ENCOURAGING BUD BREAK IN NEWLY-ROOTED SOFTWOOD CUTTINGS

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Abstract. Studies were conducted with several tree species to characterize the effects of stock plant etiolation, stem banding, and post-propagation $GA_{4/7}$, BAP, and STS sprays on the establishment and growth of rooted softwood stem cuttings. Stem banding promoted bud break and shoot growth while etiolation reduced bud break in *Carpinus* and *Malus* 'Spring Snow'. $GA_{4/7}$, but not BAP, was effective in promoting both bud break and shoot growth BAP reduced the $GA_{4/7}$ effect. STS promoted bud break and shoot growth of *Carpinus* at 1 and 5 mM, and bud break of *Syringa* at 5 mM. These methods should permit the wider use of stem cuttings for the production of those species which exhibit post-propagation shoot dormancy.

INTRODUCTION

The rooted cuttings of many tree and shrub species enter a period of dormancy following propagation (3). Pellet and Heleba (7) noted this for *Betula papyrifera* and *Forsythia mandschurica.* We have observed this post-propagation dormancy in many species, including beech, hornbeam, lilac, and oak (unpublished data). Not only does this sort of dormancy slow production, but also cutting survival over the first winter can be very low, unless additional shoot growth is produced and allowed to harden-off before overwintering (3, 9, 10). Obtaining shoot growth before overwintering has been shown to promote survival in Japanese maple, red flowered dogwood (2) and English oak (9). Treatments which have been applied to stimulate bud break and shoot elongation on rooted cuttings include night interruptions (8), defoliation (2), and foliar sprays of gibberellic acid (5, 9), cytokinin (4), or promalin, a mixture of gibberellic acid and cytokinin (4). These treatments could be useful in growing a larger plant in the first year following propagation.

Very little work has been done to characterize the effect of stock plant treatments to cutting propagation on subsequent cutting survival and growth. Behrens (1) found that shading the stock plant by 50 to 60%, which increased rooting success, actually reduced bud burst and shoot growth in cuttings of *Acer palmatum* 'Atropurpureum'. The following studies were conducted to characterize the effects of stock plant etiolation, stem banding, and post-propagation growth regulator treatments on the establishment and growth of rooted softwood stem cuttings of several woody plant species.

MATERIALS AND METHODS

The methods described below encompass several experiments utilizing stock plant etiolation and/or stem banding. For further information regarding the use of these stock plant treatments the reader is referred to (6) or is invited to contact the authors for a reprint packet.

Stock Plant Treatments: Etiolation was applied to dormant stock plants of *Carpinus betulus* 'Fastigiata', *Corylus colurna, Malus* 'Spring Snow', and *Syringa reticulata* 'Ivory Silk'. Stock plants which were just breaking bud were enclosed in a black cloth structure excluding 99% of ambient light. Shoots were allowed to grow to 5 to 10 cm before the cover was removed, and the shoots were allowed to green for up to 4 weeks before cuttings were taken. Shoots of these four species, as well as shoots on stock plants of *Franklinia alatamaha* and *Malus domestica* 'M.9' and 'MM.106' clonal rootstock, were banded with a 2.5 cm wide strips of Velcro™ applied to the base of the current season's growth. In treatments where hormone was applied with the band, the opened band was pressed into a thin layer of Hormodin #3 [0.8% indole-3-butyric acid (IBA) in talc]. Bands were left in place for up to four weeks and removed at the time the cuttings were taken.

Cutting Treatments. After harvest, cuttings were prepared to a length of 5 to 8 cm with 2 to 3 leaves per cutting, treated with a basal 5-sec dip of IBA in 50% aqueous ethanol, and allowed to dry for 5 to 10 min before sticking in a medium of peat:perlite (1:2, v/v) under intermittent mist. Rooting proceeded for 4 to 6 weeks before being assessed then rooted cuttings were potted-on. Plants were grown in a medium of perlite:peat:sandy loam soil (1:2:1, v/v/v) and fertilized weekly with 200 mg/l^{-1} 20N-10P-20K. Plants were grown under incandescent lamps suspended 3m above the stock plants and spaced 1m apart (4μmol s^{-1}m^{-1}), were used from 4 to 12 p.m. to extend the natural photoperiod to 16 hours.

