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Transplant Date Influences Cold Hardiness of Leyland Cypress following Transplanting into the Field

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Abstract. **Leyland cypress [×*Cupressocyparis leylandii* (A.B. Jacks. and Dallim.) Dallim. and A.B. Jacks.] plants were transplanted into the field monthly from Aug. 1989 through Mar. 1990, and laboratory cold-hardiness estimates of these transplants were obtained monthly for two winter seasons. Cold hardiness estimates obtained in Dec. 1989 and Jan. 1990 revealed that the Nov. and Dec. 1989 transplants were 6C less cold-hardy than those transplanted into the field earlier in the year. There was little difference in cold hardiness due to transplant date during Feb., Mar., and Apr. 1990. In the second year of the study, on the same transplants, cold hardiness varied among transplanting dates. In Dec. 1990 and Jan. 1991, those transplanted in Jan.-Mar. 1990 were up to 9C less cold-hardy than those transplanted earlier in the season. However, in Mar. and Apr. 1991, those transplanted in Jan.-Mar. 1990 were equally or more cold-hardy than those transplanted earlier in the season. Transplanting Leyland cypress into the field in August to November appears to be the best time to ensure development of cold hardiness in early winter, whereas January to March planting appears to promote greater cold hardiness in the spring months.**

Leyland cypress has greatly increased in popularity in the last decade both as an ornamental landscape plant and as a Christmas tree. Currently, its production in the United States is estimated in the hundreds of thousands of plants (Dirr, 1990). To date, this tree has few insect and disease problems, and mature trees have survived exposure to -19 and -22C in 1983 and 1985, respectively, at the Georgia Experiment Station, Griffin. Transplants, however, often experience freeze damage in the first year or two after transplanting into the field (Lindstrom et al., 1989). This is especially true for those transplants used for Christmas trees, since growers place them into the field in January and February, after their busy holiday season. No information exists on the cold hardiness of Leyland cypress throughout the winter season nor on how transplanting date affects their subsequent cold hardiness. Therefore, I used laboratory techniques to describe cold hardiness, throughout the winter season, of Leyland cypress transplanted into the field at different times of the year.

One hundred uniform, containerized (3.78-liter pots) 'Leighton Green' Leyland cypress plants (60 to 80 cm tall) were selected from

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Table 1. The lowest survival temperatures (LST) (°C ± SD) of Leyland cypress in the year of transplantation in the field. Cold-hardiness estimates were obtained monthly from Dec. 1989 to Apr. 1990. The last value of each column gives the LST of the plants on the date of transplanting. There was no variation among replicates if standard deviation is not reported.

Transplant month	Sample date (1989–90)				
	11 Dec.	8 Jan.	15 Feb.	12 Mar.	10 Apr.
Aug. 1989	−18	−21	−15	−9	−6
Sept. 1989	−18	−21	−15	−9	−6
Oct. 1989	−18	−21	−15	−9	−6
Nov. 1989	−11 ± 2	−15	−15	−9	−6
Dec. 1989	−9	−15	−12	−9	−6
Jan. 1990		−15	−12	−9	−6
Feb. 1990			−12	−9	−4 ± 2
Mar. 1990				−6	−5 ± 2

Table 2. The lowest survival temperatures (LST) (°C ± SD) of Leyland cypress on the year following transplantation into the field. Cold-hardiness estimates were obtained monthly from Dec. 1990 to Apr. 1991. There was no variation among replicates if standard deviation is not reported.

