Rooting Softwood Cuttings of Leyland Cypress Outdoors Under Shade[1]

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Abstract

Stem cuttings of Leyland cypress [x *Cupressocyparis leylandii* (A.B. Jacks. & Dallim.) Dallim. & A.B. Jacks], were rooted to determine the effect of A) date of collection, rooting substrate, and mist frequency, B) auxin formulation and concentration, C) rooting substrate, D) substrate fertility, and E) type of cutting and auxin concentration. Results were best for misting intervals of 5 to 7 min during the day, but 10 min was also adequate. Rooting was comparable for softwood cuttings collected in late May or late June. Powder and liquid auxin formulations, which both contained indolebutyric acid (IBA), yielded similar results. Cuttings that were more lignified (light tan color) at the bases benefited the most from higher concentrations [≈ 8000 ppm (0.8%)] of IBA in talc, whereas less mature cuttings (green at the bases) rooted in highest percentages with lower concentrations [≈ 3000 ppm (0.3%)]. Rooting was similar in substrates with a peat:perlite ratio (v/v) of 1:1, 1:2, or 1:4, whereas results were less satisfactory in 100% perlite. Controlled release fertilizer [1.8 kg/m^3 (4 lb/yd^3)] in the rooting substrate did not affect rooting percent, but greatly increased root mass and quality of rooted cuttings. Doubling the rate resulted in little additional improvement. Rooting was comparable for vigorous side shoots (1st-order laterals) and tips from vigorous upright branches (primary axes) of similar maturity.

Index words: Christmas trees, vegetative propagation, substrate, controlled-release fertilizer, indolebutyric acid, auxin, adventitious rooting.

Significance to the Nursery Industry

Christmas tree growers in North Carolina and elsewhere often cannot obtain high quality planting stock of Leyland cypress. Results from a series of studies have led to a protocol described herein that easily produces good quality liners in an outdoor shade structure with intermittent mist. Using softwood cuttings in May and June yields good results, and is easier and less costly than using hardwood cuttings.

Introduction

Leyland cypress [x *Cupressocyparis leylandii* (A.B. Jacks. & Dallim.) Dallim. & A.B. Jacks], a sterile hybrid between Monterey cypress (*Cupressus macrocarpa* Hartw. ex Gord.) and Alaska cedar [*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 (2, 9), and since that time has increased in popularity. Within the last decade in the Piedmont and Coastal Plain of North Carolina, it has largely replaced eastern redcedar (*Juniperus virginiana* L.) and Virginia pine (*Pinus virginiana* Mill.) in the choose-and-cut Christmas tree business.

Leyland cypress is propagated vegetatively by stem cuttings. In North Carolina, the supply of good quality planting stock has not always been adequate for Christmas tree growers. Stem cuttings of narrow-leaved evergreens are generally regarded as having the highest rooting potential when hardwood cuttings are taken between late fall and late winter (5). Good rooting of Leyland cypress has been reported for both semi-hardwood and hardwood cuttings (1, 3, 4, 5, 7). We have experienced mixed results with these types of cuttings; in some years they root well, in others years, they root poorly. Thus, a series of experiments was conducted to develop a protocol for rooting softwood cuttings of Leyland cypress in an outdoor shade structure under intermittent mist. Objectives were to determine the effect of A) date of collection, rooting substrate, and mist frequency, B) auxin formulation and concentration, C) rooting substrate, D) substrate fertility, and E) type of cutting and auxin concentration.

Materials and Methods

The source of stem cuttings was a hedged stockblock of Leyland cypress growing at Claridge Nursery (North Carolina Forest Service) in Goldsboro. 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 each year for the past decade. The usual procedure was to flatten the top, with little cutting on the sides. Plants typically responded by producing many orthotropic (vertical) shoots in the tops, as well as numerous upturned lateral branches. These shoots were the source of softwood cuttings collected the following May or June.

