# Improving the Rooting Ability of Stem Cuttings from Virginia Pine and Fraser Fir Christmas Trees by Stumping

Christopher Rosier[1] and John Frampton[2]

Keywords: vegetative propagation, maturation, crown position, indole-3-butyric acid, 1-naphthaleneacetic acid, cloning, Christmas trees, *Pinus virginiana*, *Abies fraseri*

The Christmas tree industry in North Carolina is largely based in the mountainous western part of the state where Fraser fir (*Abies fraseri* [Pursh] Poir.) is grown, which represents over 96% of all the state's Christmas tree production. Production of Christmas trees is a valuable industry in the western part the state because it provides a source of income to a largely rural region in which there are few other economic opportunities (Frampton, 2002). Fraser fir is a desirable Christmas tree due to several characteristics including dark blue-green foliage, excellent post-harvest needle retention, pleasing aroma, and natural Christmas tree shape. However, Fraser fir has two significant problems as a Christmas tree species including extreme susceptibility to the introduced insect, the balsam wooly adelgid (*Adelges piceas* Ratz.), and to an introduced root rot fungus, *Phytophthora cinnamomi* Rands.

The most common Christmas tree species in the piedmont and coastal regions of North Carolina is Virginia pine (*Pinus virginiana* Mill.). Virginia pine has several characteristics that make it a deserving Christmas tree species including its rapid growth (3 to 5 years to harvest), short needles, good branch structure for holding ornaments, pleasant pine scent, and dark green color. However, Virginia pine also has several significant problems as a Christmas tree species. Chief among these problems are poor stem form, non-uniformity, and extreme susceptibility to damage by the Nantucket pine tip moth (*Rhyacionia frustrana* (Comstock)). In fact, due to the cumulative effect of these and other problems, growers typically only market about 50% or less of Virginia pines planted.

Asexual propagation by stem cuttings could help meet future demand for elite Fraser fir and Virginia pine Christmas trees. Due to the high market value of Christmas trees (relative to forest trees), genetic improvement for desirable Christmas tree characteristics can be justified. Once selected, desirable genotypes could be propagated for both archival purposes as well as commercial use (Zobel and Talbert, 1984). However, one of the major limitations in the effective use of vegetative propagation is the developmental process of maturation (Zobel and Talbert, 1984). Maturation has been shown to increase the time for root initiation to occur, decrease rooting ability, and decrease the growth rate of cuttings following rooting (Zobel and Talbert, 1984). This is a common problem in progeny testing where trees are allowed to grow over an extended period of time, but by the time their genetic potential is determined, the material is too mature to root.

---

[1] Smurfit-Stone Container, Fernandina Beach, Florida; [2] Department of Forestry North Carolina State University, Raleigh, North Carolina 27695.

Hedging, or stumping, is an important stock plant management technique that maintains juvenility, allows for increased shoot production, allows for easier cutting collection, and reduces sexual reproduction (Hartmann et al., 2002). Previous research with Fraser fir (Wise et al., 1985), loblolly pine (*Pinus taeda* L.) (e.g., Cooney, 1999), radiata pine (*Pinus radiata*. Don) (e.g. Bolstad and Libby, 1982; Fielding, 1954; Libby et al., 1972), Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] (Black, 1972) and Norway spruce (*Picea abies* L.) (Bentzer, 1993) has demonstrated that continuous hedging of a stock plant provides a way to increase cutting production and maintain juvenility.

Two experiments were designed to investigate the possibility of increasing production and rooting of vertically oriented (orthotropic) shoots from Fraser fir and Virginia pine. *Experiment 1*, was designed to test the effects of age, stumping, and auxin treatments on shoot production and subsequent adventitious root formation. *Experiment 2*, was established to describe quantitatively the effects of stumping treatments and crown position on the rooting ability of stem cuttings from both species. Fraser fir Christmas trees were hedged to 1 whorl (trees in the field 3 and 5 years) or 1, 3, and 5 whorls (trees in the field 7 years). Virginia pine stock plants were stumped to ¼ original height, ½ original height and ¾ original height. Intact (nonstumped) control trees were also identified for comparisons.

Fraser fir

Rooting percentages increased as the age of the stock plant decreased and the severity of the stumping treatment increased. In the 3-year-old stock plants, no significant differences occurred when auxin (4 mM IBA) was applied to cuttings collecting within the same stumping treatment. However, when collected from the 5- and 7-year-old stock plants, cuttings treated with auxin (4 mM IBA) always rooted more frequently than the non-auxin treated cuttings collected from the same stumping treatment. The highest rooting percentage occurred when 3-year-old stock plants were stumped to the first whorl regardless of whether they had been treated with (51%) or without auxin (50%).

