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To direct, fund, promote and communicate horticultural research, which increases the quality and value of ornamental plants, improves the productivity and profitability of the nursery and landscape industry, and protects and enhances the environment.

Improving Early Field Growth of Leyland Cypress Liners by Grading and Potting[1]

L. Eric Hinesley and Frank A. Blazich[2]
Department of Horticultural Science
North Carolina State University, Raleigh, NC 27695-7609

Abstract

Stem cuttings of Leyland cypress [*Callitropsis* × *leylandii* (A. B. Jacks. & Dallim.) D. P. Little; syn. × *Cupressocyparis leylandii* (A. B. Jacks. & Dallim.) Dallim. & A. B. Jacks.] were rooted beginning May 2004. In February 2005, liners were sorted into four grades [1 = firm root ball, top to bottom, 2 = good root ball, but loose in the upper one-third; 3 = no distinct root ball, but with enough roots to survive when potted and grown in irrigated containers; and 4 = roots ≤ 2 cm (0.8 in) in length (discarded)]. Liners from Grades 1 and 2 were transplanted to the field April 2005. Additional liners of Grades 1, 2, and 3 were grown in 3.8-liter (1-gal) containers in a nursery during 2005, and field planted early September 2005. Height and stem diameter were recorded after 1 and 2 years. Containerizing affected stem diameter more than height. Growth during the first 2 years was proportional to initial size, indicating the benefits of grading. After 2 years, the largest plants were Grade 1 liners that went directly to the field April 2005, with no intermediate potting.

Index words: Christmas trees, containerized plants, vegetative propagation, grading, liners, *Callitropsis* × *leylandii*, × *Cupressocyparis leylandii*.

Significance to the Nursery Industry

Grading rooted liners of Leyland cypress to be grown as Christmas trees, based on the quality of the root ball, can improve growth, and bring the trees to marketable size in less time. Well developed root systems also reduce leaning that is often associated with wind, snow, flooding, or ice. Containerizing is unnecessary for well rooted, robust liners, and would increase costs. Liners with sparse root systems can benefit from 1 year in containers prior to field planting.

Introduction

Leyland cypress [*Callitropsis* × *leylandi* (syn. × *Cupressocyparis leylandii*)], a sterile hybrid between Monterey cypress [*Callitropsis macrocarpa* (Hartw.) D. P. Little (syn. *Cupressus macrocarpa* Hartw. ex Gord.)] and Alaska cedar [*Callitropsis nootkatensis* D. Don in Lambert; syn. *Chamaecyparis nootkatensis* (D. Don) Spach], is a popular landscape plant in the southeastern United States. Leyland cypress was first promoted as a Christmas tree in the South in the 1970s (7, 8), and steadily has increased in popularity. Within the last decade, it has largely replaced eastern redcedar (*Juniperus virginiana* L.) and Virginia pine (*Pinus virginiana* Mill.) in the choose-n-cut Christmas tree business in central and eastern North Carolina.

Stem cuttings of Leyland cypress often produce one or two large roots growing in one direction away from the base of the stem. An ideal root system has multiple roots configured in radial symmetry around the base of the cutting. When plants with poorly developed, imbalanced root systems are transplanted too quickly into Christmas tree plantations, it increases the potential for uprooting or leaning when they are subjected to wind, ice, or snow. Then, costly remedial measures, e.g., staking, are required to bring trees back to vertical.

Systems for grading bare-root tree seedlings — based largely on height and stem diameter — have existed in the forestry industry since the 1950s (12), and the benefits are well documented (1, 3, 5, 6, 11, 12). In addition, there are detailed guidelines for containerized plants within the nursery industry (1, 10), but in general, they apply to plants in containers ≥ 3.8 liters (1 gal) in volume. Bigger seedlings usually perform better than small seedlings in the field (1, 3, 5, 6, 11, 12), but not always (2, 13). There is an upper limit for optimum results which varies with factors including species, planting method, soil type, climate, post-planting irrigation, and weed control.

We are unaware of any grading system for rooted liners of Leyland cypress. Recently, Christmas tree growers have questioned whether rooted liners should be planted in containers the first year following propagation versus planting directly in the field. Therefore, the objective of this research was to compare 2-year growth of Leyland cypress from two production systems involving grading and containers.

