S_2)	28.31 (22.49)	2.12 (3.51)	6.66
SED	0.88	0.74	0.32
CD 5%	1.74	1.46	NS
Donor plant (D)			
Seedling (D_1)	41.28 (43.52)	2.59 (5.73)	7.76
Tree (D_2)	22.02 (14.05)	1.88 (2.56)	5.23
SED	0.88	0.07	0.32
CD 5%	1.74	0.14	0.63
Portion of shoot (P)			
Lower (P_1)	31.85 (27.84)	2.26 (4.14)	7.59
Upper (P_2)	31.45 (27.22)	2.21 (3.91)	5.40
SED	0.88	0.07	0.32
CD 5%	NS	NS	0.63

Figures in parentheses are original values;
SED = Standard error difference;
CD = Critical difference;
NS = Non significant

Effect of season

Cuttings planted in the rainy season resulted in regeneration of more roots than those planted in spring (Table 1). Degree of seasonal periodicity in rooting, which was quite discernible in *A. oblongum* cuttings, may be associated with growth phase. This is because rainy season cuttings were collected from the plants during an active growth phase, while the spring season cuttings were collected just before bud growth. Hence, the physiological conditions of spring season cuttings would be different from rainy season. Initial biochemical and nutrient status of the *A. oblongum* cuttings (Table 10) showed that spring season cuttings had higher level of N and lower levels of sugar and C/N ratio, which might be the reason for lower rooting response. Higher N content in spring season cuttings may have stimulated the shoot development so that rooting is placed at a competitive disadvantage for carbohydrate, mineral nutrients and hormones. Our results are in agreement with Nanda (1970) and Pal (1989, 1990) who reported that seasonal variations in rooting behaviour of branch cuttings are due to variation in the activities of hydrolysing enzymes. This cause seasonal fluctuations in the availability of sugars which are the principal source of metabolic energy required for cell division and differentiation activities during root initiation of cuttings. Higher N content has a negative influence on the rootability of cuttings (Bora 1990). Cuttings with high C/N ratio favours rooting (Hartmann & Hansen 1983). The seasonal periodicity in rooting as observed in this study has also been reported in other *Acer* species (e. g. Chapman & Hoover 1981).

Effect of donor plant

The cuttings of seedling origin showed significantly higher rooting, primary root number and root length over those of tree origin (Table 1). It was also noticed that cuttings emanating from seedlings (Figure 1), which retained their leaves for a longer period, accumulated significantly higher photosynthates (sugar, total carbohydrate and C/N ratio) than tree cuttings (Table 11), which showed symptoms of leaves drying (Figure 2). Similar observation has also been made by Faustov (1969) who reported that cuttings of several species which retained their leaves for longer period, rooted better than those which shed their leaves during the rooting period. General superiority of seedling cuttings over tree cuttings in respect of rooting and root characteristics has also been reported by many workers, e. g., Pryor and Willing (1963) in *Eucalyptus* spp., and Jonson and Weislinska (1982) and Helgonal and Espagne (1987) in *Betula utilis.*

Figure 1 *Acer oblongum* propagules of seedling origin

Effect of shoot position

No statistical variation was observed in respect to lower and upper portions of cuttings for per cent rooting and primary root number (Table 1). However, cuttings drawn from the lower part of the shoot gave significantly higher root length than the upper part. This may be due to the greater food reserves available in the lower part of the shoot cuttings than the upper part (Table 10).

Interaction effects

Table 2 shows that application of chemicals increased the percentage of rooting in rainy as well as in spring seasons. The values for this parameter were higher in rainy season (S_1) compared with spring season (S_2), although the latter showed more per cent increment over control. From these results it can be inferred that endogenous auxin level may be a limiting factor in spring season (S_2) cuttings.

Figure 2 *Acer oblongum* propagules of tree origin

Table 2 Rooting per cent as affected by chemical treatment × collection time interaction in *Acer oblongum* cuttings planted under mist chamber unit

Chemical treatment	Rooting Collection time Rainy season (S_1)	 Spring season (S_2)
T_1	27.05 (20.88)	11.46 (3.94)
T_2	28.58 (22.88)	15.15 (6.83)
T_3	32.50 (28.86)	25.37 (18.35)
T_4	35.95 (34.66)	35.53 (33.37)
T_5	41.01 (43.05)	38.60 (38.92)
T_6	41.52 (43.94)	37.14 (36.95)
T_7	34.38 (38.48)	34.52 (32.11)
SED	2.35	
CD 5%	4.65	

