# ROOTED CUTTINGS IN BRITISH COLUMBIA'S TREE IMPROVEMENT PROGRAM

JOHN H. RUSSELL

*Cowichan Lake Research Station*
*Box 335, Mesachie Lake*
*British Columbia, Canada VOR 2NO*

Rooted cuttings are being increasingly used in tree improvement and reforestation programs in British Columbia. Present uses include: 1) an alternative to grafting for cloning selected parent trees for seed orchards and clone banks; 2) a research tool for nursery and field trials to control genetic variability; 3) an alternative to seedlings for reforestation; 4) a means for bulking-up genetically improved seed; and 5) clonal forestry (testing, selection, and deployment of clones). Projects aimed at developing and using these techniques are established in British Columbia.

**Cloning parent tree selections.** Rooted cuttings have been used in the establishment of British Columbia's seed orchards and clone banks as an alternative to grafting. Cloning of first generation parent tree selections, which were mostly over 60 years old, was usually done by grafting. However, rooted cuttings were used where grafting techniques had not yet been developed.

Graft incompatability is a serious problem with coastal Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco var. *menziesii;* however, rooting of cuttings from old trees is also unreliable (1). Second generation parent tree selections for the coastal Douglas-fir tree improvement program are from 12- to 15-year-old trees and a research project to investigate the use of rooted cuttings from these younger selections is being carried out at the Cowichan Lake Research Station.

**Research tool.** The use of clones for forest research trials can increase the efficiency of the trial by controlling genetic variability, and increase the precision of genetic information (2). However, before clones can be used for such trials, it is important that reliable cloning techniques are developed in order to minimize within-clone variation due to "c"-effects, and to establish that rooted cuttings exhibit similar growth rate and form as seedlings. Current research projects with Sitka spruce (*Picea sitchensis* (Bong.) Carr.) (7), white spruce (*Picea glauca* (Moench) Voss), coastal Douglas-fir, yellow-cedar (*Chamaecyparis nootkatensis* (D. Don) Spach), and lodgepole pine (*Pinus contorta* Dougl. ex Loud.) (6) are addressing both these requirements. Currently, there are field trials comparing seedlings to rooted cuttings for all of the above species, as well as for interior Douglas-fir (*Pseudostuga menziesii* var. *glauca* (Beissn.) Franco).

A trial comparing seedlings to rooted cuttings of yellow-cedar was established in the field in 1978 (4). After 11 growing seasons, there is no significant difference in height, diameter, and survival between seedlings and rooted cuttings, as shown in Table 1 (4). These trials will have important ramifications for justifying the use of rooted cuttings as an alternative to seedlings.

**Table 1.** Eleven year comparative growth and survival of yellow-cedar seedlings and rooted cuttings.

| | Seedlings | Rooted cuttings |
|---|---|---|
| [1]11-year height (cm) | 274 | 277 |
| [1]11-year diameter (cm) | 2.9 | 3.1 |
| [1]survival (percent) | 85% | 88% |

[1]Differences in height, diameter, and survival between seedlings and rooted cuttings are not significant at P=0.05

**Alternative stocktype for reforestation.** Rooted cuttings can be used as an alternative to seedlings for reforestation in situations where there are seed shortages, poor seed germination, or difficulties in seedling greenhouse culture. A yellow cedar rooted cutting program was initiated in response to an increase in demand for planting stock which could not be met due to seed shortage and poor germination (3). Since 1975, 50 percent of all the yellow-cedar planted have been rooted cuttings. Over the last two years, 650,000 rooted cuttings have been propagated annually, comprising nearly all of the planting stock for this species.

The main sources of cuttings are hedge orchards and serial propagation. Orchards are hedged to 25 cm in height annually to maintain juvenility. With serial propagation, rooted cuttings are grown up to 10 cm over target height and, prior to lifting and cold-storage, the tops are cut back and used for more cuttings.

