STUDIES ON THE EFFECT OF AUXIN AND SEASON ON ROOTING STEM CUTTINGS OF SOME IMPORTANT SHRUBS IN NURSERY BEDS

N.K. JOSHI*, S. SHARMA, G.S. SHAMET AND R.C. DHIMAN**

Department of Silviculture and Agroforestry,
Dr. Y.S. Parmar University of Horticulture & Forestry,
Solan (Himachal Pradesh)

Introduction

Like trees, shrubs provide a veritable range of valuable products e g. fuel, fodder and medicinal–aromatic substances of commerce. Also, shrubs outmanouvre tree vegetation in colonising degraded areas, as better adapted to withstanding drought, frost and fire than the latter. Their tenacity to grow on skeletal soils provide them the added advantage of introduction in poor sites and wasteland afforestation. Moreover, importance of shrubs as an under-storey in forest system and in augmenting the present meagre fuel and fodder supply to rural masses needs to be better appreciated.

Vegetation has an important role to play in increasing biomass production through use of site specific and screened planting material in afforestation programmes (Brix and an Vden Driessche, 1977; Zobel, 1981) specially the poor and degraded sites (Maithani *et al.*, 1988). Shrubs have received little attention so far, therefore the present investigation on rooting stem cuttings of some important shrub species was carried out during different seasons of the year 1988-89.

Material and Methods

Stem cuttings of *Debregeasia hypoleuca*, *Coriaria nepalensis*, *Woodfordia floribunda* and *Berberis lycium* were prepared from current year shoots of shrubs growing in the farm area of Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni (Solan). Cuttings packed in bundles were brought to the laboratory in plastic bags. The following day, they were trimmed to 18 cm length and leaves and buds removed from basal 10 cm portion with sketeurs. Cuttings were thereafter divided in ten groups of ten cuttings each and soaked in 4-5 cm auxin solutions in beakers for 24 hours. The treatments tested were : control; IAA 100 mgl^{-1}; IAA 400 mgl^{-1}; IAA 700 mgl^{-1}; IBA 100 mg l^{-1}; IBA 400 mgl^{-1}; IBA 700 mgl^{-1}; NAA 100 mgl^{-1}; NAA 400 mgl^{-1} and NAA 700 mgl^{-1}.

On expiry of the prescribed period of dip, cuttings were removed, the basal ends washed and then set 10 cm deep, spaced 30cm×30cm in nursery beds. Powder formulation treatments used only in monsoon planting consisted of : control; talc; 1% IBA; 0.5% IBA-talc; 0.25% IBA-talc; activated charcoal (AC); 1% IBA-AC, 0.5% IBA-AC

Presently : * Director, Forest Research Institute, Dehra Dun.
** at Forest Research Institute, Dehra Dun.

and 0.25% IBA-AC. Powders were prepared by dissolving the calculated quantity of IBA in ethyl alcohol, then making a slurry with talc or AC; evaporating the ethyl alcohol and sifting and finally stored in plastic containers for later use. These formulations were applied to cuttings so as a small amount adhered to their base.

The experiments were laid in a randomised block design; there being ten treatments each replicated thrice with ten cuttings per plot. In all 4800 cuttings with 1200 samples per species were treated during the year 1988-89. Observations on rooting per cent, number of roots per cutting, root length (cm), callus formation were recorded after 30, 45 and 70 days of planting. Per cent data were transformed to arc sine $\sqrt{\text{proportion}}$ for analysis of variance.

Results and Discussion

Both, season as well auxin application influence rooting (Table 1 and 2), there being complete failure during winter months. Apparently, food reserves required to initiate root initials during this period were too low or dormancy in the plants renders rooting difficult. Welander (1978) and Hansen *et al.* (1978) have shown strong relations between carbohydrate, nitrogenous compounds, auxin and adventitious root formation.

Effect of season

Debregeasia hypoleuca and *Woodfordia floribunda* rooted best in spring with a maximum 67.67 per cent and 30 per cent success when cuttings were treated with 100 mgl^{-1} IBA and 100mgl^{-1} NAA respectively. Rainy season yielded 53 33 per cent and 26.67 per cent rooting with cuttings soaked in 400 mgl^{-1} IBA solution. Apparently, endogenous auxin levels appear to have fallen by the time cuttings were again tried in rainy season which otherwise restricted the root initiation. Our results with *D. hypoleuca* confirm this as control and IBA 100 mgl^{-1} resulted in 23.33 per cent and 40 per cent rooting respectively. Therefore, to achieve higher percentage the threshold value of endogenous auxin must be raised to an optimum level i.e. 400 mgl^{-1} IBA, thus providing a maximum 53.33 per cent rooting during the rainy season.

