Cuttings Production: Alternative Strategies and Potential Techniques for the Future©

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INTRODUCTION

In commercial plant production, the size and shape of cuttings is often strongly determined by the propagation environment they are placed in to root. In an attempt to minimise stress effects, particularly water stress, nurserymen will often select relatively short nodal cuttings, trim-back or remove a number of the leaves, and pinch-out the soft nonlignified apical tip. By understanding more about the environmental constraints imposed on cuttings (Harrison-Murray and Knight, 1997), and developing more "supportive" rooting environments, however, there may be opportunities to use larger or better-formed cutting material. The research outlined here aimed to examine whether the use of larger cuttings, or cuttings that had branches pre-formed on them, had any advantage over conventional cuttings in terms of rooting ability and speed of development. If any advantage proved commercially significant, then future research resources could be targeted at improving existing propagation environments and developing production protocols that accelerated liner (rooted cutting) development and enhanced quality.

The research focused on three particular questions. First, to what extent are leaves and growing shoot tips on the cutting important to rooting? Second, if they are important, what is the mechanism of their action? And, third, how does cutting morphology affect subsequent plant development and shape after rooting. *Cotinus coggygria* 'Royal Purple' was used as an example of a ornamental woody plant with which rooting can be inconsistent and the production of an appropriately well branched liner remains a challenge.

MATERIALS AND METHODS

Field-grown stock plants were pruned to 1 m in winter to encourage vigorous shoot growth the following summer. In one set of stock plants, actively growing shoots were tip-pruned in June. This encouraged the development of axillary buds and the promotion of shoots with side lateral branches. These shoots were then harvested as 'branched cuttings'. Single-stemmed 'apical cuttings' were obtained from the distal stems of shoots from a set of stock plants that were not tip-pruned. Cuttings were placed in "wet" fog with basal heat set at 20°C.

Rooting percentages were recorded after 5 weeks and the development of established liners was assessed 6 months after propagation. Data are presented with standard errors of the mean (SE) or least significant differences (LSD) values based on significance at P=0.05.

Experiment 1: The Importance of Leaves and Growing Tips to Root Initiation. Branched cuttings were used to assess the relative influence of new developing branches or shoot tips, and leaf area, on rooting. In half the cuttings, all the branches were removed entirely (nonbranched cuttings, shown as Non in Fig. 1 below). In the other half, only excess shoots were removed to leave four branches

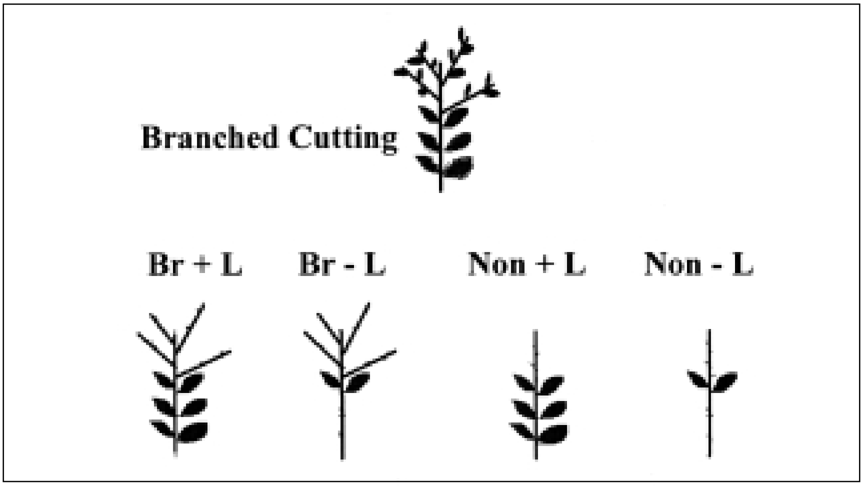


Figure 1. Branched cuttings and the treatments imposed on them (branches retained = Br; branches removed = Non; mature leaves retained = +L; and reduced number of mature leaves = -L.

per cutting (branched cuttings, shown as Br). Each of these groups was then subdivided on the basis of leaf number, with half retaining all six fully-expanded leaves (full leaf area, shown as +L), compared to the rest where leaf number was reduced to two per cutting (reduced leaf area, shown as -L).

