USE OF VEGETATIVE PROPAGULES IN REFORESTATION IN B.C.[1]

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ABSTRACT—Vegetative propagation is a silviculturist's reforestation tool which can be used for various purposes including: bulking-up a scarce seed supply; delivering genetic gains from selected families for improved traits such as pest resistance; and for clonal forestry. The focus of this talk will be to describe the above, using specific species as case studies. As well, recent innovations in vegetative propagation and future directions will be discussed.

INTRODUCTION

As interest in vegetative propagation for reforestation increases, nursery growers are faced with the task of learning to manage new and often challenging stock types, including cuttings, emblings, seedling donor plants and hedge orchards. What is driving this trend, and will it continue? Is vegetative propagation really necessary? There are several reasons why these programs are implemented, including: bulking-up a scarce seed supply, bulking-up elite families, ease of propagation, and clonal forestry. Not all forest tree species are amenable to vegetative propagation. As well, the reasons for implementing a program are usually quite species-specific.

YELLOW-CEDAR—BULKING-UP SCARCE SEED; CLONAL FORESTRY

The yellow-cedar (*Chamaecyparis nootkatensis*) cutting program is the largest and oldest operational vegetative program in B.C. It was implemented in the 1970's to bulk-up a scarce seed supply, and is now becoming the vehicle for clonal forestry.

Historically, there has not been enough yellow-cedar seed available to meet demand. Cone crops in the wild are erratic, and the number of filled seed per cone is low. Yellow-cedar seed orchards have never really produced; there are a number of problems associated with them. Also, seed germination has been poor in the past. However, yellow-cedar roots naturally through layering, thus rooted cuttings were an obvious alternative.

Seedling production is better now, due to improved cone collections and learning how to overcome seed dormancy. Over one million yellow-cedar seedlings are now produced annually in B.C. Even so, there is still a shortfall, and up to one million cuttings are grown annually to help meet the demand.

Most of the yellow-cedar cuttings come from hedge orchards, which may be field-grown or containerized. It is important to maintain juvenility and health of hedges to achieve a good quality cutting crop (figs. 1a, 1b). An alternate method of obtaining juvenile cutting material is through serial propagation, which at least one B.C. nursery is doing.

a b

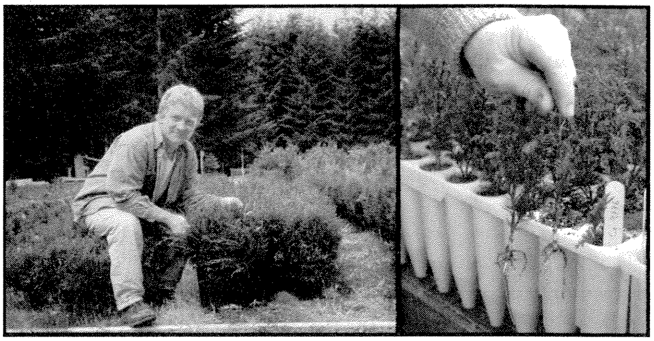

Figure 1—a) A juvenile containerized yellow-cedar hedge orchard, b) a newly rooted yellow-cedar cutting.

Quality is an issue, and one effective way of improving the cutting crop is to rogue donor plants based on nursery performance. Individual seedlings within a family can vary widely in characteristics such as stem form and rooting percentage. By identifying and clonally bulking-up the good seedlings in a hedge orchard, and removing the poor seedlings, the cutting crop quality can be greatly improved. MacMillan Bloedel has done this with very good results.

Clonal selection for nursery performance is only the beginning. A clonal breeding program for field performance is in place, led by the Ministry of Forests and Western Forest Products. Seedlings from the breeding program were cloned using cuttings, and the clones were put out into field tests. The results are forthcoming; selections have been made and are being bulked now. A volume gain of 10-20 percent at rotation is anticipated from orchards composed of this elite clonal material (J. Russell, unpub. data).

HYBRID POPLAR—CLONAL FORESTRY; EASE OF PROPAGATION

The hybrid poplar vegetative propagation program was implemented specifically for clonal forestry, and takes advantage of the relative ease of propagation of poplar. Poplar culture is relatively new in B.C. compared to the U.S. There are mainly two companies involved, Scott Paper and Pacifica Paper (formerly part of MacMillan Bloedel).