Nanda *et al.* (1970), Nanda and Anand (1970) and Nanda (1970) demonstrated that seasonal changes in auxins effects on rooting are related to changes in the levels of endogenous regulatory substances and nutritional status of cuttings. These in turn are caused by temperature and day light changes experienced during annual cycle of plant growth.

Similar is the case with *W. floribunda* which revealed a maximum rooting of 26.67 per cent in rainy season. 1% IBA-AC enhanced rooting to 63.33 per cent in *D. hypoleuca* while supressed it to 6.67 per cent in *W. floribunda* (Table 3). However 1% IBA in talc proved beneficial for the latter giving a maximum 26.67 per cent success in rainy season.

Though statistically at par, *C. nepalensis* produced slightly better results in rainy season, giving 53.33 per cent rooting compared to 50.00 per cent in spring, when cuttings were treated with 100 mgl^{-1} IBA and 400 mgl^{-1} IBA respectively. 0.5% IBA-AC formulation further enhanced rooting to 56.67 per cent in the rainy season (Table 3).

Table 1

Effect of IAA, IBA and NAA on rooting of stem cuttings in some important shrubs during spring 1988-89

Treatment mg/l	*Debregeasia hypoleuca*			*Coriaria nepalensis*			*Woodfordia floribunda*		
	%R[Z]	N	L	%R[Z]	N	L	%R[Z]	N	L
Control	30.99 (26 67)*	10.11	7.44	28 78 (23.33)	6.67	2 72	18.44 (10.00)	6.83	1.40
IAA 100	35.22 (33.33)	16.11*	12.22*	30 90 (26.67)	7.33	3.11*	23.85 (16.67)	8.33*	1.77*
IAA 400	39.23 (40.00)	18.89*	15.44*	35.22 (33.33)	8.00*	3.22*	26.56 (20.00)*	9.83*	2.37*
IAA 700	33.00 (30.00)	13.33	11.28*	41.15 (43.33)*	9.67*	4.11*	23.85 (16.67)	11.94*	2.57*
IBA 100	54.78 (67.67)*	29.89*	20.11*	43.08 (46.67)*	10.56*	4.89*	23.85 (16.67)	11.00*	2.07*
IBA 400	45.00 (15.00)*	21.89*	16.89*	45.00 (50.00)*	11.89*	5.78*	28.78 (23.33)*	13.22*	3.03*
IBA 700	41.07 (43.33)*	18.67*	15.45*	38.85 (40.00)*	8.78*	4.28*	30.99 (26.76)*	13.83*	4.27*
NAA 100	35.01 (33.33)	15.17*	10.83*	41.15 (43 33)*	9.78*	4.22*	33.00 (30.00)*	18.83*	6.57*
NAA 400	39.15 (40.00)	19.22*	15 33*	39.23 (40.00)*	9.11*	4.11*	28.78 (23.33)*	13.06*	4.87*
NAA 700	37.22 (26.67)	18.89*	12.44*	37 22 (36 67)*	8.67*	3.89*	23.85 (16.67)	8 33*	2.40*
SEm ±	4.38	1.78	0.77	4.14	0.52	0.43	3.57	0.60	0.10
CD 5%	9.19	3.74	1.62	8.69	1.09	0.09	7.50	1.27	0.22

%R — Percentage rooting, N — Number of roots per cutting, L — Average root length (cm).
Z — Each value is the mean for 30 cuttings.

* Significant at 5 per cent l.o.s.

Figures in parenthesis are the actual values and those outside are the transformed values.

