COMPARISONS OF STOCK PLANT ETIOLATION WITH TRADITIONAL PROPAGATION METHODS

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INTRODUCTION

The development of any novel or improved technology would be incomplete without extensive comparisons to pre-existing technology. For novel methods of propagating ornamental plants this comparison typically starts in the research phase with comparisons of rooting, establishment, and survival percentages. Yet, ultimately, the comparison ends on the accountant's desk, where the costs incurred in each propagation method are balanced with the revenue returned from each plant sold.

At Cornell University we have worked for the last eight years on improving and testing methods for increasing the success of softwood cutting propagation. We have focused on improved stem banding methods and stock plant etiolation schedules which extend the production season in northern climates by moving stock plants indoors early in the year. We have applied stock plant etiolation and stem banding with success to nearly 60 ornamental tree species and cultivars (12). These methods consistently improve the rooting percentages, root numbers, and quality produced by species which are reputedly very difficult to root, and extend the window of propagation opportunity, allowing higher rooting responses up to 2 to 3 months after the rooting of untreated material has fallen-off. Admittedly, our interests have been research-based, and etiolation and banding have been useful tools for our investigations into the physiological and anatomical bases for adventitious root formation in stem cuttings.

Many of the treatment responses we have observed fall into the ''commercially acceptable range''. We recognize, however, that the value of a technological improvement is limited until it is adopted by the industrial world. To see if stock plant etiolation and banding methods can make this hurdle, we have turned our attention to an examination of the establishment, survival, post-propagation performance and quality of plants propagated from initially etiolated or banded shoots, as compared to plants produced by cuttage, graftage, seed, and micropropagation.

WHY USE CUTTINGS?

Vegetative propagation uses clonal material for its obvious advantages: preserving desired genetic and epigenetic traits for their economic value, accelerating species selection and improvement by preserving genetic gains made through conventional breeding programs, and making efficient use of selected germplasms by avoiding problems of alternate bearing in seed production.

As compared to graftage or micropropagation, cutting propagation makes more efficient use of limited production space with less skilled labor and fewer costs. And while the producers of micropropagated plants have come a long way in reducing costs, largely by increasing production volumes, they may never compete with cuttage in terms of the species diversity, level of skill, or lower costs possible when propagating low-volumes of plant material.

The rooted cutting has been touted as the solution to problems of incompatibility, suckering, and rootstock variability encountered in budding and grafting. This has probably come true for the more easily rooted species, but budding and grafting still remain the methods of choice in the production of dwarfed fruit trees and those species which do not root readily from cuttings (including material from mature stock), and budded or grafted plants often overwinter and grow better the first year, due in large part to the vigorous and well-established understock (5, 8). However, cuttings, with their genetically uniform roots and shoots, can be expected to grow more uniformly than grafts.

The recent attention given to problems with somaclonal variation among micropropagated plants, which increases with the rate of adventitious shoot formation, suggests that cuttage will continue to be one of the most important means of vegetatively propagating ornamental trees and shrubs (10).

COMPARISONS OF ROOTED CUTTINGS AND PLANTS PROPAGATED BY OTHER MEANS

Numerous comparisons of propagation methods have been made over the years. The initial growth of plants raised from seedlings and cuttings appears to be about equal (e.g. lowbush blueberry (1); Douglas fir (5); Monterey pine (7); Nootka cypress (11); English oak (14); white pine (15), although later on the growth of cuttings may lag if ramet maturation comes into play, as mature material typically grows more slowly (7, 11, 15). The greatest problem with cutting-grown, as opposed to seedling or seedling-grafted material, may be that the adventitious root system is of lower quality.

The roots of cutting-grown plants are typically shallower, less well-branched, and less adept at nutrient (15) and water uptake (9). Flemer (8) recounted several disappointments with own-rooted plants which died unexpectedly, did not overwinter well, or were poorly anchored. It has been suggested that the number of major roots on plants propagated from cuttings is determined at the time of propagation (15). If this number is low it might detract from subsequent plant growth or root system support.