[1]Wigmore, B.G.; Russell, J.H. 1999. Use of vegetative propagules in reforestation in B.C. In: Landis, T.D.; Barnett, J.P., tech. coords. National proceedings: forest and conservation nursery associations—1998. Gen. Tech. Rep. SRS-25. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 116-118.[2]5909 Deuchars Drive, Duncan, BC V9L 1L5, Canada;TEL: 250/748-0357.
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So why hybrids? and why clones? The hybrid poplars used are crosses between the native *Populus trichocarpa* and the non-native *P. deltoides* (or occasionally another non-native species). Hybrids between related species are not usually successful, but occasionally there is a phenomenon called hybrid vigour, wherein a hybrid offspring has a much faster growth rate than either of its parents. This hybrid vigour occurs in a few clones within some families of *P. trichocarpa x deltoides.* Many clones are screened to find these elite ones. Both Scott and Pacifica have selected approximately 20 clones that they use for most of their plantations.

Poplar cuttings are produced in stoolbeds. Whips are harvested while dormant by cutting the stools back to the ground. The whips are then cut into the desired lengths, and planted directly in the field. Poplar roots very easily in the field, they can even be planted upside-down and still root.

Scott Paper plants 200-600K cuttings per year. Pacifica Paper plants 1.2 million cuttings a year, but only 40 percent of that is in B.C. and the rest is in Washington. There is little available good land for poplar plantations left in B.C., hence the expansion to the U.S. Hybrid poplar plantations are highly productive, with a rotation age of 10-12 years, and an average yield of 300-350 m^3/ha at age 10 (D. Pigott, pers. comm.).

WEEVIL-RESISTANT SPRUCE—BULKING-UP ELITE FAMILIES; CLONAL FORESTRY

Yellow-cedar and hybrid poplar are well-established vegetative propagation programs in B.C., but propagation of weevil-resistant spruce has only recently become operational. The white pine weevil (*Pissodes strobi*) causes significant damage to both interior spruce (*Picea glauca x englmannii*) and Sitka spruce (*P. sitchensis*). Two propagation systems for weevil-resistant spruce are under development, rooted cuttings and somatic embryogenesis. Sitka spruce rooted cuttings will be discussed as an example of bulking-up elite families, while somatic seedlings (emblings) will be addressed for their potential value in clonal forestry.

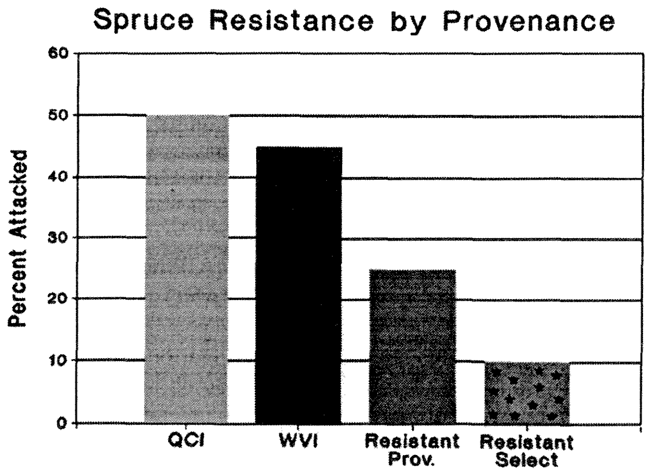

Figure 2—Percentage of Sitka spruce trees attacked by white pine weevil at a test site near Jordan River, B.C., by provenances and select families.

Planting of Sitka spruce on the coast of B.C. has been reduced from 10 million trees annually to about 0.5 million because of the weevil. Only the Queen Charlotte Islands are free of the weevil and can be planted successfully with Sitka. Two provenances, Qualicum and Haney, have been identified as having some resistance to the weevil. Wild stand collections from the Qualicum provenance show about 50 percent resistance compared to the Queen Charlotte and West Vancouver Island provenances (fig. 2). Qualicum seedlots are recommended for use in low weevil-hazard areas.

A selection program has identified particular families within the Qualicum provenance that show superior resistance (fig. 2). By using these selected families, planting of Sitka can be expanded to the medium weevil-hazard areas, which could result in a demand for around 5 million trees annually (J. King, pers. comm.). Seed from these families, however, will be in chronically short supply for some time; thus vegetative propagation is used as a tool to help meet the demand. Rooted cuttings are currently the best way to bulk up these resistant families, and after an initial research period are now being produced operationally.

It is important to use juvenile donor material for spruce, and neither long-term hedging nor serial propagation are particularly successful for this species. Therefore one-year-old seedling donor plants are used, which, when potted and grown aggressively, yield an average of about 50 cuttings per plant (fig. 3a). New crops of donor stock plants are sown each year. This system is similar to that employed by Weyerhaeuser for Douglas-fir (Ritchie 1994), and as developed for interior spruce in B.C. (Russell and Ferguson 1990).