Plant Growth Regulator Treatments. Gibberellic acid ($GA_{4\ 7}$; ProGibb, Abbott Laboratories, North Chicago, IL) was applied to rooted cuttings of *Carpinus, Corylus, Malus,* and *Syringa* at 250 and 500 mg/l^{-1}, alone and in combination with 10 mg/l^{-1} 6-benzylaminopurine (BAP). Silver thiosulfate (STS) was applied to plants of *Carpinus* and *Syringa* at 0, 1, or 5 mM. All sprays were applied to leaf-runoff, a rate of about 0.1 ml/cm^{-2}.

Growth Measurements. Percentage bud break as a percentage of rooted cuttings, and average shoot growth were measured periodically over the growing season.

RESULTS

The bud break of *Carpinus* was increased slightly in cuttings from banded shoots (Table 1). Initial etiolation decreased subsequent bud

break, but appeared to promote more shoot growth. The bud break of *Malus* 'Spring Snow' cuttings was not improved by banding, and actually was decreased by banding etiolated shoots. Shoot growth was reduced greatly in initially etiolated cuttings. Neither *Corylus* nor *Syringa* exhibited bud break or growth responses to stock plant treatment. The rooting of these species in response to stock plant etiolation and stem banding was presented by Maynard and Bassuk, this volume.

Table 1. Effect of stock plant treatments on bud break and shoot growth (cm, in parentheses) of *Carpinus betulus* 'Fastigiata' and *Malus* 'Spring Snow'[1]

		Bud break (%) (cm growth in parentheses)	
Stock plant lighting	Stem banding[2]	*C. betulus* 'Fastigiata'	*Malus* 'Spring Snow'
Light-grown	No-band	32 (1.4)	75 (5.2)
Light-grown	Band - H3	54 (2.1)	55 (4 9)
Light-grown	Band + H3	50 (4.6)	80 (5.8)
Etiolated	No-band	23 (3.6)	64 (1.9)
Etiolated	Band - H3	37 (2.5)	25 (1.8)
Etiolated	Band + H3	34 (4.3)	36 (1 8)

[1] Bud break and growth measured after 100 days Percentage means are based upon 32 plants, shoot lengths on only those plants which broke bud
[2] Abbreviations H3-Hormodin #3 (0.8% IBA in talc)

The rooting and after-growth of *Franklinia* and *M. domestica* 'MM.106' in response to stem banding and 4 levels of IBA at sticking is shown in Tables 2 and 3, respectively.[1] Though banding actually decreased rooting response somewhat in *Franklinia,* it partially reversed the IBA inhibition of bud break. Banding increased the rooting of *M. domestica* 'MM.106' over the entire range of IBA applied, while IBA at 2000 mg.liter^{-1} inhibited the rooting percentage of non-banded shoots. Previously banded *Malus domestica* 'MM.106' showed large increases in bud break and shoot growth 4 to 8 weeks after potting.

Table 2. Effect of stock plant treatments on rooting (%) and root number per rooted cutting (in parentheses) of *Franklinia alatamaha* and *Malus domestica* 'MM.106'[1].

IBA conc. (mg liter^{-1}	*Franklinia alatamaha*		*Malus domestica* 'MM.106'	
	Non-banded	Banded	Non-banded	Banded
0	96 (8)	87 (9)	5 (-)	24 (2)
500	100 (91)	96 (89)	60 (4)	72 (6)
1000	100 (127)	96 (124)	88 (9)	93 (9)
2000	100 (100)	96 (106)	56 (10)	93 (15)

[1] Percentage means are based upon 25 cuttings (*Franklinia*) or 5 replications of 6 cuttings (*Malus* 'MM 106')

[1] These results are also published in *J Environ. Hort.* 9(1). 40-43, 199.

