Postharvest Characteristics of Canaan fir and Fraser fir Christmas Trees

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We gratefully the acknowledge the Pennsylvania Christmas Tree Growers Association for their support of this research project.

The United States annually utilizes approximately 35 million live Christmas trees. Postharvest quality of cut trees is an important concern of growers, wholesalers, retailers and consumers. Christmas tree postharvest quality deteriorates over time and is a function of water status (Chastagner, 1986). Common postharvest quality problems include premature needle drop, poor foliage color, fragrance loss, reduced branch flexibility and increased susceptibility to fire (Hinesley, 1984). Conifers used as cut Christmas trees vary in their rate of drying following harvest, and their capacity to maintain freshness during display (Seiler, et al., 1988). Because of its excellent postharvest quality characteristics, Fraser fir [*Abies fraseri* (Pursh) Poir.] has become one of the most important tree species grown in the Eastern U.S. for use as a cut Christmas tree. Fraser fir loses water slowly, has a high damage threshold, retains its needles well when dry, and is quite durable in the postharvest environment (Mitcham-Butler et al., 1988). Fraser fir is in higher demand compared to other species grown in the Eastern U.S. and acreage is increasing (Tompkins, 2000). However, expansion of Fraser fir production is limited on poorly drained sites because of its susceptibility to certain root rotting pathogens (Sidebottom, 2001).

In recent years, interest has developed in the use of Canaan fir [*Abies balsamea* var. *phanerolepis* (L.) Mill.] as a Christmas tree in the Eastern United States. Canaan fir is generally considered to have high quality foliage characteristics and is very similar in appearance to Fraser fir. Grower experience also indicates that Canaan fir is less susceptible to the soil borne pathogens that limit the production range of Fraser fir (Brown, 1998). Because of this, there is increased interest in growing Canaan fir as an alternative to the more site-demanding Fraser fir. Little is known, however, concerning the postharvest handling of Canaan fir. The following study was undertaken to compare postharvest quality characteristics of Canaan fir with Fraser fir. We examined moisture status, current season needle retention and overall tree quality.

Materials and Methods

Twenty-eight Canaan fir and twenty-eight Fraser fir trees of uniform vigor and density, ranging in height from 6-7 ft., were selected in a commercial growers field near Boalsburg, PA. Trees had been grown under conditions of uniform fertility, appeared free of insect and disease damage, had at least three age classes of live foliage, and were U.S. No. 1 grade according to USDA standards. The Fraser fir seed source was Roan Mountain, N.C. and the Canaan fir seed source was Canaan Valley, W.Va. Eight Canaan fir and eight Fraser fir were cut on 15, 17, and 18 Dec. 2000 and four Canaan fir and four Fraser fir were cut on 19 Dec. for a total of fifty-six cut trees. All trees remained outside and unbailed to simulate sales lot storage conditions. Trees were laid on the ground in rows unprotected from rain and wind for the 0, 24, 48 or 96 hour storage treatments. Trees were bailed prior to being transported in a closed truck 19.2 km to the postharvest display room on 19 Dec. 2000. Prior to placement indoors, a .5-1.0 inch section was trimmed from the base of the trunk on four trees of each species from the 24, 48 and 96-hr. storage duration treatments. All trees were drilled before placement on a 1 gal., center-peg tree stand. Less than 2 hr elapsed from the time of harvest to display for trees of the 0-hr storage duration treatment. Water was replenished so that the proximal end of the trunk always remained submerged. The trees were displayed in a post harvest display room at the Russell E. Larsen Research Center and maintained under continuous standard fluorescent lighting, at 48% ± 5% relative humidity, and 68°F ± 2. During display, water was added to each tree stand to ensure that the water level in the stand was always maintained above the base of the tree. Water use was recorded for each tree. Moisture status (Ψ) was measured with a pressure chamber at 0, 1, 2, 4, 8,15, 20 and 25 days during display using 3-4 inch lateral stems from each tree. Needle loss data were obtained at day 0, 7, 14, 28 and 35 by randomly selecting representative branches and gently rubbing two fingers over current season needles during display. The extent of current season needle loss was evaluated on a 0 to 10 scale, where 0 = none, 1 = 1-10%, …, 10 = 91-100% loss. Each tree was evaluated subjectively for overall quality at 0, 10, 20, 30 and 40 d during display and rated on a 1 to 5 scale where 5 = excellent, 4 = good, 3 = fair, 2 = below average, 1 = poor, unacceptable. Needle color was evaluated on each tree using a R.H.S. color chart (Royal Horticultural Society, London).

