Rooting Stem Cuttings of Atlantic White Cedar Outdoors in Containers

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Abstract. Stem cuttings of Atlantic white cedar [Chamaecyparis thyoides (L.) B.S.P.] were collected in early June 1995, divided into two parts (distal tip and proximal segment), and rooted for 12 weeks in shaded containers outdoors. Total rooting was near 80%. Mist intervals of 8 and 15 min yielded the best rooting percentages and the least dieback and injury. Two rooting media were tested, with similar results. Rooting was slightly higher in Spencer-Lemaire Roottrainers (Hillson size), compared to RoPak Multi-pots (#45). More than 90% of the tips rooted, even without IBA treatment. Auxin improved rooting of stem segments, but the difference between IBA at 1.5 and 3.0 g L⁻¹ was small. Yield of cuttings suitable for transplanting or potting was 80% for tips, 58% for segments. Dividing stem cuttings into two or more parts allows multiplication of rooted propagules from a collection. Chemical name used: 1H-indole-3-butyrilic acid (IBA).

In recent years, there has been increasing interest in restoring tree species to former swamps and wetlands along the Atlantic and Gulf coasts of the United States (N.C. Forest Serv., unpublished Workshop Proc., 1-3 Aug. 1995; Stockton College, unpublished Workshop Proc., 25 June 1996). In eastern North Carolina, vast acreages were previously exploited for timber (Ashe, 1894) and/or cleared, ditched, and drained for agriculture (Frost, 1987; Lilly, 1981), but some of this land is now undergoing reforestation. Atlantic white cedar is a valuable tree species indigenous to these wetlands, but now exists only on a small remnant of the acreage it formerly occupied (Frost, 1987; Kuser and Zimmerman, 1995).

Current demand for planting stock of Atlantic white cedar is strong. The North Carolina Forest Service has traditionally produced a small number (=30,000) of bare-root seedlings annually. Another source of plants is stem cuttings, which root easily (Boyle and Kuser, 1994; Hinesley et al., 1994; J.H. Hughes, Weyerhaeuser Co., unpublished). Recent tests indicate that cuttings will root in outdoor nursery beds, and yield high-quality transplants (Hinesley, unpublished; J.H. Hughes, unpublished). However, the latter approach could result in excessively wet soil, which might hinder nursery operations. Rooting stem cuttings in containers with soiless mixes would circumvent some of the potential problems associated with rooting in mineral soil.

Rooting response is affected by factors such as time of collection, type of cutting, mist schedule, and type and/or concentration of rooting hormone. Rooting of white cedar has been studied on a limited basis in greenhouses (Boyle and Kuser, 1994; Hinesley and Blazich, 1994), but not outdoors. Numerous questions must be answered before finalizing a protocol for rooting stem cuttings outdoors. Therefore, our objective was to evaluate the influence of several factors (mist schedule, container type, cutting type, rooting medium, and IBA treatment) on the rooting capacity of Atlantic white cedar stem cuttings outdoors under shade.

Materials and Methods

The research was conducted at Claridge Nursery (N.C. Forest Service, Goldsboro) (lat. 35° 20' N; long. 78°W). Wooden pallets (1.2 × 1.2 m) were arranged in two rows (12 pallets/row). Spacing of pallets within and between rows was 3 and 5 m, respectively. There were four replications, each consisting of six adjacent pallets within a row. One of six mist schedules was randomly assigned to each pallet within each replication. Mist intervals were 60, 45, 30, 15, and 8 min with mist duration of 60, 45, 30, 22, and 15 s, respectively. We assumed the 8-min interval would keep cuttings constantly wet, and that 60 min might cause stress cuttings, and thereby decrease rooting. A sixth treatment was controlled by a Mist-A-Matic (E.C. Geiger, Harleysville, Pa.), which applied mist when the surface of a stainless steel screen dried. About 15 s of misting was required to depress the screen. Mist was applied between 0700 and 1800 h daily in all treatments.

The four pallets that received a given mist regime were connected to a common water line (1.9 cm i.d., black polyethylene) and a solenoid. Water lines were buried underneath pallets to avoid problems with excessive heating from sunlight. Solenoids were operated by a MIC-8 Rainbird Controller (Rainbird, Glendora, Calif.). Two mist nozzles (Flora-Mist model C; 0.86 L/min at 0.27 MPa (Hummert Intl., Earth City, Mo.)) were spaced 0.9 m apart and =0.45 m above each pallet. Nozzles and feeder hoses (0.95 cm i.d., clear spray tubing) were taped to steel rods (0.32 cm in diameter) that were driven vertically into the ground.