Table 3. Effect of stock plant treatments on bud break (%) of *Franklinia alatamaha*, and on bud break (%) and shoot growth (cm, in parentheses) of *Malus domestica* 'MM.106'[1].

	Franklinia alatamaha		*Malus domestica* 'MM 106'			
	4 wks after sticking		4 wks after potting		8 wks after potting	
IBA conc. (mg liter^{-1}	Non-banded	Banded	Non-banded	Banded	Non-banded	Banded
0	88	97	0 (-)	86 (2)	0 (-)	100 (8)
500	28	44	32 (3)	86 (3)	73 (7)	86 (13)
1000	3	11	0 (-)	67 (4)	6 (11)	75 (14)
2000	3	11	0 (-)	28 (6)	0 (-)	60 (13)

[1] Percentage means are based upon 23 to 25 cuttings (*Franklinia*) or upon 7 to 25 plants (*Malus* 'MM.106'), shoot lengths on only those plants which broke bud

Shoots of *M. domestica* 'M.9' were banded for 0, 5, 10, 15 or 20 days prior to propagation. Rooting was allowed to proceed for 36 days and bud break was assessed over a 3 month time following propagation. Shoot lengths were measured after 5 months (Table 4). The rooting responses to increased banding time were dramatic, and banding for 15 days or longer before propagation promoted higher bud break and shoot growth after 71 days.

Table 4. Effect of length of stem banding treatment on rooting response, bud break, and final shoot growth of *M domestica* 'M.9'[1]

	Rooting response after 36 days		Bud break (%) days after transplant			Final shoot
Days of banding	Percentage	Roots/ rooted cutting	36	71	106	length (cm)
0	49	1 4	1	24	39	8
5	55	1 1	0	24	31	6
10	72	2 2	4	37	43	8
15	85	3.6	3	50	67	14
20	88	5 2	0	56	66	12

[1] Rooting percentage means are based upon 5 replications of 12 cuttings, bud break percentage upon number of transplanted cuttings Root number and shoot length determined from rooted cuttings or growing plants, respectively.

$GA_{4/7}$ treatments stimulated bud break in rooted cuttings of *Carpinus*, *Corylus*, and *Malus* 'Spring Snow,' but not *Syringa* which broke bud 100% following natural defoliation during propagation (Table 5). The addition of 10 mg liter^{-1} BAP reduced the bud break of $GA_{4/7}$ treated *Carpinus* and *Corylus*, but not *Malus* shoots. Shoots lengths also increased with $GA_{4/7}$ treatment though, again, this effect was reduced for all species, except *Malus*, by the addition of 10 mg liter^{-1} BAP. STS promoted bud break and shoot growth in *Carpinus* at 1 and 5 mM, and yielded greater shoot lengths in *Syringa* at 5 mM.

Table 5. Effect of growth regulator treatments on bud break (%) and shoot growth (cm, in parentheses) of four woody ornamental tree species [1]

Growth regulator	Conc [3]	Species[2]			
		C b 'F'	C c	M 'SS'	S r 'IS'
control	0	24 (2 4)	17 (8 5)	63 (0 9)	100 (4 2)
$GA_{4\ 7}$	250	40 (4 1)	—	—	100 (8 3)
	500	38 (5 8)	58 (11 6)	70 (4 4)	100 (10 2)
$GA_{4\ 7}$ + BAP	250 + 10	32 (3 8)	—	—	100 (5 7)
	500 + 10	27 (4 8)	42 (8 7)	69 (5 9)	100 (9 7)
STS	0	35 (1 7)	—	—	100 (3 0)
	1	60 (2 9)	—	—	100 (3 4)
	5	64 (3 9)	—	—	100 (7 5)

[1] Bud break and growth measured after 100 days (after 30 d for *Corylus colourna*) Percentage means are used upon 32 plants, shoot lengths on only those plants which broke bud

[2] Abbreviations C b F - *Carpinus betulus* 'Fastigiata', C c - *Corylus colourna*, M 'SS' - *Malus* 'Spring Snow', S r 'IS' - *Syringa reticulata* 'Ivory Silk'.