Materials and Methods

The source of stem cuttings was a hedged stock block of Leyland cypress at Claridge Nursery (North Carolina Forest Service), Goldsboro, NC. Stock plants had been hedged at a height of about 1.2 to 1.5 m (4 to 5 ft) during late summer or early fall for the past 8 years. The usual procedure was to flatten the top, with no cutting on the sides. This procedure yielded many orthotropic (vertical) shoots in the tops, as well as numerous upturned lateral branches.

Stem cuttings of Leyland cypress were collected late May 2004, and rooted in containers outdoors under shade (4). Containers were Anderson bands [6 × 6 × 12 cm (2.4 × 2.4 × 5 in)] held in deep propagation flats [41 × 41 × 13 cm (16 × 16 × 5 in)], with 36 cells per flat (Anderson Tool & Die, Portland, OR). Shade (50%) was removed October 1, 2004, and the unheated greenhouse frame was covered with white plastic the first week of December.

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[2]Professors.

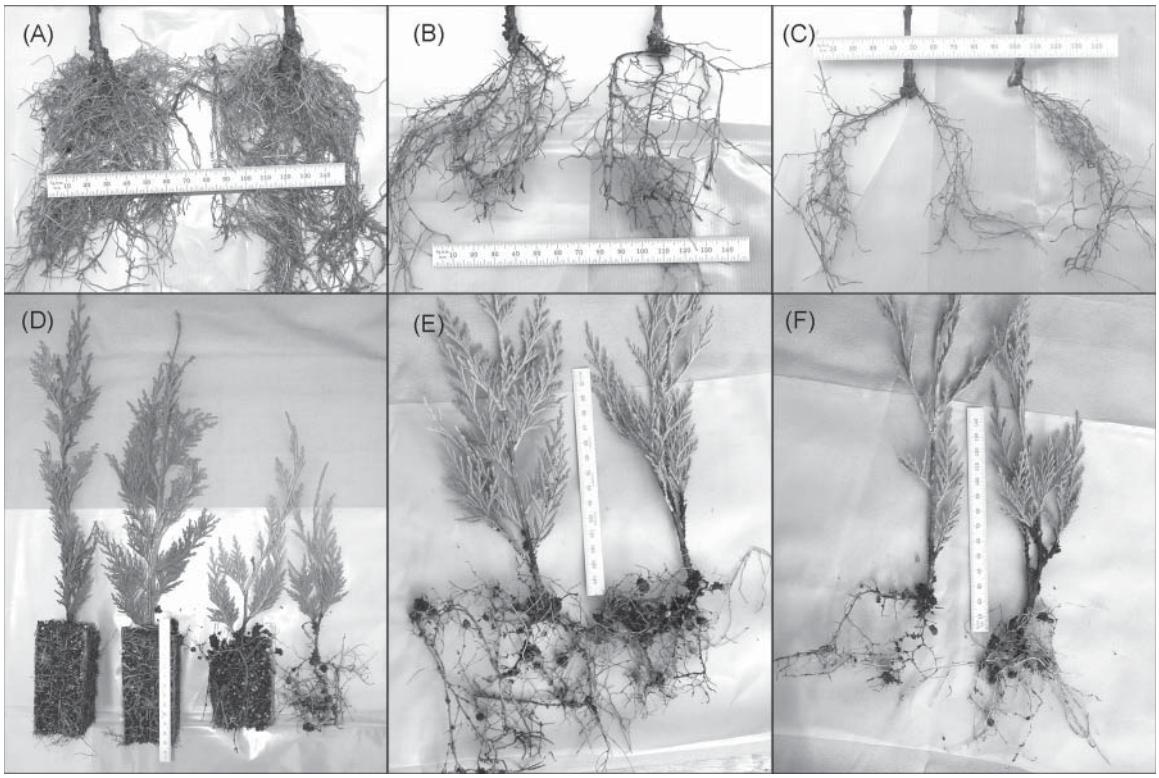

Fig. 1. (A) Grade 1 liners with washed roots, (B) Grade 2 liners with washed roots, (C) Grade 3 liners with washed roots, (D) Two Grade 1 liners (left) and two Grade 2 liners (right) with root balls, (E) Grade 2 liners with rooting substrate removed, and (F) Grade 3 liners with rooting substrate removed. Grade 1 liners had a firm root ball, top to bottom, with many roots visible on all surfaces. The root ball of Grade 2 liners maintained the shape of the container, but was loose in the top portion where there were fewer roots. Grade 3 liners had several good roots, but not enough to maintain the shape of the root ball when removed from the container. Rule = 15 cm (6 in). Containers were Anderson bands [6 × 6 × 12 cm (2.4 × 2.4 × 5 in)] held in deep propagation flats [41 × 41 × 13 cm (16 × 16 × 5 in)], with 36 cells per flat.