Figures in parentheses are original values

Irrespective of the collection time, seedling cuttings superseded the tree cuttings (Table 3). Higher rooting per cent was observed with seedling cuttings (S_1D_1) collected in rainy season and its variance from all other treatment combinations was significant. In the interaction effect between collection time and portion of the shoot, maximum rooting per cent was recorded with treatment combination of S_1P_2 and it was found to be significantly higher than all other treatment combinations (Table 4). The performance of lower portion was better in spring than that of upper portion whereas upper portion cuttings performed well in rainy season. In seedlings, the cuttings collected from the lower portion of shoot showed higher rooting per cent compared with the cuttings from the upper portion, whereas in the tree cuttings, the case was reverse (Table 5).

Table 3 Rooting per cent as affected by collection time × donor plant interaction in *Acer oblongum* cuttings planted under mist chamber unit

Collection time	Rooting (%) Donor plant	
	Seedling (D_1)	Tree (D_2)
Rainy season (S_1)	45.52 (50.90)	24.46 (17.14)
Spring season (S_2)	37.04 (36.28)	19.59 (11.24)
SED	1.25	
CD at 5%	2.48	

Figures in parentheses are original values

Table 4 Rooting per cent as affected by collection time × portion of shoot interaction in *Acer oblongum* cuttings planted under mist chamber unit

Collection time	Rooting (%) Portion of shoot	
	Lower (P_1)	Upper (P_2)
Rainy season (S_1)	31.53 (27.34)	38.45 (38.66)
Spring season (S_2)	32.17 (28.34)	24.45 (17.13)
SED	1.25	
CD at 5%	2.48	

Figures in parentheses are original values

Table 5 Rooting per cent as affected by donor plant × portion of shoot interaction in *Acer oblongum* cuttings planted under mist chamber unit

Donor plant	Rooting (%) Portion of shoot	
	Lower (P_1)	Upper (P_2)
Seedling (D_1)	43.76 (47.83)	38.80 (39.26)
Tree (D_2)	19.94 (11.63)	24.11 (16.68)
SED	1.25	
CD at 5%	2.48	

Figures in parentheses are original values

In the three way interaction effect of collection time × donor plant × portion of shoot, maximum per cent rooting was recorded in the treatment involving seedling cuttings collected in rainy season from the lower portion of shoot ($S_1D_1P_1$), which, however, remained statistically alike $S_1D_1P_2$ but proved significantly better in comparison with all other treatment combinations (Table 6).

The maximum number of primary roots (Table 7) was recorded in rainy season cuttings collected from upper portion of shoot (S_1P_2), which, however, remained statistically identical to S_1P_1 and S_2P_1 combinations. The primary root length, regardless of the time of cutting collection, was comparatively more in cuttings of seedling origin than tree origin (Table 8). The cuttings of seedling origin planted in spring (S_2D_1) attained the highest value, which differed significantly from all the treatment combinations.

Table 6 Rooting per cent as affected by collection time × donor plant × portion of shoot interaction in *Acer oblongum* cuttings planted under mist chamber unit

Collection time	Rooting (%)			
	Donor plant			
	Seedling (D_1)		Tree (D_2)	
	Lower (P_1)	Upper (P_2)	Lower (P_1)	Upper (P_2)
Rainy season (S_1)	45.59 (51.02)	45.45 (50.78)	17.47 (9.01)	31.66 (27.23)
Spring season (S_2)	41.93 (44.65)	32.14 (28.50)	22.42 (14.54)	16.76 (8.31)
SED	1.77			
CD at 5%	3.51			

Figures in parentheses are original values

Table 7 Primary root number as affected by collection time × portion of shoot interaction in *Acer oblongum* cuttings planted under mist chamber unit

Collection time	Primary root length	
	Portion of shoot	
	Lower (P_1)	Upper (P_2)
Rainy season (S_1)	2.28 (4.19)	2.44 (4.93)
Spring season (S_2)	2.26 (4.00)	2.00 (2.98)
SED	0.10	
CD at 5%	0.20	

Figures in parentheses are original values

Table 8 Primary root length (cm) as affected by collection time × donor plant interaction in *Acer oblongum* cuttings planted under mist chamber unit

Collection time	Primary root length (cm)	
	Donor plant	
	Seedling (D_1)	Tree (D_2)
Rainy season (S_1)	6.43	6.25
Spring season (S_2)	9.10	4.23
SED	0.45	
CD at 5%	0.89	

Table 9 shows that the application of chemicals significantly increased the primary root length of tree cuttings only. The lengths were, however, higher in seedling cuttings compared with tree cuttings, although the latter showed more per cent enhancement over control. These results are in agreement with the findings of Bini (1981) and Bogdanov (1983), who concluded that beneficial effects of applied auxins increased with stock plant age. From these results it can be inferred that endogenous auxin levels may be a limiting factor in tree cuttings.