Rooting success of yellow-cedar is affected by the age, hedging height, and crown position of the cutting donors such that:

1) rooting percentage decreases as cutting donor age increases;
2) rooting percentage decreases as cutting donor hedging height increases;
3) rooting percentage decreases as cuttings are taken higher in the cutting donor crown;
4) hedging the cutting donor delays maturation.

Hedging cutting donors also affects the growth and form of subsequent rooted cuttings. Table 2 illustrates the influence of cutting donor hedging height on the diameter, stem straightness, and root and shoot dry weight of one-year-old rooted cuttings. All of the traits are significantly improved by hedging cutting donors to a height of 25 or 50 cm.

**Bulking-up genetically improved seed.** In the early stages of a tree improvement program, genetic information is usually avail-

**Table 2.** Effect of hedge height of cutting donors on growth and form of one-year-old yellow-cedar rooted cuttings.

| | Hedge height (cm) | | | |
|---|---|---|---|---|
| | 25 | 50 | 100 | No hedging |
| [1]Stem straightness | 1.24 a[2] | 1.35 a | 1.91 b | 2.61 c |
| Root collar diameter (mm) | 3.88 a | 3.77 ab | 3.41 b | 2.98 c |
| Shoot dry weight (gm) | 2.56 a | 2.19 b | 1.72 c | 1.31 d |
| Root dry weight (gm) | 0.89 a | 0.72 b | 0.56 c | 0.42 c |

[1]Stem straightness: 1=upright; 2=45 to < 90 angle from horizontal; 3=0 to < 45 angle from horizontal.
[2]different letters in the same row indicate significant differences at the P=0.05 level according to Duncan's Multiple Range test.

able before seed orchards are producing large quantities of seed. Rooted cuttings can be used as an interim measure for transferring genetic gain to operational plantings. Seeds from superior clones, which are in limited supply, are grown in greenhouses under accelerated conditions and cuttings are rooted from these seedlings to bulk-up the number of plants for reforestation. The technique is illustrated and described for white spruce in Figure 1. This procedure produces a large number of cuttings from each seedling in a short period of time, while maintaining the juvenility of the cutting donor. An operational trial at the Cowichan Lake Research Station uses this procedure to produce white spruce and coastal Douglas-fir, genetically improved, rooted cuttings.

**Clonal forestry.** The ultimate use for rooted cuttings in forestry is for the deployment of genetically improved, tested clones (5). The major obstacle to practising clonal forestry with conifer species is the problem associated with ageing of the original clones as testing proceeds. Clonal forestry research is currently being conducted within the British Columbia Forest Service to determine the feasibility of this strategy for yellow-cedar, Sitka spruce, and white spruce.

A clonal testing strategy, being developed for yellow-cedar, involves the following steps:

1. Production of full-sib families from container-grown grafts of selected parent trees;
2. Cloning of one-year-old seedlings from the full-sib families;
3. Establishment of nursery-bed clonal trials;
4. Establishment of clonal hedges concurrent with clonal tests;
5. Rogueing poor clones out of the hedge orchard, based on four year growth in clonal trials.

The early selection provides genetic gains which can be transferred to operational use through mass propagation of the better