An A-shaped frame (=1.5 m tall at the center) was installed on each row of pallets, and covered with a continuous piece of 50% black saran shade cloth. The shade cloth draped to the ground on both sides, and edges were secured with concrete weights. To prevent drift of mist, a vertical divider of clear plastic (0.15 mm thick, 1 m high) was installed halfway between adjacent pallets, underneath the shade. This setup worked fairly well, but we eventually concluded that a coarser spray would have been more uniform and less subject to drift.

Two types of containers were used: Spencer-Lemaire Roottrainers (Spencer-Lemaire Industries, Edmonton, Alberta, Canada) (Hillson size: 32 cells/tray, cell volume = 172 cm³; cell size = 3.8 × 3.8 × 12.7 cm), and RoPak Multi-Pots (Stuewe & Sons, Corvallis, Ore.) (45 cells/tray, cell volume = 98 cm³; cell diameter = 3.8 cm, depth = 12.1 cm). Four trays of each type were randomized on each pallet between the two mist nozzles.

Two rooting media were used. The first was 6 Canadian peat : 4 coarse vermiculite : 3 perlite (v/v/v), the standard medium used by the N.C. Forest Service for containerized longleaf pine (Pinus palustris L.). The second medium was 1 peat : 1 perlite (v/v). Both media were amended with dolomitic lime at 2.9 kg·m⁻³. Oxymar 10G (Pratt-Gabriel Div., Miller

Table 1. Analysis of variance for rooting response of stem cuttings of Atlantic white cedar outdoors.

<table>
<thead>
<tr>
<th>Source</th>
<th>Total</th>
<th>Usable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mist schedule (W)</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Container type (C)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Media (M)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>IBA treatment (A)</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Type of cutting (T)</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>W × A</td>
<td>NS</td>
<td>*</td>
</tr>
<tr>
<td>M × A</td>
<td>NS</td>
<td>*</td>
</tr>
<tr>
<td>A × T</td>
<td>NS</td>
<td>*</td>
</tr>
</tbody>
</table>

* Only the significant main effects and interactions are shown.
** "Non"significant or significant at P ≤ 0.05 or 0.01, respectively.
Each cutting was divided into a proximal and distal sections, each =15 to 18 cm long. The distal portion (tip) had succulent, light green stem tissue. The proximal section (segment) had light green, current-year growth at the top, and tan or brown, 1-year-old stem at the base. Excluding controls (no auxin treatment), the basal 1.5 cm of each cutting was treated with IBA at 1.5 or 3.0 g·L⁻¹ in 50% isopropyl alcohol. A fresh cut was made, and the base was dipped into the solution for 2 to 3 s. Following 10 to 15 min of air drying (lying horizontal), cuttings were inserted 2.5 to 3.8 cm into the rooting medium. Cuttings were misted soon after sticking.

The design was a split-plot with four replications. All factors were cross-classified. Main plots (pallets) were mist regimes. Each of the eight trays on a pallet represented one combination of two container types × two media × two cutting types, making those three factors equal in the second level of the analysis. Every tray contained one plot for each of the three IBA treatments, making this factor a subplot treatment in the third level of the analysis. Each plot contained eight cuttings, and a blank row of cells separated adjacent plots. There were 192 trays, 576 plots, and 4608 cuttings. Average weekly maxima/minima during the 13-week experiment were (beginning the second week of June): 29.4/17.8, 27.2/18.9, 30.0/21.1 °C; July—30.6/21.1, 32.3/21.1, 33.9/ 22.8, 33.3/23.3 °C; August—33.3/22.8, 32.2/ 21.1, 33.2/21.1, 30.6/21.1 °C; and September—27.8/18.3 °C. June and July are two of the wetter months in North Carolina, but the sporadic occurrence of precipitation is not adequate to sustain cuttings without systematic watering. Relative humidity was not measured.

The experiment was terminated on 8–9 Sept. 1995. Individual cuttings were evaluated in two ways. First, did the cutting have roots? Second, was the cutting usable, meaning that it was subjectively rated as having enough roots to survive and grow in an irrigated transplant bed in the nursery? Data were expressed as percentages, modified with the arcsin transformation, and subjected to analysis of variance.