Table 9 Primary root length (cm) as affected by chemical treatment × donor plant interaction in *Acer oblongum* cuttings planted under mist chamber unit

Chemical treatment	Primary root length (cm) Donor plant	
	Seedling (D_1)	Tree (D_2)
T_1	7.43	2.35
T_2	8.09	4.38
T_3	7.80	6.58
T_4	7.64	7.16
T_5	8.12	5.81
T_6	7.90	5.74
T_7	7.40	5.24
SED	0.84	
CD 5%	1.66	

Table 10 Biochemical and nutrient status of *Acer oblongum* cuttings as recorded at the time of their collection

Parameter	Donor plant: Seedling cuttings (D_1)		Mean	Tree cuttings (D_2)		Mean	Simple correlation coefficient
	Rainy season (S_1)	Spring season (S_2)		Rainy season (S_1)	Spring season (S_2)		
Sugar content (%)							
Lower portion (P_1)	2.44	1.30	1.87	1.74	1.12	1.43	
Upper portion (P_2)	1.96	1.40	1.68	1.16	1.63	1.40	
Average	2.20	1.35	1.78	1.45	1.38	1.42	0.277*
Total carbohydrate content (%)							
Lower portion (P_1)	2.92	2.62	2.77	1.94	2.73	2.34	
Upper portion (P_2)	2.13	2.29	2.21	1.35	2.28	1.82	
Average	2.53	2.45	2.49	1.64	2.50	2.08	0.468*
Nitrogen content (%)							
Lower portion (P_1)	0.32	0.54	0.43	0.45	1.14	1.02	
Upper portion (P_2)	0.49	0.43	0.46	0.30	1.46	0.88	
Average	0.41	0.48	0.45	0.37	1.26	0.95	0.658*
C/N ratio							
Lower portion	9.17	4.82	7.00	9.23	1.58	5.41	
Upper portion	5.25	5.33	5.29	5.08	1.35	3.22	
Average	7.21	5.08	6.15	7.16	1.45	4.32	1.042

*Significant at 5% level

Table 11 Biochemical and nutrient status of seedling and tree cuttings of *Acer oblongum* at the time of their root initiation

Donor plant	Sugar content (%)	Total carbohydrate content (%)	N content (%)	C/N ratio
Seedling	2.81 (1.78)	5.91 (2.49)	11.71 (6.15)	0.50 (0.45)
Tree	1.87 (1.38)	3.40 (2.08)	2.88 (4.32)	1.36 (0.95)
SED	0.06	0.07	0.18	0.01
CD 5%	0.12	0.14	0.36	0.02

Figures in parentheses represent initial biochemical and nutrient status at the time of cutting collection

The seedling cuttings collected during rainy season which displayed better root regeneration also had higher sugars, total carbohydrate content and C/N ratio (Table 10). Both sugar and total carbohydrate contents had significantly positive relationship with rooting response. Initial carbohydrate content must be sufficient to supply cuttings with energy for optimum rooting (Veierskov *et al.* 1982). Vieitez *et al.* (1980) observed that suboptimal rooting in leafless cuttings of *Castanea sativa* was due to low initial carbohydrate.

Spring season cuttings of *A. oblongum* with maximum N content showed poor rooting. This means that high N level in the cuttings had a deterring effect on the per cent rooting of cuttings. Simple correlation coefficient also depicted a negative relationship between rooting and N content (Table 10). These results are supported by reports on other plant species (Haun & Cornell 1951, Basu & Ghosh 1974).

Conclusions

From the present investigation it can be concluded that *A. oblongum* can be mass multiplied through stem cuttings. Application of chemicals appreciably enhanced the adventitious root regeneration abilities. The cuttings from seedling donor can be rooted in spring as well as in rainy season, irrespective of portion of shoot. The tree cutting can be satisfactorily rooted during rainy season only, when collected from upper portion of the shoot.

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