Transplant month	Sample date (1990–91)				
	10 Dec.	7 Jan.	12 Feb.	11 Mar.	9 Apr.
Aug. 1989	−18	−15	−18	−15	− 9
Sept. 1989	−18	−15	−18	−15	− 9
Oct. 1989	−18	−15	−18	−15	− 9
Nov. 1989	−15	−15	−18	−15	− 9
Dec. 1989	−15	−12	−15	−15	− 9
Jan. 1990	− 9	−12	−15	−15	−12
Feb. 1990	−11 ± 2	−12	−15	−15	−12
Mar. 1990	− 9	−15	−17 ± 2	−15	−12

a set of propagated stock (Lindstrom et al., 1989) and placed in an unheated shade/poly structure until planting into the field. The remaining plants were used as controls to monitor the state of cold hardiness of the housed plants on the date each group was transplanted into the field. The polyhouse was constructed with double polyethylene covering with no shading. No heat was supplied to the structure. The plants were watered daily, no fertilizer was added while in the overwintering structure, and the pots were kept weed-free. Ten plants were transplanted into the field on 22 Aug., 27 Sept., 23 Oct., 22 Nov., and 22 Dec. 1989 and 24 Jan., 23 Feb., and 21 Mar. 1990 using a randomized complete-block design. No fertilizer, irrigation, or other chemicals were applied to the plants during the remainder of the study. The alleyways were mowed to keep weeds and grasses under control. Cold hardiness was determined from each transplanting group that was in the field on 11 Dec. 1989 and 8 Jan., 15 Feb., 12 Mar., and 10 Apr. 1990 for the first year of the study and 10 Dec. 1990 and 7 Jan., 12 Feb., 11 Mar., and 9 Apr. 1991 during the second year of the study. Sixty uniform, lo-cm-long stem segments (leaves intact) were removed from plants from each treatment group for each test day. Samples were wrapped in wet paper towels, put in plastic bags, and placed on ice in an ice chest for transport to the laboratory. The stem segments were prepared for freezing within 2 h of collection.

For the freezing test, the terminal 7 cm of each stem segment was removed, wrapped in moist cheesecloth, and placed into a test tube (25 × 200 mm). The tubes were then submerged in a 1 ethylene glycol : 1 water solution (v/v) in a temperature bath (Model 2425; Forma Scientific, Marietta, Ohio) precooled to -2 ±+ 0.5C. Sample temperatures were measured by thermocouples (Type T; Omega Engineering, Stamford, Conn.) placed next to the submerged samples and recorded by a datalogger (Model CR7-X; Campbell Scientific, Logan, Utah). Crushed ice crystals were applied to the wet cheesecloth to ensure that samples did not undercool. The temperature of the samples was held constant at -2 ± 0.5C for ≈14 h. Samples were then cooled to -24C at a rate of ≤ 4C/h. Ten randomly selected stem segments for each transplant date were removed from the bath at progressively lower temperatures at 3C intervals. Controls were prepared as described above, except they were not placed in the bath, and were kept at 4C for the duration of the freezing test.

After being thawed at 4C overnight, samples were removed from the tubes and placed in disposable 100 × 15-mm petri dishes containing filter paper saturated with deionized water to maintain 100% relative humidity. Petri dishes were placed on their sides at room temperature (22 ± 2C) for 10 to 14 days. At this time, samples were visually evaluated for injury (Fuchigami et al., 1971; Hummel et al., 1982; Smithberg and Weiser, 1968; Stergios and Howell, 1973; van Huystee et al., 1967). Stems showing brown discoloration and breakdown of cells in the cambium and phloem, as viewed through a dissecting microscope, were rated as dead. Similarly, injured leaves were identified by tissue browning and water soaking. Controls and samples not injured by the freezing treatments remained green and showed no discoloration in the cambium, phloem, or leaves. The number of stem segments killed at each temperature exposure level was recorded, and from these data, the lowest survival temperature (LST) was determined. The LST is the lowest temperature at which little or no injury is observed (Sakai et al., 1986). In all but a few cases, there was no variability in LST among replicates.