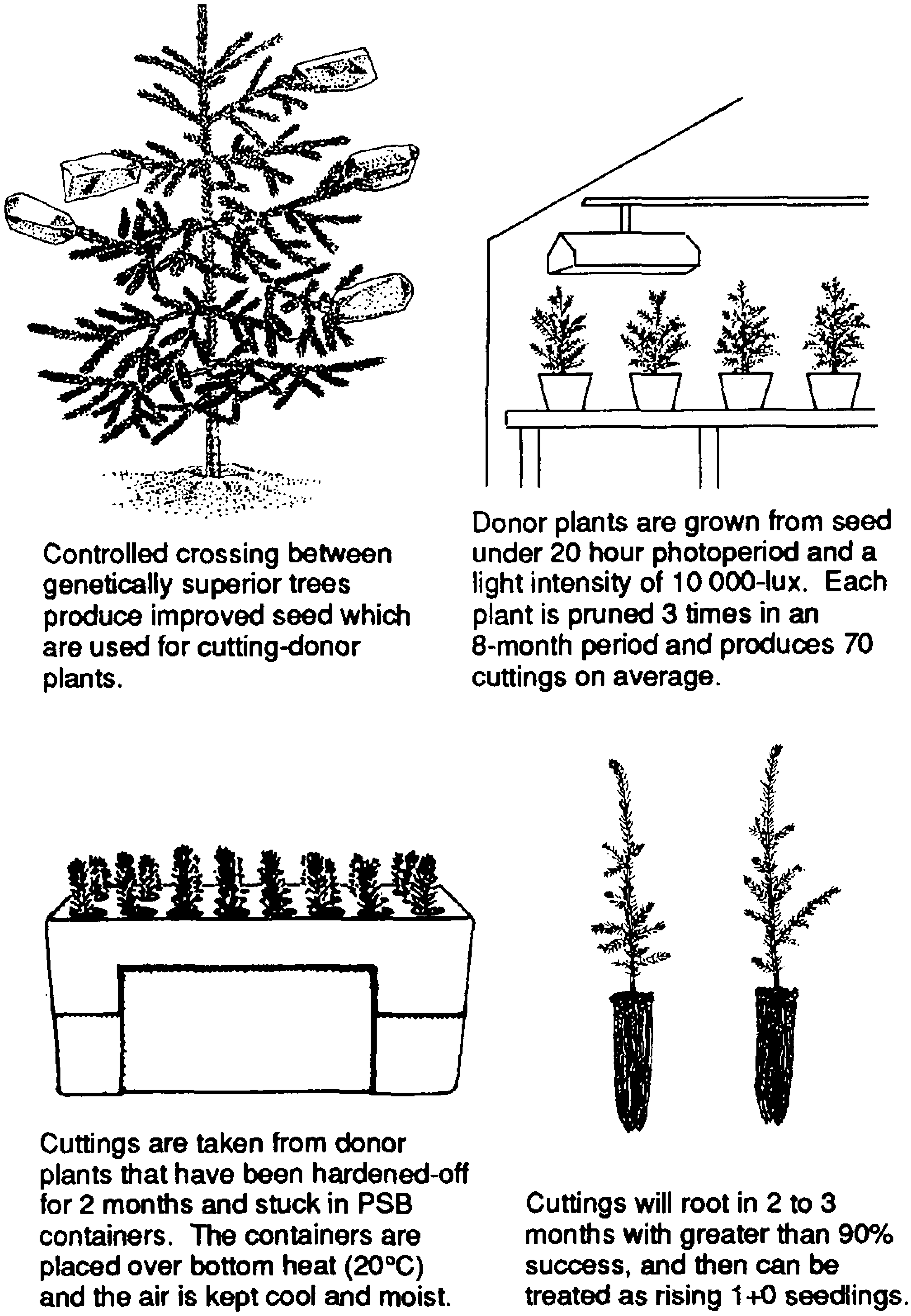


**Figure 1.** Production of genetically superior rooted cuttings of spruce.

clones in the hedge orchard. As more reliable techniques for maintaining juvenility of cutting donors are developed, selection of superior clones can be made at an older age with more confidence.

## CONCLUSIONS

Rooted cuttings have been an integral part of British Columbia's tree improvement and reforestation program for over 15 years. Selected parent trees that have been cloned by rooted cuttings for seed orchards are now producing genetically improved seed for reforestation. Yellow-cedar rooted cuttings are the primary stocktype currently being used for reforestation. Most of the cuttings are produced by private growers, using the techniques developed at the Cowichan Lake Research Station.

Recent research initiatives within the British Columbia Forest Service have resulted in new techniques, which allow the expanded use of rooted cuttings, including the bulking-up of genetically improved seed, the use of the clone as a research tool, and the testing, selection and deployment of genetically improved clones. Rooted cuttings will remain an integral part of British Columbia's silviculture program for years to come.

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