Table 2

Effect of IAA, IBA and NAA on rooting of stem cuttings in some important shrubs during rainy season 1988-89

Treatment mg/l	*Debregeasia hypoleuca*			*Coriaria nepalensis*			*Woodfordia floribunda*		
	%R^Z	N	L	%R^Z	N	L	%R^Z	N	L
Control	28.78 (23.33)	7.17	6.78	30.99 (26.67)	7.50	2.72	6.37 (3.33)	1.55	1.17
IAA 100	30.99 (26.67)	11.00x	7.67	33.00 (30.00)	9.11x	3.56	18.44 (10.00)	2.71	1.55x
IAA 400	35.00 (33.33)	12.95x	9.44x	37.22 (36.67)	12.44x	4.11x	21.15 (13.33)	2.77x	1.57x
IAA 700	33.00 (30.00)	13.17x	7.56	30.99 (26.67)	10.28x	4.33x	6.37 (3.33)	1.61	1.18
IBA 100	39.15 (40.00)x	21.33x	13.89x	46.92 (53.33)x	21.56x	7.67x	18.44 (10.00)	2.89x	1.65x
IBA 400	47.00 (53.33)x	21.67x	16.11x	43.08 (46.67)x	15.89x	6.11x	30.78 (26.67)x	3.61x	1.92x
IBA 700	30.99 (26.67)	12.39x	8.44x	39.15 (40.00)	13.67x	5.56x	21.15 (13.33)	2.94x	1.69x
NAA 100	37.22 (36.67)	19.00x	13.22x	41.15 (43.33)x	16.22x	6.22x	12.40 (6.67)	2.30	1.38
NAA 400	33.00 (30.00)	13.22x	8.89x	43.08 (46.67)x	20.56x	6.67x	6.37 (3.33)	1.61	1.18
NAA 700	28.78 (23.33)	10.67x	6.67	35.22 (33.33)	15.00	4.22x	0.33 (0.00)	1.00	1.00
SEm ±	4.85	1.28	0.68	3.89	0.72	0.46	7.43	0.57	0.16
CD 5%	10.18	2.69	1.42	8.17	1.51	0.96	15.61	1.20	0.34

%R — Percentage rooting, N— Number of roots per cutting, L — Average root length (cm).
Z — Each value is the mean for 30 cuttings.

x Significant at 5 per cent l.o.s.

Figures in parenthesis are the actual values and those outside are the transformed values.

Table 3

Effect of IBA-talc and IBA-activated charcoal formulations on rooting of stem cuttings in some important shrub species during rainy season 1988-89

Treatment mg/l	*Debregeasia hypoleuca*			*Coriaria nepalensis*			*Woodfordia floribunda*		
	%R[Z]	N	L	%R[Z]	N	L	%R[Z]	N	L
Control	28.78 (23.33)	7.17	30.00	30.99 (26.67)	7.83	33.33	6.37 (3.33)	1.55	1.77
Talc	33.21 (30.00)	12.11[x]	96.67[x]	33.21 (30.00)	10.44[x]	33.33	6.37 (3.33)	1.61	1.77
0.25% IBA-talc	35.22 (33.33)	24.00[x]	150.00[x]	45.00 (50.00)[x]	19.88[x]	46.67[x]	12.40 (6.67)	2.28	3.00
0.05% IBA-talc	43.07 (46.67)[x]	26.00[x]	170.00[x]	35.22 (33.33)	15.33[x]	36.67	26.56 (20.00)[x]	3.83[x]	5.24[x]
1.0% IBA-talc	30.99 (26.67)	12.83[x]	50.00[x]	28.78 (23.33)	11.33[x]	26.67	30.99 (26.67)[x]	4.20[x]	5.57[x]
Activated charcoal	33.21 (30.00)	11.50[x]	36.67[x]	35.21 (33.33)	11.67[x]	26.67	0.33 (0.00)	1.00	1.00
0.25% IBA-AC	33.00 (30.00)	15.72[x]	66.67[x]	39.14 (40.00)[x]	19.33[x]	56.67[x]	6.37 (3.33)	1.55	1.77
0.5% IBA-AC	37.22 (36.67)[x]	21.67[x]	116.67[x]	48.85 (56.67)[x]	21.78[x]	93.33[x]	12.40 (6.67)	2.44	3.00
1.0% IBA-AC	52.77 (63.33)[x]	26.67[x]	206.67[x]	33.21 (30.00)	6.17	10.00	12.40 (6.67)	2.49	3.39
SEm ±	3.12	0.48	5.49	3.32	0.70	4.58	7.46	0.79	1.15
CD 5%	6.61	1.02	11.64	7.04	1.48	9.71	15.82	1.67	2.44

%R — Percentage rooting, N — Number of roots per cutting, L — Total root length (cm).
Z — Each value is the mean for 30 cuttings.