Grading of plants. Plants were graded February 2005. A well developed root system always was accompanied by a vigorous, healthy shoot, whereas the converse was not always true. Well rooted cuttings always produced significant new shoot growth, in most cases with an orthotropic primary axis or stem. On the other hand, a few cuttings, even after 8 months of propagation, still appeared green and healthy even though they had essentially no roots. Consequently, liners were graded based on quality of the root ball (4), not just the appearance of the shoot. Grade 1 liners exhibited heavy rooting, a firm root ball, many roots visible on the sides and at the bottom of the root ball, extensive air pruning at the bottom of the cells, and vigorous, orthotropic shoot growth (Fig. 1A and D). These plants, when removed from the container, maintained the rectangular shape of the container from top to bottom, with no sloughing of substrate from the sides (Fig. 1D). Grade 2 liners were well rooted, with an intact root ball, and some roots visible on the sides, but root density was noticeably less in the top third of the container compared to the bottom (Fig. 1B, D, and E). Grade 3 liners had only a few roots, but were regarded as usable when potted and grown in irrigated nursery containers (Fig. 1C and F). Grade 4 liners had roots ≤ 2 cm (0.8 in) in length, and were discarded. In February 2005, fifteen representative liners of each grade were measured for height (Table 1) and stem diameter. Stem cross-sectional area was calculated as the area of a circle with diameter equal to the average of two measurements (opposite directions) at the soil surface (Table 1).

Containerized plants. This phase of the experiment was located at the Horticultural Field Laboratory, Raleigh, NC. On April 18, 2005, twenty representative liners from Grades 1, 2, and 3 were potted in 3.8-liter (1-gal) containers using aged pine bark amended with 1.8 kg/m^3 (4 lb/yd^3) of 15N–4P–10K (15N–9P_2O_5–12K_2O) Osmocote 12–14 month southern blend controlled release fertilizer (CRF) with micronutrients (Scotts-Sierra Hort. Products Co., Marysville, OH), and 2.7 kg/m^3 (6.0 lb/yd^3) of powdered dolomitic lime. Containers were placed under 50% shade, and initially watered 8 min twice daily. Nozzles were Nelson (L.R. Nelson Corp., Peoria, IL) 7170 multi-arc [2.1-m (7-ft) radius, 5.1 liters (1.35 gal) per min at 0.20 MPa (30 psi), 5.0 cm (2.0 in) per hr] spaced 1.35 m (7 ft) apart. On June 20, 2005, containers were placed on an unshaded gravel nursery pad, and watered 30 min twice daily with Nelson 30 overhead sprinklers [10.7 m (35 ft) on center, 0.27 to 0.34 MPa (40 to 50 psi)]. The experimental design for containerized plants on the gravel nursery pad was a randomized complete block with 20 blocks and three treatments, totaling 60 plants. Containers were side by side, grouped by block. Weeding was by hand.

Field site. The planting site was a Christmas tree farm about 15 km (10 miles) south of Raleigh, NC, on an Appling sandy loam, 2 to 6% slope, eroded (9). It was situated at the end of rows in a level field previously site prepared and planted with Leyland cypress in 2004. Planting spaces were flagged for a randomized complete block design with

Table 1. Early field growth of Leyland cypress liners in response to grading and potting.[z]

Treatment or contrast	Description[y]	df	Height (cm)			Stem area (cm^2)[x]		
			Feb. 2005	Sept. 2005	Sept. 2006	Feb. 2005	Sept. 2005	Sept. 2006
1	Grade 1: field planted April 2005	—	40[w]	69.5	175	0.17	0.53	8.54
2	Grade 2: field planted April 2005	—	30	50.2	136	0.10	0.30	4.56
3	Grade 1: containerized April 2005; field planted Sept. 2005	—	40	73.2	160	0.17	1.00	5.70
4	Grade 2: containerized April 2005; field planted Sept. 2005	—	30	59.6	146	0.10	0.61	4.60
5	Grade 3: containerized April 2005; field planted Sept. 2005	—	22	48.6	123	0.08	0.33	3.33
Tmt. 1 vs. Tmt. 3		1	—	NS	*	—	**	**
Tmt. 2 vs. Tmt. 4		1	—	**	NS	—	**	NS
Tmt. 3 vs. Tmt. 4		1	—	**	*	—	**	NS
Tmt. 4 vs. Tmt. 5		1	—	**	**	—	**	*