Results and Discussion

Canaan fir and Fraser fir differed in moisture retention, current season needle loss and overall tree quality. Fraser fir generally outperformed Canaan fir in the postharvest environment and Canaan fir exhibited higher variability for measured attributes.

Canaan and Fraser fir trees cut immediately prior to placement in water had an average Ψ of –1.5 and –1.2 MPa, respectively (Figure 1). Trees cut and stored for 24 and 48 hr dried rapidly to a xylem pressure potential between –2.1 and –3.2 MPa prior to placement in water. All trees, except the 96 hr storage treatment, rehydrated to –1.0 MPA or higher within four days of being placed in water, indicating that most of the water stress associated with sales lot storage and the warm, dry climatic conditions prior to harvest had been alleviated. Xylem pressure potential never exceeded –1.2 MPa for the 0, 24, or 48 hr storage treatments for either species throughout the remainder of the display period.

Canaan fir cut 96 hr prior to display dried to an average Ψ of –3.6 MPa (trimmed and untrimmed), while Fraser fir dried to –3.5 (trimmed) and –3.3MPa (untrimmed) (Figure 1). Trimmed Canaan fir Ψ for trees stored 96 hours rose from –3.6 MPa to –1.0 MPa within four days of placement in water and remained above –1.2 MPa throughout the display period. Untrimmed Canaan fir in the 96 hr treatment rehydrated more slowly than the trimmed Canaan fir and had average Ψ of –1.7 MPa after four days in water, however trees began to dry through the remainder of the display period to a final Ψ of –2.4 MPa. Trimmed and untrimmed Fraser fir stored 96 hr rehydrated more rapidly than Canaan fir and maintained higher Ψ throughout the display period. At the end of the display the 96 hr, untrimmed treatment, Fraser fir had a Ψ of –1.3 MPa compared to –2.4 MPa for Canaan fir.

Fraser fir needle retention was excellent across all treatments and trees had only minimal needle loss (Figure 2). By the end of the experiment, needle loss was less than 3% and less than 7% for the 96 hr untrimmed and 24 hr untrimmed treatments, respectively. The degree of needle loss on Canaan fir generally increased for all treatments during the display period. Needle loss among Canaan fir trees in particular treatments, however, was highly variable. Trees stored for 96 hr before placement in water showed no needle loss at the beginning of the experiment. After 35 days on display however, trimmed trees in the 96 hr treatment exhibited between 21-30% needle loss whereas untrimmed trees had only about 5% needle loss (Figure 2). During the first 14 days on display, needle loss for Canaan fir in all treatments was between 0 and 10%. After 28 days on display the 96 hr trimmed, 48 hr untrimmed, and 24 hr trimmed and untrimmed treatments all exhibited needle loss over 10%. Both trimmed and untrimmed Canaan stored for 24 hr exhibited 11-20% needle loss by the end of the experiment. Needle loss in Canaan fir began relatively soon during display, with some trees beginning to shed green needles within 5 days.

Overall quality of Fraser fir was rated “excellent” to “good” throughout the 40-day display period for all treatments (Table 1), whereas Canaan fir ranged from “good” to “below average” by the end of the display period. After 20 days all Fraser fir trees were rated 4.75 or higher while no Canaan fir treatments received a rating above 4.5. Fraser fir stored for 96 hours lost the most quality, but remained above 4.0 after 40 days on display. Canaan fir trees placed immediately (0 h) and within 24 hours (trimmed and untrimmed) maintained a high level of visual quality and rated “good” to “excellent” throughout the experiment. Canaan trees stored for 48 hours before rehydration were intermediate in overall quality and rated as “fair” by the end of the experiment. All Canaan fir trees stored for 96 hours decreased in quality from “good” to “fair” within the first 10 days on display, and were rated as “below average” by the end of the experiment. This finding may indicate that some of the trees had dried beyond the damage threshold. The damage threshold is the water content below which a cut tree experiences irreversible damage which can contribute to needle discoloration and premature needle loss following rehydration (Hinesley and Snelling, 1991). Published Ψ values for damage thresholds are –4.0 MPa for Fraser fir (Hinesley, 1984), -3.5 MPa for Douglas fir (Montano and Proebsting, 1985) and –3.0 MPa for eastern white pine (Seiler et al., 1988). Canaan fir trees stored for 96 hr dried to –3.6 MPa before placement in water. These low Ψ values for Canaan fir stored 96 hr correspond to low overall quality ratings but did not consistently coincide with needle retention trends among the same treatments.

