Clonal Christmas Trees

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In the October 1996 issue of Christmas Trees (p20 & 22), Walter Ballinger, discussed the value of clonal Christmas tree production in an article entitled *The Urgent Need for Cloning of Christmas Trees*. As a follow-up, this article 1) discusses issues related to clonal Christmas tree production and 2) outlines plans for a clonal Christmas tree program for eastern redcedar (*Juniperus virginiana* L.) in North Carolina.

Cloning is the production of trees of identical genotypes usually through vegetative (rather than seed) propagation. While various methods of vegetative propagation such as grafting, air-layering or even tissue culture may be employed, trees are usually operationally cloned using rooted cutting propagation. It is generally the easiest and least costly method. Only a few clones are currently being used for Christmas tree production. One clone which is gaining popularity for Christmas trees and is extremely popular as an ornamental tree in North Carolina is the 'Leighton Green' cultivar of Leyland cypress (*x Cupressocyparis leylandii* Dall. & Jacks.). Two clones of Arizona cypress (*Cupressus arizonica* Greene var. *glabra* Sudw.) are also being investigated for Christmas tree production by growers in North Carolina; 'Carolina Sapphire' and 'Clemson Greenspire'.

Benefits of Cloning

Some of the potential benefits to be derived from cloning Christmas trees rather than using trees propagated via seed include:

1) **Greater genetic gain.** When trees selected for desirable characteristics are propagated through seed, only a portion of the total genetic gain is captured in their offspring (***progeny***). All of this genetic gain is utilized when trees are cloned.
2) **Greater uniformity.** Seed propagation from select trees results in progeny that are genetically variable. No genetic variation is present among a clone since its members (referred to as ***ramets***) have the same genotype.
3) **Greater ability to combine desirable characteristics.** Since progeny resulting from seed propagation inherit gene combinations different than those of either parent, it is difficult to produce seedlings that possess all of the desirable characteristics of select trees. However, when trees selected for a combination of several desirable characteristics are cloned, the resulting propagules also possess the desirable characteristics to the extent that they are controlled by genetics.

4) **Greater flexibility in meeting customers' needs**. In a cloning program, a number of clones with distinctly different characteristics can be selected and grown to meet various customers' tastes. Also, clones can be rapidly replaced to meet changing customer tastes. This flexibility is difficult to effectively accomplish using seed.

Problems associated with Cloning

Although the potential benefits of clonal Christmas tree production are great, some difficulties will be encountered in the implementation of such a program. One difficulty is the production and cost of using rooted cuttings rather than seedlings. A rooted cutting operation requires special facilities that are not needed when growing seedlings. Cuttings are usually rooted in greenhouses or outside under shade using a carefully controlled mist system. Depending on the species, such a facility can be relatively inexpensive or extremely costly. In any case, additional capital must be invested and new propagation techniques mastered. Generally, rooted cuttings cost 2 to 5 times more than seedlings. Although this cost is usually more than justified by the resulting increase in value of the final Christmas tree crop, many growers cannot afford such an investment.

Another difficulty associated with cloning of many coniferous species is the effect of maturation on their vegetative propagation ability. Cuttings from these species become more difficult to root as they mature. In addition, the cuttings rooted from older trees often display mature characteristics. In the case of pines (*Pinus* spp.), such cuttings may display reduced growth and less branching. Older trees may also produce rooted cuttings which are plagiotropic (i.e., exhibit branch-like growth) as frequently occurs in firs (*Abies* spp.). To circumvent the problems associated with maturation, clonal programs for pine and fir species must incorporate methods to either 1) maintain juvenility while clones are being tested or 2) rejuvenate selection-aged trees. While cloning programs with these species are possible, additional costs and complexities must be handled. Fortunately, the propagation ability of some conifers used for Christmas tree production such as the junipers (*Juniperus* spp.), cypresses (*Cupressus* spp.) and false cypresses (*Chamaecyparis* spp.) is negligibly affected by maturation. Numerous clones of species in these genera have been selected and widely utilized in the horticulture industry. There is great potential for using these horticultural clones or of developing new clones of these species for the Christmas tree industry.

The Need for Clonal Testing

Tremendous variation exists in natural tree stands for many important Christmas tree traits. Growers often encounter this variation in their Christmas tree plantations. Observed characteristics such as growth rate or color are referred to as the ***phenotype*** of a tree. A tree's phenotype is determined by both its genetic constitution, or ***genotype*** and the effect of the ***environment*** as described by the following equation:

$$\mathbf{P = G + E}$$

where,

P = phenotype
G = genotype
E = environment.