[z]Cuttings were collected late May 2004, and rooted according to procedures in Hinesley et al. (2).

[y]Grades = 1 (best), 2 (good), 3 (marginal), 4 (cull).

[x]Cross-sectional area of the stem 2 cm (0.8 in) above groundline.

[w]Each mean is based on 15 plants.

NS, *, ** Nonsignificant or significant at $P \leq 0.05$ or 0.01, respectively.

five treatments and 15 blocks, using single-tree plots. Within each block, planting spaces were randomly assigned to the five treatments. Owing to limited area, spacing was 1.5 m (5 ft) between rows and 0.9 m (3 ft) within rows. On April 21, 2005, fifteen Grade 1 liners (Tmt. 1) and 15 Grade 2 liners (Tmt. 2) were hand planted in the field, and watered. Fifteen containerized plants from each grade (Grades 1, 2, and 3) (Tmts. 3, 4, and 5, respectively; Table 1) were planted September 26, 2005. These plants were watered after planting and once weekly until October 8 when the first significant rain occurred. All plants in the field received standard cultural practices in 2006, and received only natural rainfall.

Data and statistical analyses. Analysis was carried out with GLM procedures in SAS (SAS Inst., Inc., Cary, NC). All plants in containers as well as in the field were measured for height and stem diameter September 2005 and 2006. Diameter was measured 2 cm (0.8 in) above ground line (two directions) using calipers. Stem area was calculated as the area of a circle with diameter equal to the average stem diameter. One-degree-of-freedom contrasts were included to test certain *a priori* treatment comparisons, e.g., field-planted Grade 1 (Tmt. 1) versus containerized Grade 1 (Tmt. 3).

Results and Discussion

After 1 year (September 2005), differences in height and stem diameter of containerized plants were significant ($P \leq 0.01$) for all three grades (Table 1). Containerized Grade 1 plants (Tmt. 3) had an average height and stem area of 73 cm (29 in) and 1.00 cm^2 (0.16 in^2), respectively, compared to 49 cm (19 in) and 0.33 cm^2 (0.05 in^2) for containerized Grade 3 (Tmt. 5). Containerized Grade 2 liners (Tmt. 4) were 19% taller and had ≈100% greater stem area than Grade 2 liners planted April 2005 (Tmt. 2) (Table 1). Grade 1 liners field planted April 2005 (Tmt. 1) and containerized Grade 1 liners field planted September 2005 (Tmt. 3) were similar in height, whereas the containerized plants had almost 100% more stem cross-sectional area.

Differences in plant grades were still evident after 2 years (September 2006) (Table 1). Trees from containerized Grade 1 liners (Tmt. 3) were 14 cm (6 in) taller ($P \leq 0.05$) than those from containerized Grade 2 (Tmt. 4) and 37 cm (1.2 ft) taller ($P \leq 0.01$) than those from containerized Grade 3 (Tmt. 5). Similarly, they had 24 and 71% more stem area, respectively. Grade 1 plants field planted April 2005 (Tmt. 1) were 15 cm (6 in) taller ($P \leq 0.05$) than containerized Grade 1 plants (Tmt. 3), and had 50% greater stem area ($P \leq 0.01$) (Table 1). Field-planted Grade 2 liners (Tmt. 2) and containerized Grade 2 liners (Tmt. 4) were similar in height and stem area. Grade 3 liners were not field planted Spring 2005 because we thought their survival and growth would be unsatisfactory.

Grade 1 liners field planted April 2005 (Tmt. 1) outgrew containerized Grade 1 liners field planted September 2005 (Tmt. 3) during the second year (2006) in the field (Table 1). Containerized Grade 1 liners (Tmt. 3) appeared to be somewhat root bound when they were field planted September 2005, possibly contributing to this difference. Although containers ≥ 3.8 liters (1 gal) would have yielded more growth and less root crowding, they probably cannot be justified in standard culture of Christmas trees owing to the expense. This limitation would not apply in the production of shorter-rotation, higher value products such as tabletop Christmas trees [containerized trees up to to 1.3 m (4 ft) in height].