[x] Significant at 5 per cent l.o.s.

Figures in parenthesis are the actual values and those outside are the transformed values.

Effect of auxins

In *D. hypoleuca* all treatments produced roots regardless of auxins or medium used i.e. water, IBA, IAA or NAA. The new roots were found to emerge from base as well sides. IBA 100 mgl^{-1} and 400 mgl^{-1} treatments resulted in a maximum 67.67 per cent and 53.33 per cent rooting in spring and rainy season respectively. Highest average root length (20.11 cm) and number (29.89) were recorded in cuttings treated with 100 mgl^{-1} IBA solution. Rooting results for IAA, and control were statistically at par, being inferior to those of IBA treated cuttings.

C. nepalensis appeared moderately hard to root species under field conditions, the rooting varying from 23.35 to 50.00 % in spring and 26.67 to 53.33 % in rainy season. Rooting response as well quality declined as concentration of auxins increased. It is evident from the study that auxin treatment triggered adventitious root formation almost doubling it over control. Maximum 53.33 per cent rooting was obtained when cuttings treated with 100 mgl^{-1} IBA were struck in rainy season. Higher root number (21.56) as well average root length (7.67 cm) were recorded in 100mgl^{-1} IBA treated cuttings in rainy season. NAA soaking enhanced rooting and callus formation over IAA and control cuttings in both the seasons. Rooting increased qualitatively as well as quantitatively when cuttings were dipped in 0.5% IBA-AC formulation just before sticking in the nursery beds.

Study revealed *W. floribunda* difficult to root species as only 30 per cent and 26.67 per cent success was achieved when cuttings were treated with 100 mgl^{-1} NAA and 400 mgl^{-1} IBA in spring and rainy season respectively. It was obvious that auxins promoted root initiation, as only 3 to 10 per cent of control cuttings rooted in both the seasons. Bahuguna *et al.* (1988) reported that cuttings soaked in 200 ppm IBA promote rooting in *W. fructicosa* when struck in monsoon season. Average root length and number was found to be maximum in plots treated with 100 mgl^{-1} NAA during spring.

A neglegible success in rooting cuttings (< 7 per cent) was obtained in ***B. lycium*** when cuttings were treated with 100 mgl^{-1} IBA during spring. Callussing of cuttings was poor, that often rotted at the base. Parmar and Khamu (1989) failed to initiate rooting when auxin treated *B. aristata* cuttings were planted in June and July. They however obtained 35.5 per cent success when branches were air layered with 5000 ppm IBA in July. The hard to root nature may be attributed to presence of some anatomical barriers or inhibitors (Spiegel, 1955; Fadl and Hartmann, 1967) and absence of some rooting cofactors (Hess, 1959, 1965, 1968; Challenger *et al.*, 1965) in the species.

Callus formation appeared 4-6 weeks after treatment but its extent bore little relation to subsequent root formation in all the species. Callus formation was much slower in the controls and often failed to differentiate into root initials. It did not appear in extreme concentrations either, the cuttings generally rotted at the basal ends in 5 to 7 weeks.

SUMMARY

This paper describes the results of experiments on rooting of stem cuttings of *Debregeasia hypoleuca*, *Coriaria nepalensis*, *Woodfordia floribunda* and *Berberis lycium* as affected by season and auxin application. 100 mgl^{-1} IBA and 100 mgl^{-1} NAA gave maximum rooting in *D. hypoleuca* and *W floribunda* respectively during spring whereas, 100 mg^{-1} IBA resulted in better rooting of *C. nepalensis* during rains. Rooting of *C. nepalensis* was enhanced when cuttings were dipped in 0.5 per cent IBA-AC during rainy season. *B lycium* failed to initiate roots irrespective of season and auxin application.