Regarding comparisons of rooted cuttings with micropropagated plants, it must be remembered that virtually all of the micropropagules produced today are still just rooted cuttings, and there is no consistent evidence that tissue-cultured plants will outgrow rooted cuttings or grafted plants (4, 10). Observations that micropropagated plants branch or grow better could reflect the residual effects of growth hormones applied to the plants *in vitro*. One real benefit of tissue culture is the potential for year-around propagation, and the potential to maintain the active growth of the propagule, which is difficult to achieve using rooted cuttings. Each propagation method has obvious advantages for either propagation, growth, or establishment. The bottom line, however, remains economic, and any method stands to benefit from technological or labor-saving advancements.

HOW DO WE EXPECT STOCK PLANT ETIOLATION AND STEM BANDING TO STACK UP?

Certainly, the need for stock blocks or containerized stock and the cost of material and labor for shading and banding will add to the expense of producing plants from etiolated and/or banded shoots. An excellent cost accounting of the production of several flowering dogwood cultivars by stem cuttings yielded a final cost estimate of about $0.34 per cutting (2). We have estimated that etiolation and banding could be expected to add from $0.11 to $0.16 to this cost, for a total of $0.45 to $0.50 per cutting (3). These costs are perhaps five to ten times that expected in the production of a 1-0 seedling (16), one-half that estimated for a budded plant (3), and one-third to equal that of a micropropagated plant. The trade-off must come from the benefits we can attribute to propagating from etiolated or banded shoots: increasing the range of species available from cuttings, using a simple yet effective technology, extending the production schedule, and obtaining improvements in plant quality deriving from the increased root numbers and root system quality typical of initially etiolated or banded cuttings. Forcing containerized stock in the greenhouse allows us to propagate earlier in the season, which may allow for additional top-growth, shortening production times and reducing costs. A plea was voiced recently for increasing the use of stock blocks and hedges (6), both of which adapt wonderfully to the application of stock plant etiolation and shading.

USING ETIOLATION IN THE NURSERY INDUSTRY

In cooperation with Schichtel's Nursery of Orchard Park, New York, we obtained funds from the New York State Agricultural Research and Development Grants Program, in 1989, to evaluate the commercial potential of cutting propagation using etiolation and banding, and to compare this with conventional methods. We have completed the propagation phase of this project, and the materials we propagated are being grown-on and overwintered before we start a field comparison this next year. Our goal is to assess the effects of initial stock plant etiolation and stem banding on rooting, establishment, survival, plant quality and cost. Etiolation, which refers to initially growing cutting material in the dark, has been recognized for decades as a technique for improving the rooting of stem cuttings. Banding is a localized form of etiolation using hormone-laden black Velcro tape to cover the base of the shoot as it is developing on the stockplant. We are focusing on four ornamental tree species not produced in large volumes because of the cost or difficulty of current methodology. We will compare the field growth of cuttings produced from initially etiolated or banded stock with plants propagated by seed, budding, and micropropagation. A cost analysis of the etiolation and banding treatments applied on a commercial scale will complete the study.

The following species were chosen for this study (the comparison method of propagation is indicated in parentheses). *Carpinus betulus* 'Fastigiata', European hornbeam (cleft grafted seedling understock); *Corylus colurna*, Turkish hazelnut (seed); *Malus* 'Spring Snow', flowering crabapple (micropropagated or budded); and *Syringa reticulata* 'Ivory Silk', Japanese tree lilac (budded on seedling understock). Between 1,200 and 3,200 cuttings of each of these four species were taken from containerized stock forced in a greenhouse in February, and field-grown stock in June, 1990. The cuttings were rooted in peat:perlite (1:2, v/v) under mist for 60 days (Table 1—indoor propagation; Table 2—field propagation) and, though root number and length were also evaluated, only percentage rooting data are shown. All of the species except the Japanese tree lilac showed strong responses to the use of indole-3-butyric acid (IBA) as a 5-sec dip at sticking. The European hornbeam and Turkish hazelnut responded to the application of Hormodin 3 at the time of banding, while the 'Spring Snow' crabapple responded to both etiolation and banding, with no additional response to hormone on the band. The Japanese tree lilac also responded to hormone on the band, and showed a synergism between banding and prior etiolation. Greenhouse forcing also improved overall rooting percentages over that seen in field-grown cuttings, a common observation in cutting propagation.