Overall quality in a cut Christmas tree is impacted by needle retention as well as foliage color characteristics. In this study, Canaan fir needle color was much more variable and inconsistent, and also deteriorated noticeably over time among certain trees, contributing to lower overall quality ratings. Slight differences in needle color characteristics were evident at the onset of the experiment. Canaan fir needles tended to be paler green or exhibit a yellowish hue compared to the deeper green Fraser needles (data not shown). Canaan needles also turned brown on some trees in the 96 hr treatment but did not drop during the display period. Canaan needle loss seemed to be independent of changes in needle color. In contrast, foliage color for Fraser fir retained its dark green to blue-green color in addition to excellent needle retention characteristics.

Current recommendations for stem trimming Christmas trees include the removal of a .25 to .50 inch thick disk perpendicular to the basal portion of the stem prior to displaying the tree in water (Chastagner and Hinesley, 2000). Studies have shown that a trees ability to rehydrate after cutting decreases with time, and differs by species. In this study, stem trimming appeared to influence xylem pressure potential only in the trees stored for 96 hr (Figure 1), and did not appear to be a factor in the overall quality of Fraser fir (Table 1). Water consumption by individual trees did not appear to be influenced by stem trimming (data not shown), and may be more a function of stem diameter.

Overall, the Canaan fir used in these studies had inferior needle retention characteristics and tree quality compared with Fraser fir. However, the data suggests that drying alone does not completely account for loss of needles and quality in Canaan fir, as some dry trees exhibited very good needle retention. Previous work with other species suggests that needle retention is a highly hereditary characteristic (Hinesley and Snelling, 1997). It may therefore be possible to identify Canaan fir seed sources that possess better needle retention traits. If this is possible, the postharvest quality of Canaan fir may be improved through selection and breeding programs. Efforts are currently underway at Penn State University, in collaboration with Dr. Gary Chastagner, Washington State University, to identify individual Canaan fir trees that possess superior needle retention characteristics. Trees identified as having excellent needle retention will also be screened for acceptable form and needle color, and will eventually be grafted into seed orchards.