रोपणी की क्यारियों में कुछ महत्वपूर्ण क्षुपों की स्तम्भ कलमें लगाने पर उनमें जड़ें निकलने पर ऑक्सिनों और मौसम के प्रभाव का अध्ययन

एन० के० जोशी, एस० शर्मा, जी० एस० शामेट व आर० सी० धीमान

साराँश

इस अभिपत्र में डेब्रेजिएसिया हाइपोल्यूका, कोर्येरिया नेपालेंसिस, वुडफोर्डिया फ्लोरिबंडा और बर्बेरिस लीसियम की स्तम्भ कलमों में जड़ें निकलने पर मौसम और ऑक्सिन देने के सपरीक्षणों के परिणाम दिए गए हैं। 100 मिग्रा प्रति लीटर इण्डोल ब्यूटिरिक अम्ल और 100 मिग्रा प्रति लीटर न्यूथलिक एसेटिक अम्ल क्रमशः डे० हाइपोल्यूका और वु० फ्लोरिबंडा में देने पर उनमें बसंत में अधिकतम जड़ें निकली जबकि 100 मिग्रा प्रति लीटर इण्डोल ब्यूटिरिक अम्ल को० नेपालेंसिस में देने पर उसमें वर्षा ऋतु में श्रेष्ठतर परिणाम मिले। को० नेपालेंसिस की कमलों को 0.5% इण्डोल ब्यूटिरिक अम्ल-एसी में डुबोने पर वर्षा ऋतु में उसमें जड़ें निकलना बढ़ गया। ब० लीसियम में किसी भी मौसम और कोई भी ऑक्सिन देने के बावजूद जड़ें निकलना आरम्भ नहीं हुआ।

References

Bahuguna, V K., V.K. Dhawan and B.D. Pant (1988). Studies on effect of growth hormones for vegetative propagation of *Woodfordia fruticosa* Kurz. by rooting of branch cuttings. *Indian Forester*, **114** (12) : 832-836.

Brix, H. and R. Van den Driessche (1977). Use of rooted cuttings in reforestation. British Columbia Forestry Service/Canadian Forestry Service. *Joint Report* No. 6 : 1-16.

Challenger, S., H.J. Lucey and B.H. Howard (1965). The demonstration of root promoting substances in apple and plum rootstocks. *A Rep. E. Malling Res. Stn. For.* 1964 : 124 128

Fadl, M S. and H T. Hartmann (1967). Relationship between seasonal changes in endogenous promoters and inhibitors in Pear buds and cuttings bases and the rooting of pear hardwood cuttings. *Proc. Amer. Soc. Hort. Sci.* 91-112.

Hansen, J., L.H. Stromquist and A. Ericsson (1978). Influence of irradiance on carbohydrate content and rooting of cuttings of pine seedlings (*Pinus sylvestris* L.). *Plant Physiol.* **61** : 974-979.

Hess, C.D. (1959). A study of plant growth substances in easy and difficult to root cuttings. *Proc. Inter. Plant. Prop. Soc.* **9** : 39 95.

Hess, C.E. (1965). Rooting cofactors. Identification and functions. *Proc. Inter. Plant Proc. Soc.* **15** : 181-186.

Hess, C.E. (1968). Internal and external factors regulating root initiation. *Plant Physiol.* Lancaster 40 : (Suppl.) XLV.

Maithani G P., V.K. Bahuguna and J.D.S. Negi (1988). Survey of shrubs for hastening the process of reclamation of ecologically vulnerable areas of Central Himalayas. *Indian Forester*, **114** (5) : 243-250.

Nanda, K K. and V.K. Anand (1970). Seasonal changes in auxin effects on rooting of stem cuttings of *Populus nigra* and its relationship with mobilization of starch. *Physiol. Plant.* **23** : 99-107.

Nanda, K.K., V.K. Anand and P. Kumar (1970). Some investigations of auxin effects on rooting of stem cuttings of forest plants. *Indian Forester*, **96** : 171-187.

Nanda, K K. (1970). Investigations on the use of auxins in vegetative propagation of forest plants. *Final Report PL-480, Res. Project*-215 pp.

Parmar, C. and V. Khamu (1989). A note on sexual and asexual propagation of the Indian Berberry (*Berberis aristata*) *Indian Forester*, **115** (7) : 508-509.

Spiegel, P. (1955). *Some internal factors affecting rooting of cuttings.* 16th Intern. Hort. Congr. : 239-246.

Welander, T. (1978). Influence of nitrogen and sucrose in the medium and of irradiance of stock plants on root formation in *Pelargonium* petioles grown *in-vitro. Physiol. Plant* **43** : 136-141.

Zobel, B.J. (1981). Vegetative propagation in forest management. *Proc. 16th South For. Tree Imp. Comm. Meet.* Virginia : 149-159.