### Results and Discussion

Because the analysis of variance was lengthy, only the significant main effects and interactions are shown (Table 1). The main effect for mist regime (W) was significant for total rooting percentage, and there were no significant interactions of W with other factors. Average total rooting was near 80% for intervals of 60, 45, and 30 min (Fig. 1A). A 15-min interval increased rooting to 90%, and the maximum was 92% for 8 min. There was also less dieback of cuttings misted at 8- or 15-min intervals. The interaction for mist regime × IBA treatment (W × A) was significant for yield of usable cuttings (Table 1), but in general, results were similar to those for total rooting. Highest yields were for 15- and 8-min mist intervals, particularly for nontreated cuttings (Fig. 1B). A 60-min interval yielded better rooting than 45 min, but we have no explanation for this apparent aberration.

Total rooting of cuttings watered with Mist-A-matic was only 52%. Many cuttings that survived and rooted died back to a branch or point near the soil surface. Dieback was more severe in this treatment than others. Without modification, this method would be unacceptable.

The main effect for container type (C) was significant, and there were no significant interactions of this variable with other factors (Table 1). Means for Rootrainers exceeded those for RoPak by ≈ 13% for total rooting percent, and 18% for percent usable seedlings (Table 2), possibly owing to a larger rooting volume and/or better aeration. Because they had seams, the folded Rootrainer books tended to dry faster than tubes in a RoPak.

Rooting medium (M) had no influence on total rooting percentage, and there were no significant interactions with other factors (Table 1); means were 79% for both media. However, rooting medium affected the percent of usable cuttings, and significantly interacted with IBA treatment (Table 1). Nontreated

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### Table 2. Influence of type of container on rooting of stem cuttings of Atlantic white cedar.

<table>
<thead>
<tr>
<th>Container Type</th>
<th>Total (%)</th>
<th>Usable (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RoPak</td>
<td>78.0</td>
<td>65.2</td>
</tr>
<tr>
<td>Rootrainer</td>
<td>80.7</td>
<td>73.1</td>
</tr>
</tbody>
</table>

*Significant at P ≤ 0.05 and 0.01, respectively.

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Fig. 2. (A) Yield of usable plants from stem cuttings of Atlantic white cedar as influenced by rooting medium and IBA treatment. Medium 1 [Canadian peat : 4 perlite : 3 coarse vermiculite (v:v:v)] ; Medium 2 [1 peat : 1 perlite (v:v)]. (B) Total rooting percentage for tip and segment cuttings of Atlantic white cedar as influenced by IBA concentration.
In the analysis for total rooting percentage, there was a significant interaction of cutting type (T) x IBA treatment (A) (Table 1). Total rooting averaged =91% for tips, regardless of IBA concentration (Fig. 2B). Rooting of segments increased linearly from 62% in nontreated cuttings to 72% for those treated with IBA at 3.0 g·L⁻¹. These results were not unexpected, owing to the more mature wood at the base of segments. The difference in yield of usable plants was highly significant (Table 1), averaging 80% for tips and 38% for segments.

When the study ended in early September, many cuttings were nearly root bound, although they received no fertilizer during the experiment. About 1000 usable cuttings (15 to 20 cm tall, adequate root system) (Fig. 3) were transplanted into an irrigated, fertilized, sandy loam nursery bed. Most of these plants were large enough to be planted in the field in early 1996. By comparison, a typical 1-year-old seedling is 10 to 20 cm tall when planted, and smaller seedlings are discarded. Most rooted cuttings in the transplant bed were ≥40 cm tall after the 1996 growing season.

In summary, a high percentage of stem cuttings of Atlantic white cedar rooted outdoors in containers with soilless mixes. Rooting was best with mist intervals of 8 or 15 min, resulting in less dieback and stress, compared to treatments with longer intervals. Rootainers yielded a slightly higher percentage of rooted and/or usable cuttings than RoPak Multi-pots, but might be more difficult to store and use. Total rooting percent averaged =79% for both media. More than 90% of cuttings derived from tips rooted, even without IBA treatment. Auxin treatment improved rooting of cuttings derived from stem segments, but the difference between IBA at 1.5 and 3.0 g·L⁻¹ was small. Finally, dividing long stem cuttings into two or more sections [tip, segment(s)] offers a means to multiply rooted propagules from a given collection, but might tend to increase variability among the resulting plants.

**Literature Cited**