When selecting trees, what you see is not necessarily what you get. Genetically inferior trees may sometimes appear phenotypically desirable because they grew in an unusually favorable micro-environment. Conversely, genetically superior trees may appear phenotypically undesirable due to poor environmental conditions. Since characteristics vary in the degree of genetic versus environmental influence, the selection process is more effective for some traits than others. Regardless of the traits of interest, it is advisable to test select trees across a number of environments before using them in commercial Christmas tree plantations.

Another critical reason for testing clones before using them in commercial Christmas tree plantations is to verify that no detrimental propagation effects have occurred. Due to the previously discussed maturation effects or other propagation effects (such as poor root formation), the field performance of rooted cuttings from select trees may sometimes be substantially different than that of the original tree.

Eastern Redcedar Cloning Program

Eastern redcedar makes an ideal species for clonal Christmas tree production. It produces roots readily at the ages of concern for Christmas tree production and maturation effects on the growth and development of its rooted cuttings appear to be negligible. Many cultivars (clones) of eastern redcedar exhibiting a wide variety of growth habits and colors have been propagated in the horticultural industry. Although redcedar is an important Christmas tree species, the relatively small number of trees planted each year makes it difficult to justify a large-scale breeding program for this species. For these reasons, a clonal redcedar program for North Carolina Christmas tree production is being developed. Clonal screenings within the currently used planting stock will provide growers with uniform and superior planting stock. Later, if new clonal material is desired, screening of other sources of redcedar or of its hybrids with other *Juniperus* species may be undertaken.

Select trees which are outstanding in any of the following four categories will be candidates for the clonal testing program: 1) growth and form, 2) foliage color, 3) foliage softness, or 4) disease resistance. Selection criteria for each of the four categories are outlined in Table 1. Disease resistance in the last category is to *Phomopsis* blight caused by the fungus *Phomopsis juniperovora* Hahn. The primary symptom of this disease is browning and death of branches. Although its extent is not currently known, numerous growers are having severe problems with this disease in their Christmas tree plantations. For selection to be effective, disease-free trees in plantations with a high incidence of the disease must be located.

Selection Trait	Criteria
Growth & Form	• exceeds or equals height of the 30 nearest trees • pest-free • premium quality form (not-cigar shaped) • good color
Foliage Color	• unusually pleasing color either before or after artificial coloring • equals or exceeds mean height of the nearest 30 trees • pest-free • premium quality form (not-cigar shaped)
Foliage Softness	• less than 5% of foliage is of juvenile (prickly) type • equals or exceeds mean height of the nearest 30 trees • pest-free • premium quality from (not cigar-shaped)
Resistance to *Phomopsis* Blight	• pest-free • at least 80% of the nearest 30 trees have *Phomopsis* blight • premium quality form (not cigar-shaped) • good color

Table 1. *Selection criteria for four traits of interest in the North Carolina eastern redcedar clonal program.*

Christmas tree plantations will be searched for select trees. Growers interested in having trees selected in their plantations must 1) have at least 100 cedar trees that are 3 years or older from planting and 2) must be willing to protect select trees and maintain them as hedges until they can be rooted and archived in a clone bank. Up to a total of 50 selections will be made. These selections will be rooted in a propagation greenhouse during early 1997 and out-planted in clonal trials in the fall of 1997 (Table 2). If rooting success is adequate, multiple copies of each clone will be represented in clonal tests at each of three sites. These tests will be measured annually. Rooted cuttings of all clones will be archived in a clone bank. A protocol will be developed for making cutting material available to North Carolina growers and nursery producers interested in developing hedge orchards of the most promising clones for their rooted cutting production.

Date	Activity
1996	Approve up to 50 selections
1997 Jan-Apr Apr-Aug Sep	 Root up to 100 cuttings/selection Grow and harden-off rooted cuttings Establish clonal field trials
1998	Root cuttings and establish clonal archive 1st year field measurements
1999	Start production hedge orchard 2nd year field measurements
2000	Continue hedge orchard development 3rd year field measurements

Table 2. *Schedule for developing an eastern redcedar clonal program in North Carolina.*

Conclusion

The use of clonal material offers tremendous potential benefits in quality and uniformity to Christmas tree growers. However, only a few clones of relatively minor importance are currently being used in the Christmas tree industry. The need and cost of producing rooted cutting rather than seedling planting stock presents one difficulty in clonal production. For some species, the negative impact of maturation on the ability to root cuttings presents further difficulties in implementing a clonal program.

Fortunately, these problems appear minimal for some Christmas tree species. For one such species, eastern redcedar, a clonal program is being developed for North Carolina Christmas tree growers. Experience gained from this prototype clonal Christmas tree program may prove useful in developing similar programs for other species and/or geographic areas.