Experiment 2: The Role of the Developing Shoot Tip in Relation to Auxin. This experiment aimed to determine if exogenous distal application of the auxin, indole-3-butyric acid (IBA) could substitute for the presence of lateral shoots. In addition an auxin transport inhibitor, 2,3,5-triiodobenzoic acid (TIBA) was tested to investigate if this had a negative effect on rooting. Branch number was restricted to four per cutting and cuttings were divided into the following treatments:

Cuttings with Branches Retained. Branched cuttings (Br); branched cuttings with proximal (basal) end dipped in 6.2 mM IBA soln (Br + IBA); branched cuttings with 1 mM TIBA (in lanolin) applied below the basal node of each branch on the cutting (Br + TIBA).

Cuttings with Branches Removed. Branches removed (Non); branches removed and proximal end dipped in 6.2 mM IBA solution (Non + IBA); branches removed, but a single application of 200 mM IBA applied to the distal cut surfaces (Non + IBA, 1 × distal application); branches removed and 100 mM IBA applied in lanolin to the cut surfaces (Non + IBA, distal lanolin) in an attempt to prolong the influence of the IBA.

Experiment 3: Influence of Branched Cuttings on Size and Quality at Liner Stage. Comparisons were made between conventional, single-stem (apical, approx. 9 cm long), and branched (Br, approximately 12 cm long) cuttings on rooting ability and subsequent liner quality. Liners were assessed for growth and quality after 6 (Jan.) and 12 (June) months. A single pruning treatment was applied to both treatments after the initial recording in January.

RESULTS

Experiment 1: The Importance of Leaves and Growing Tips to Root Initiation. Rooting was promoted by retention of both branches and a full leaf area, with 84% of cuttings rooting in the Br + L treatment (Table 1). Removing leaves reduced the rooting to 44%. Greatest reductions in rooting potential were associated with treatments involving the removal of the developing branches. Statistical analyses indicated that the presence of lateral branches was highly significant in determining rooting (P<0.01), although there were also significant interactions between branches and leaves (P<0.05).

Dry weights of stems were significantly affected by leaf area and the retention of branches (Table 1). Removing branches or maintaining full leaf area promoted increases in stem weight, and greatest dry matter accumulation was associated with the Non + L treatment.

Table 1. The effect of retaining (Br) or removing branches (Non) and/or mature leaves (+L vs. -L) from branched cuttings, on rooting and on changes in stem weight during the rooting period.

Treatment	Rooted ± S.E. (%)	Change in stem dry weight (mg)
Br +L	84 ± 6.9	64
Br -L	44 ± 8.9	-73
Non +L	14 ± 6.2	229
Non -L	22 ± 7.7	9
LSD (df =12)	N.A.	45.5

Experiment 2: The Role of the Developing Shoot Tip in Relation to Auxin. The presence of branches on cuttings increased rooting (95% rooted) compared to cuttings where the branches were detached and there was no further treatment (15%) (Fig. 2). In cuttings where branches were retained, the application of TIBA significantly reduced rooting to 35%. Applying IBA to cuttings without branches increased rooting, especially when the IBA was incorporated in lanolin and placed on the cut stem (60%).

Experiment 3: Influence of Branched Cuttings on Size and Quality at Liner Stage. The use of the pre-branched cuttings promoted well branched good quality liners, very rapidly. Assessing liners 6 months after propagation indicated that lateral shoots on branched cuttings had continued to develop during the rooting and growing-on phases. Plant quality at the 12-month stage was superior to plants derived from conventional apical cuttings. Liners from branched cuttings had significantly more overall growth and greater numbers of total and large lateral branches (Fig. 3).