Sitka spruce cuttings root relatively easily and generally have good form. All three nurseries growing them achieved over 90 percent rooting in 1998. Rooted cuttings of this species cost only 60-75 percent more than seedlings, and the program is expanding from 50K in 1998 to over 100K in 1999, with further increases expected as more companies become involved. Sitka spruce cuttings from juvenile donors perform as well as seedlings in the field, and they have been in use for about twenty years in the U.K. (Morgan and Mason 1992).

The alternative propagation method for resistant spruce is somatic embryogenesis (s.e.). This technology is capable of producing an infinite number of copies of particular clones. Also, tissue can be cryo-preserved for many years, thereby maintaining juvenility of the clone while waiting for field test results. However, until individual clones have been tested for weevil-resistance, s.e. provides no additional gain over capturing an elite family's breeding value, which is achievable through rooted cuttings at a lesser cost. In fact, due to the large number of recalcitrant families and clones in s.e. technology, it is possible that the clones being bulked now are not representative of the parental breeding values. However, when superior clones are identified through field tests, and cost is reduced, then s.e. will be a valuable tool.

DOUGLAS-FIR AND WESTERN HEMLOCK—BULKING-UP ELITE FAMILIES

As with rooted cuttings of Sitka spruce, cuttings of Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) are also used for bulking-up elite families. The only difference is that the families are selected for growth and/or wood quality, rather than pest-resistance.

Weyerhaeuser Co. in the U.S. has a successful Douglas-fir cutting program, and it was hoped that a similar one could be developed in B.C. One-year-old stock plants have been grown here successfully, but there are problems with plagiotropism in the cuttings. Weyerhaeuser grows Douglas-fir cuttings as a 1+1 stocktype, and the cuttings make a transition from plagiotropic to upright growth in the nurserybed in their second year. In BC, however, a 1+0 container stocktype is required. Some progress has been made in overcoming plagiotropism - there are cultural techniqes and genetic factors that help, but container Douglas-fir cuttings are still too unreliable and costly for operational use.

Western hemlock rooted cuttings are more successful. The Ministry's realized gain trials show that greater than 20 percent volume gains at rotation are attainable using top families (J. King, pers. comm.). Canadian Forest Products has some of these elite trees in their seed orchard. Through controlled crossing, elite seedlots are produced, which can then be bulked up through rooted cuttings. Again, one-year-old seedling donor plants are used (fig. 3b). Several private nurseries are involved with growing hemlock cuttings for CFP, and high rooting rates and good crop quality have been achieved. Trials have been established to compare performance of cuttings and seedlings in the field.

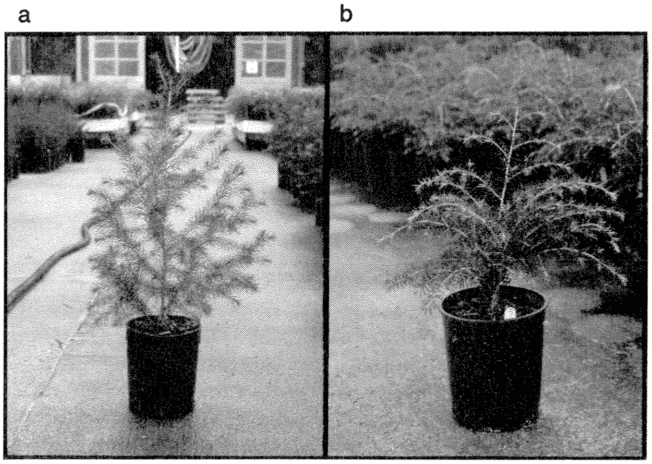

Figure 3—a) Sitka spruce donor plant, less than one year old, yielding about 50 cuttings; b) western hemlock donor plant, less than one year old, yielding about 70 cuttings.

CONCLUSION—VEGETATIVE PROPAGATION IN THE NEXT MILLENNIUM

Vegetative propagules will become increasingly common in the next millennium. In just a few years, yellow-cedar cuttings will be used for clonal forestry. Clonal forestry with hybrid poplar is already well established. Somatic embryogenesis will become operational for spruce and possibly other species. Also, genetic engineering is not far-fetched, and s.e. will be the vehicle for that technology. There will be continual increase in the use of rooted cuttings to bulk-up elite families, as there is always a lag of several years between the time when tree improvement selections are made, and when fully-producing seed orchards can be established.

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