Primary root production generally increased as the severity of the stumping treatment increased and age of the stock plant decreased. Root production was always greater in auxin treated cuttings, compared to nonauxin treated cuttings. The greatest production of primary roots (8.1) occurred when 3-year-old stock plants were stumped to the first whorl.

The effect of height consistently explained more of the variation in every age class and stumping height than horizontal position, with the exception of the 7-year-old nonstumped controls; however, in this treatment, height did explain a significant portion of the variation. In general, rooting percentages increased as the age of the stock plant decreased and the severity of the stumping treatment increased. In the nonstumped controls of the 3- and 7-year old trees, rooting percentage increased as the distance from the base of the stem decreased. This phenomenon is less obvious in the stock plants

stumped to the first whorl, most likely due to the limited distance from the base of the stock plant to where the stumping treatment was applied.

Virginia pine

Stumping height, auxin type and concentration significantly affected rooting percentage. In general, rooting percentages increased as the severity of the stumping treatment increased. When IBA was applied, the highest rooting percentage (73%) occurred when stock plants had been stumped to ½ original height and treated with 2 mM. When NAA was applied to the base of the cuttings, the highest predicted rooting percentage (76%) using the nonlinear regression analysis occurred when trees where stumped to ¼ original height and treated with 4 mM.

Primary root production, was significantly affected by auxin type and concentration, and increased with increases in auxin concentration, regardless of the type of auxin applied. When IBA was applied, the predicted number of primary roots produced increased with increases in auxin concentration to peak at 3.1 for cuttings treated with 12 mM. When NAA was applied, the number of primary roots produced dramatically increased with increases in auxin concentration to peak at 5.5 when 12 mM was applied.

When compared to the position traits, primary needle length explained more of the variation at every stumping height. Percent rooting and total root length were significantly affected by primary needle length and continued to increase as the length of the primary needle increased. For the crown position variables in stumped stock plants, the effect of height consistently explained more of the variation in rooting than horizontal position for the stumped stock plants. In the nonstumped stock plants, distance from the main stem was the most influential position variable.

In conclusion, the current findings suggest that asexual propagation by stem cuttings could provide some assistance in meeting future demand for elite Fraser fir and Virginia pine Christmas trees. This management technique may prove to be most useful in bulking up clonal material following progeny test selections or field selections for trees that exhibit a desirable characteristic such as pest and disease resistance. Research is underway to assess field growth of cuttings following rooting.

## LITERATURE CITED

Bentzer, B. G. 1993. Strategies of clonal forestry with Norway spruce, p. 120-138. In: M.R. Ahuja and W.J. Libby. (eds.). Clonal Forestry II, Conservation and Application. Ed. By M.R. Ahuja and W.J. Libby. Springer-Verlag. Berlin Heidelberg.

Black, D. K. 1972. The influence of shoot origin on the rooting of Douglas-fir stem cuttings. Proc. Intl. Plant Prop. Soc. 22:142-157.

Bolstad, P. V. and W. J. Libby. 1982. Comparisons of radiata pine cuttings of hedge and tree-form origin after seven growing seasons. Silvae Genetica. 31: 9-13.

Cooney, B. 1999. Effects of family, shearing height, pruning intensity and time of shoot origin on shoot morphology and rooting of loblolly pine stem cuttings. MS Thesis. N. C. State University, Raleigh, N.C.

Fielding, J. M. 1954. Methods of raising Monterey pine from cuttings in the open nursery. For. and Timber Bur Bull. 32, 29 pp.

Frampton, J. 2002. North Carolina's Christmas tree genetics program. p. 94-100 in: Proc. 26th Southern Forest Tree Improvement Conf., Athens, Ga., 26-29 June, 2001.

Hartmann, H. T., D. E. Kester, F. T. Davis, Jr., and R. L. Geneve. 2002. Hartmann and Kester's plant propagation: Principles and practices. 7th ed. Prentice Hall, Upper Saddle River, N.J.

Libby, W. J., A. G. Brown, and J. M. Fielding. 1972. Effects of hedging radiata pine on production, rooting, and early growth of cuttings. New Zealand J. For. Sci. 2:263-283.

Wise, F. C., F. A. Blazich, and L. E. Hinesley. 1985. Propagation of *Abies fraseri* by cuttings: Orthortropic shoot roduction form hedged stock plants. Can. J. Forest Res. 16:226-231.

Zobel, B. and J.Talbert. 1984. Applied forest tree improvement. Wiley, Prospect Heights, Ill.