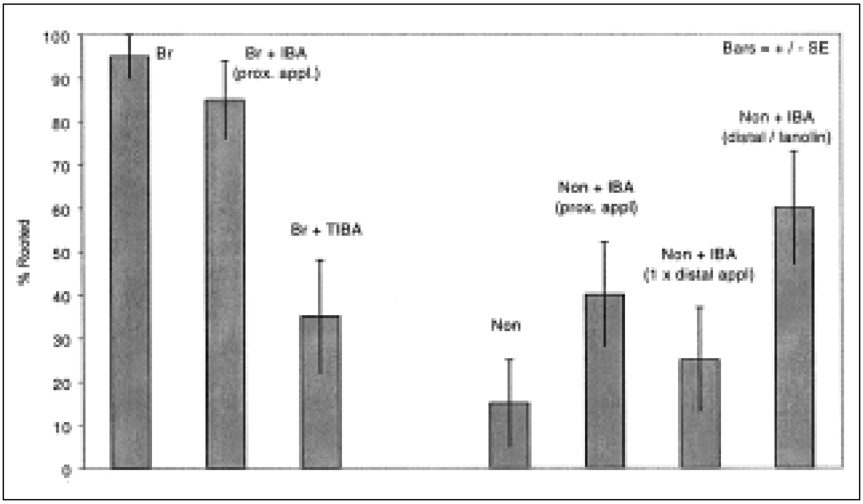


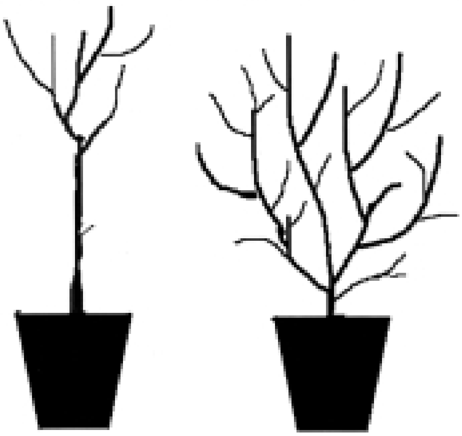
Figure 2. The effect of retaining (Br) or removing branches (Non) and additional applications of exogenous IBA or TIBA on rooting of branched cuttings.

DISCUSSION

Both shoot tips and leaves are important for the rooting of *Cotinus* cuttings. The advantage of retaining the growing shoot tips appears to relate to the maintenance of an endogenous auxin signal (Blakesley et al., 1991), rather than providing additional carbohydrates (Leakey and Coutts, 1989). Indeed, the developing laterals act as a carbon sink, and as such, a full leaf area is required to provide enough carbohydrates to enable both optimum rooting and continued shoot development. The second experiment provides evidence that the young shoots are a primary source of endogenous auxin and are providing the root-promoting signal to the base of the cutting. The shoot tips may also have an important role in the transport of the applied IBA, or its conversion to IAA within the cutting (Cambridge and Morris, 1996).

These results have important implications for commercial production of difficult-to-root species. Traditionally, nurserymen have removed leaves and developing shoots from cuttings in an attempt to minimise water stress in the propagation environment, and inadvertently may have been reducing the chances of root initiation in certain species. In contrast to the traditional approach, the results here indicate that large branched cuttings can enhance rooting potential, providing cuttings are placed in a supportive rooting environment. Indeed, increasing the number of developing lateral branches on the cutting may promote rooting through increased synthesis and polar transport of endogenous auxin, and thereby provide opportunities to reduce the requirement for exogenous application.

In addition, the use of branched cuttings not only improved rooting, but in turn, enhanced subsequent lateral shoot development. The net result is the potential to produce high quality finished plants quickly, and reduce production schedules compared to that of conventional single-stemmed cuttings.



	Apical	Branched	LSD
Height (cm)	66	58	8.0
Growth (cm)	160	244	36.2
Total Lats	7.2	19.1	3.87
Large Lats	3.9	7.2	1.42

Figure 3. Twelve-month-old liners derived from Apical (left) and Branched (right) cuttings. Values represent mean plant height, total shoot growth, number of total and large (> 10 cm) laterals present.

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