Little variation existed among replicates because individual taxa, uniform by nature, were used and the cold-hardiness estimates were determined only within a 3C range. Where variability was present, the standard deviation was reported. Differences in cold hardiness among transplant dates were observed, on several sampling dates, throughout the study. During the first year of the study, trees transplanted into the field in Aug., Sept., and Oct. 1989 attained a cold hardiness of -18C by 11 Dec. 1989 (Table 1). Those transplanted into the field in November and December had a cold hardiness of only -11 and -9C, respectively. A similar pattern in cold hardiness estimates was observed on 8 Jan. and 15 Feb. 1990. Those plants transplanted into the field in Aug., Sept., and Oct. 1989 were 6C more cold-hardy on 8 Jan. 1990 than those transplanted in the field later in the season, while the August through November transplants were only 3C more cold-hardy on 15 Feb. 1990 than those transplanted later in the season. All transplants increased in cold hardiness from 3 to 6C between the Dec. 1989 and Jan. 1990 sampling dates, but lost from 0 to 6C of cold hardiness, depending on the transplant date (Table l), between the Jan. and Feb. 1990 sampling date. On 12 Mar. and 10 Apr. 1990, there was little difference in cold hardiness among transplant dates, and cold-hardiness levels progressively decreased from Feb. through Mar. 1990 (Table 1).

During the second year of the study, even though all transplants had a full summer and fall in the field, differences in cold-hardiness levels among the transplanting dates still existed. On 10 Dec. 1990, plants transplanted in Aug., Sept., and Oct. 1989 were 3C more cold-hardy than those transplanted in Nov. and Dec. 1989, which, in turn, were 4 to 6C more cold-hardy than those transplanted in Jan., Feb., and Mar. 1990 (Table 2). On 7 Jan. 1991, the Aug. through Nov. 1989 transplants were 3C more cold-hardy than those transplanted later in the season, except for those transplanted in Mar. 1990, which responded the same as those transplanted earlier in the fall and winter. A similar pattern was also observed on 12 Feb. 1991. On 11 Mar. 1991, all plants, regardless of the date transplanted, had the same cold-hardiness estimates. However, on the final sampling date (9 Apr. 1991) of the second year of the study, plants from the January, February, and March transplant dates were 3C more cold-hardy than those transplanted into the field in the fall and early winter.

In both years of the study, plants transplanted into the field in Aug., Sept., and Oct. 1989 were more cold-hardy on the Dec., Jan., and Feb. 1990 sampling dates than those plants transplanted into the field later in the season. The reason for this is not clear. During the first year of the study, the lower cold-hardiness levels were expected for the later transplants since the plants were kept in a plastic-covered overwintering house before being transplanted into the field. The conditions in the plastic house prevented the plants from developing as much cold hardiness as the plants in the field. Hence, at the time of transplanting, they were less cold-hardy than those transplanted into the field earlier, and it would take time for them to develop cold-hardiness levels comparable to the earlier transplants. However, this phenomenon again occurred in the second year, even though the transplants had been in the field over spring, summer, and fall, emphasizing the importance of the time of year for transplanting from overwintering structures. It appears that transplanting in December through March reduces the cold hardiness of the transplants for at least the year of and the year following transplanting. This is significant in that most Christmas tree growers plant the majority of their plantations during December through March.

On the March and April transplant dates of both years, plants transplanted into the field during December through March either lost less or retained more cold hardiness than those plants transplanted earlier in the year. Those plants transplanted in December through March were slower to attain their maximum cold-hardiness levels but retained higher levels in April as compared to plants transplanted into the field at an earlier date (Table 2). The reason for this shift in acclimation pattern is not clear, but the date transplanted from the overwintering structure may have influenced the onset of acclimation and the subsequent deacclimation. If later transplanting dates can delay acclimation patterns, this phenomenon could be significant, especially for plants with a higher chilling hour requirement and for those that grow in the southern part of their range. If the onset of rest is delayed, there may not be sufficient cooling hours to break rest in a warmer climate.

Transplanting in August to November appears to be the best time to ensure more cold hardiness earlier in the year. Transplanting in January to March appears to promote greater cold hardiness in the spring months. Nursery managers and gardeners can use this information to better plan their management practices to fit their particular needs.

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