[3] Control, $GA_{4\ 7}$, $GA_{4\ 7}$ = mg/l [1], STS = mM.

DISCUSSION

These studies suggest that stem banding to promote rooting can have a dramatic effect on subsequent bud break and shoot growth. Stock plant etiolation also benefits rooting, but appears to reduce bud break in the months following propagation.

$GA_{4,7}$, but not BAP, was effective in promoting both bud break and shoot growth when applied as a foliar spray. The reduction in the GA effect by BAP supports the observations of Wooley and Wareing (11), who noted that when GA and BAP, which each promoted bud release, were applied together they completely inhibited lateral bud growth in *Solanum* cuttings. The promotive effect of STS, an ethylene action inhibitor, on bud break and shoot growth suggests that these growth phenomena are somehow inhibited by endogenous ethylene. Ascertaining this possibility would require verification in additional studies using ethylene synthesis and action inhibitors, and quantifying endogenous ethylene in rooted cuttings. We have a project underway which will examine the usefulness of STS in reversing the inhibition of bud bread and shoot growth resulting from IBA application to stimulate adventitious root formation in cuttings.

These studies confirm that there are numerous methods by which we may promote the after growth of rooted tree and shrub stem cuttings. It is hoped that this will contribute to greater success in the use of stem cuttings for the production of those woody plant species which exhibit post-propagation dormancy.

LITERATURE CITED

1 Behrens, V. 1988 Influence of light intensity on the propagation success of *Acer palmatum* 'Atropurpureum' propagated by cuttings *Acta Hort* 226.321-326.

2 Goodman, M.A and D P. Stimart 1987 Factors regulating overwinter survival of newly propagated stem tip cuttings of *Acer palmatum* Thunb 'Bloodgood' and *Cornus florida* L var. rubra *HortScience* 22· 1296-1298

3 Hartmann, H.T., D E. Kester, and F.T Davies, Jr 1990. *Plant Propagation Principles and Practices.* 5th ed. Prentice-Hall, Inc., Englewood Cliffs, NJ.

4. Keever, G J. and W.J Foster, 1990. Chemically induced branching of woody landscape plants. *Jour Environ Hort* 8·78-82

5. Loach, K and D.N. Whalley 1975 Use of light, carbon dioxide enrichment, and growth regulators in the overwintering of hardy ornamental nursery stock cuttings *Acta Hort* 54 105-116

6 Maynard, B and N Bassuk 1987 Understanding the Dark. Researchers grow plants under cover for better cuttings. *Amer Nurs* 165.124-128, 130-131

7 Pellett, N and D Heleba 1990 Shoot growth stimulation during softwood cutting propagation of *Betula* and *Forsythia. HortScience* 25 1084.

8. Smalley, T.J. and M.A. Dirr. 1988. Effect of night interruption photoperiod treatment on subsequent growth of *Acer rubrum* cuttings. *HortScience* 23 172-174

9 Smith, D.J and W W. Schwabe 1984 Acceleration of early growth of seedlings and rooted cuttings of *Quercus robur* L *Forestry* 57.143-157.

10. Stimart, D P., M A Goodman, and E.N Ashworth 1985 The relationship of shoot growth and nitrogen fertilization to cold hardiness of newly rooted *Acer palmatum* Thunb. 'Bloodgood' stem cuttings *Sci Hort.* 27 341-347

11 Wooley, D J and P.F. Wareing 1972 The interaction between growth promoters in apical dominance I Hormonal interaction, movement and metabolism of a cytokinin in rootless cuttings. *New Phytol.* 71.781-793.