Confounding made definitive comparisons among treatments difficult. Not all treatments were imposed in the same location or environment. During the first year (2005), containerized plants were in a nursery and experienced better conditions with respect to fertility, irrigation, and competition. One can reasonably assume nursery-grown plants should grow better than nonirrigated field-grown plants that likely experience more drought stress and weed competition. Christmas tree growers in North Carolina do not use irrigation in the field, so the field-grown trees were cultivated without irrigation. Even though these cultivation practices would favor containerized plants, the field planted Grade 1 liners (Tmt. 1) still outgrew the containerized Grade 1 liners (Tmt. 3) the second year (2006).

Height and stem diameter indicate vigor; the greater the vigor, the faster a Christmas tree reaches market height, and the more rapidly and efficiently the branches and foliage fill the crown volume. For containerized liners (Tmts. 3, 4, and 5)

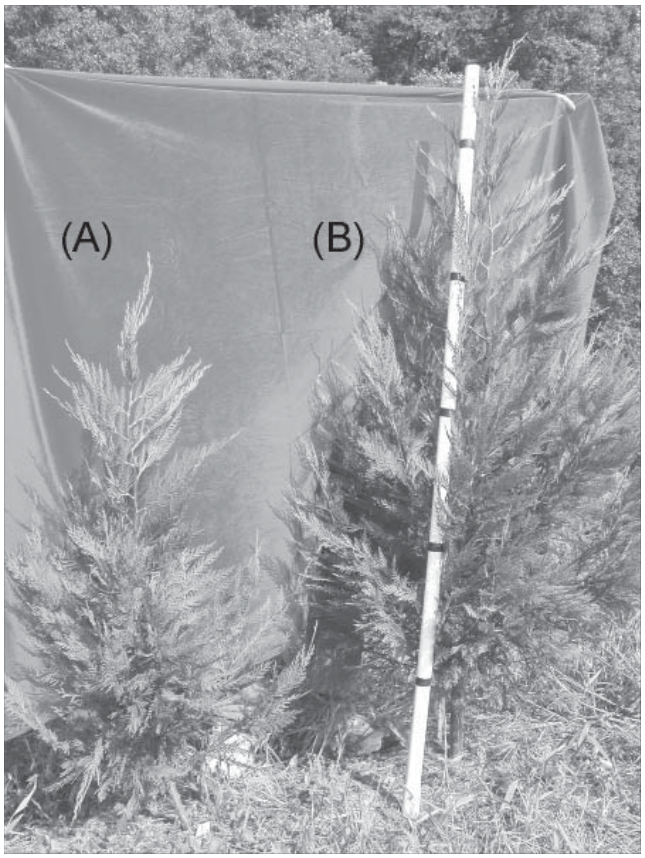

Fig. 2. (A) Grade 3 liner (Tmt. 5, containerized April 2005 and field planted Fall 2005), and (B) Grade 1 liner (Tmt. 1, field planted April 2005) after two growing seasons (September 2006). Scale divisions = 30 cm (1 ft).

the largest and most heavily rooted liners (Grade 1) in April 2005 were still the largest plants after two growing seasons (Table 1), underscoring the advantage of grading. After 2 years (September 2006), planted Grade 1 liners (Tmt. 1) were 43% taller and 156% larger in stem area than containerized Grade 3 liners (Tmt. 5) (Table 1, Fig. 2). Less clear, however, is the potential merit of growing liners in containers for 1 year before field establishment. When rooted liners initially have underdeveloped root systems (Grade 3), this practice could be beneficial. Rooted liners in Grades 1 and 2 can go directly to the field. In addition, growing Grade 1 liners for 1 year in 3.8-liter (1-gal) pots is not recommended because it results in some loss of potential growth. Some growers in North Carolina have adopted a hybrid system where all rooted liners are grown in irrigated and mulched transplant beds for 1 year before going to the field. Root crowding in beds is not a big concern as it would be in 3.8-liter (1-gal) pots containing soilless substrate, and irrigation also is less critical.

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