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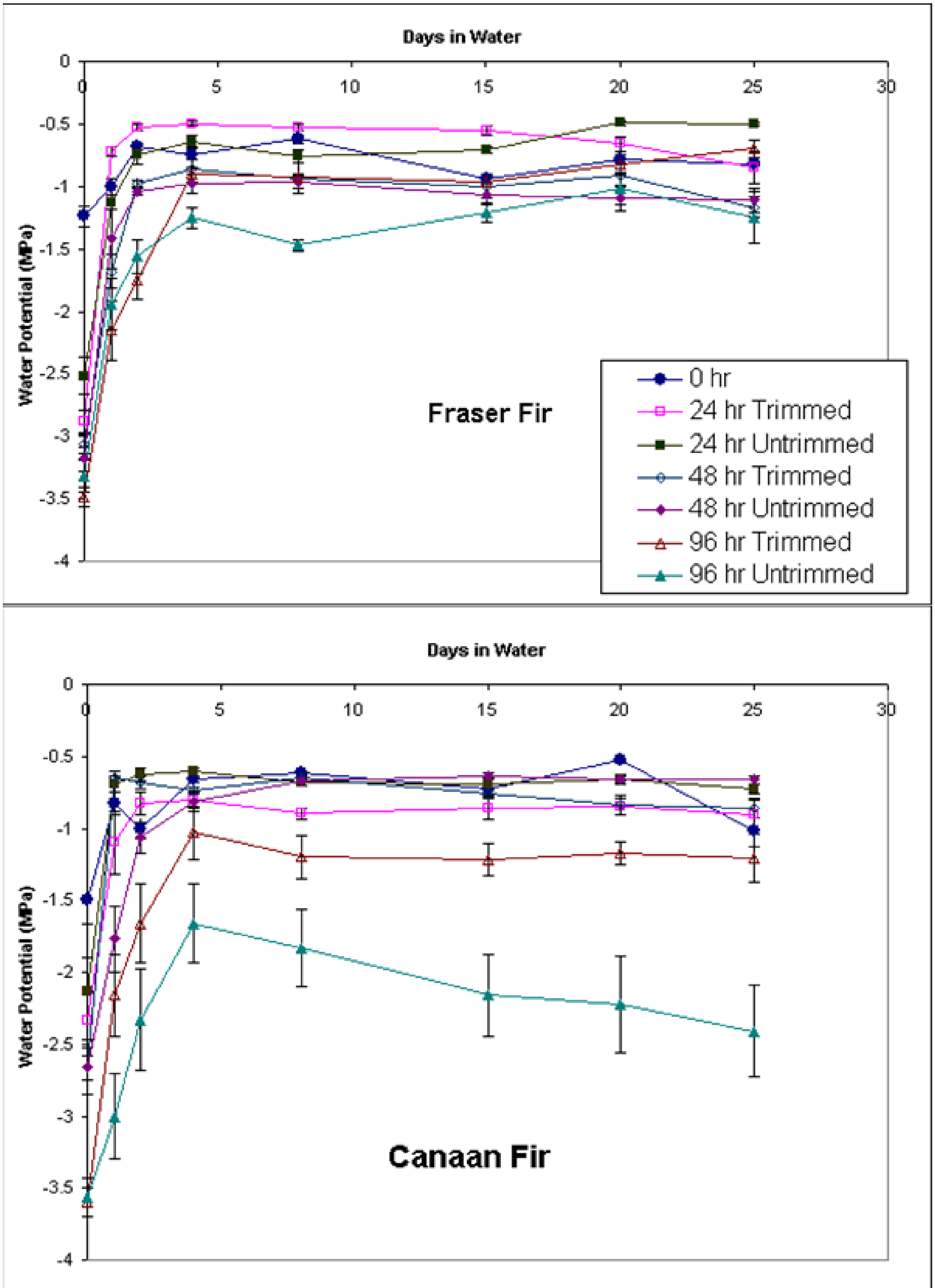
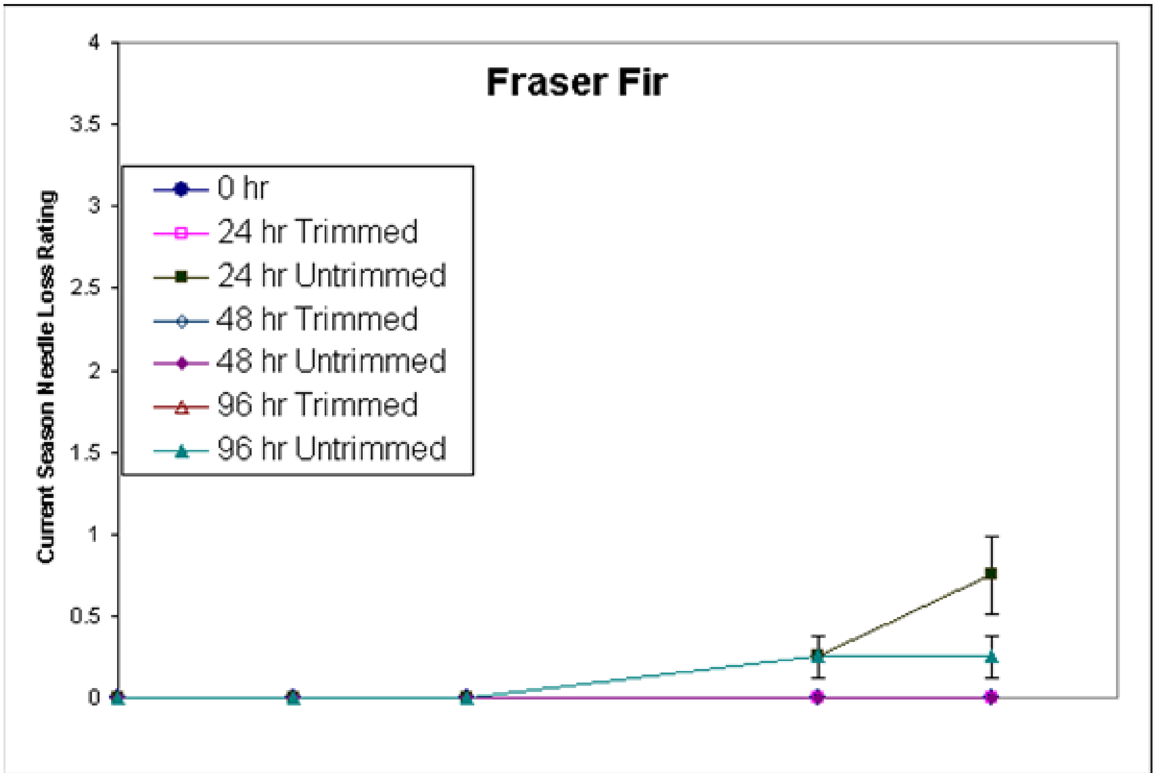
Figure 1. Changes in xylem pressure potential after rehydrating Fraser and Canaan fir trees in water after trees were stored outdoors under ambient conditions for 0, 24, 48, or 96 hours. Open symbol represents butt re-cut prior to rehydration. Bars represent SE of four replications




Fraser Fir
Current Season Needle Loss Rating
4
3.5
3
2.5
2
1.5
1
0.5
0
0 hr
24 hr Trimmed
24 hr Untrimmed
48 hr Trimmed
48 hr Untrimmed
96 hr Trimmed
96 hr Untrimmed