Table 1. Effect of stock plant etiolation and stem banding on rooting percentages of four greenhouse-forced ornamental tree species[1]

Species	IBA conc (ppm)[2]	Light-grown			Etiolated		
		No band	Band 3[3]	Band +H3	No band	Band -H3	Band +H3
Carpinus betulus 'Fastigiata'	0	17	21	21	10	31	55
	2000	91	98	78	97	88	85
Corylus colurna	0	0	0	13	0	0	13
	2000	3	6	41	2	13	28
Malus 'Spring Snow'	0	7	15	7	11	35	38
	2000	18	17	20	33	69	41
Syringa reticulata 'Ivory Silk'	0	51	51	64	75	86	100
	2000	67	61	72	69	97	98

[1] Each mean represents 6 replications of 6-12 cuttings
[2] IBA applied as a 5-sec dip at sticking
[3] H3 The application of Hormodin #3 (0 8% in talc) with the Velcro™ band was investigated as an additional factor in the banding response of rooting

Cuttings which rooted were grown on in a greenhouse and treated to stimulate additional shoot growth using combinations of defoliation, night interruption, cold and growth regulator treatments (see article by Maynard, Sun, and Bassuk in this volume). In the spring of 1991, these plants will be lined-out in side-by-side comparisons with the corresponding budded, micro or seed propagated materials of equivalent production age.

The determination of costs associated with etiolation and banding are underway, and final growth and cost evaluations will be completed by October, 1991

CONCLUSIONS

The stock plant treatments of stem banding, etiolation, and even light shading are proven research tools, and can yield tremendous improvements in propagation response. However, as Mark Richey of Zelenka Nursery, Inc. (13) pointed out, the bottom line in plant propagation is not just the percentage rooting but also the labor given to the production of the crop. We hope that our story does not end here. Whether it is by increasing the range of materials which may be produced on their own roots, by extending the production season, or by increasing the success of propagation and establishment, we hope that methods which exclude or reduce light during shoot development will be recognized as valuable tools available to the commercial plant propagator.

Table 2. Effect of stock plant etiolation and stem banding on rooting percentages of four field-grown ornamental tree species[1]

Species	IBA conc (ppm)[2]	Light-grown No band	Light-grown Band -H3[3]	Light-grown Band +H3	Etiolated No band	Etiolated Band -H3	Etiolated Band +H3
Carpinus	0	4	8	54	13	25	31
betulus	1000	27	34	76	34	40	61
'Fastigiata'	4000	39	31	82	40	48	57
Corylus	0	0	0	6	—	—	—
colurna	2000	6	2	27	—	—	—
	4000	5	0	14	—	—	—
Malus	0	3	13	12	—	—	—
'Spring	2000	3	18	28	—	—	—
Snow'	4000	2	27	27	—	—	—
Syringa	0	38	35	69	—	—	—
reticulata	2000	3	18	28	—	—	—
'Ivory Silk'	4000	2	27	27	—	—	—

[1] Each mean represents 6 replications of 6 to 12 cuttings.
[2] IBA applied as a 5-sec dip at sticking.
[3] H3 The application of Hormodin #3 (0 8% in talc) with the Velcro™ band was investigated as an additional factor in the banding response of rooting (—) = Treatments not applied.

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Thursday Morning, December 13, 1990

The morning session was convened at 8:00 a.m. with Anna J. Knuttel serving as moderator.