As cuttings were collected, they were placed in plastic bags in ice chests, transported back to Raleigh, and set (inserted into the rooting substrate) the same day or the next day. If necessary, they were stored overnight in the ice chests inside a 4C (39F) coldroom. Cuttings were trimmed from the bases to a length of 20 to 25 cm (8 to 10 in), and foliage was stripped from the basal 4 to 5 cm (1.6 to 2.0 in) before setting. Many cuttings were also pruned at the distal end to remove succulent, immature growth, resulting in a straighter propagule.

When using rooting formulations of Hormex 3 [3000 ppm (0.3%) indolebutyric acid (IBA) in talc], or Hormex 8 [8000 ppm (0.8%) IBA in talc] (Brooker Chemical Corp., Chatsworth, CA), the basal 2.5 cm (1 in) of each cutting was first dipped in water; then, dipped into the powder. The base of the cutting was then tapped gently to remove any excess powder and the basal 5 cm (2 in) of the cutting set into the rooting substrate using a dibble. For treatments involving

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solutions of 2500 (0.25%) or 5000 ppm (0.5%) of the free acid of IBA dissolved in 50% isopropyl alcohol, the lower 2.5 cm (1 in) of each cutting was dipped for 2 sec, followed by 10 min of air drying before setting into the rooting substrate.

Cuttings were rooted in plastic Anderson bands (Anderson Tool & Die, Portland, OR) [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 (6 rows × 6 columns). Each flat was divided into three plots with 12 adjoining cells per plot (2 rows × 6 cells/row).

Trays were placed on wooden pallets [1.2 × 1.2 m (4 ft × 4 ft)] resting on gravel, and there was one irrigation riser in the middle of each pallet. Mist nozzles were Roberts spot-spinners (Roberts Irrigation Products, San Marcos, CA) [1.1 liters/min (0.3 gal/min)]. Unless otherwise stated, the mist frequency was 10 sec every 5 min during daylight hours, and once hourly at night. Pallets were isolated with vertical plastic barriers to prevent overspray. Trays were maintained under 50% black polypropylene shade.

During the final evaluation of each experiment, cuttings were rated as alive or dead, and any cutting with at least one primary root longer than 1 mm (0.04 in) was classified as rooted. The number of roots was recorded, and in Experiments 1, 2, and 5, the length of each of the longest three roots was measured. A rooted cutting was subjectively evaluated as 'usable' if, in our opinion, it had enough roots to allow the cutting to survive and grow adequately following transplanting into a pot. After one season in pots, these cuttings would be suitable for planting in the field.

Experiment 1 — Date of collection, rooting substrate, and mist frequency. Cuttings were collected May 27 and June 20, 2002, and set the next day. Rooting substrates were 1:2 peat:perlite (v/v) or 3:2 pine bark:perlite (v/v). There were three auxin treatments: Hormex 3, Hormex 8, or a nontreated control. Mist intervals were 15 sec every 5, 10, 15, or 20 min during daylight hours, and once hourly at night. Because intervals of 15- and 20-min proved inadequate for the first collection, those two intervals were reduced to 7 and 9 min for the second collection.

The experimental design was a split-plot with six blocks. Mist intervals comprised the main-plots. Each main-plot contained four propagation trays (sub-plots) representing one of the four combinations of 2 collection dates × 2 substrates. Each tray was divided into three plots (plot = 2 rows × 6 cells/row) which were randomly assigned to the three auxin treatments. There were 1728 cuttings for each collection date. The first collection ended August 29, 2002; the second ended October 4, 2002.

Experiment 2 — Auxin formulation and concentration. This experiment was conducted concurrently with Experiment 1, using the same procedures and operational setup. There were five treatments: control (nontreated), Hormex 3, Hormex 8, or IBA in 50% isopropyl alcohol at 2500 ppm or 5000 ppm. The IBA treatments were added as additional plots in Experiment 1, collection date 2, water treatment 1 (15 sec every 5 min). Plots used to evaluate Hormex treatments were common to both experiments. The experimental design was a randomized complete block with 60 plots (6 blocks × 5 hormone treatments × 2 substrates) and 720 cuttings. Final evaluation was October 4, 2002.

Experiment 3 — Rooting substrate. Canadian peat and perlite were combined in the following ratios (v/v): 1:1, 1:2, 1:4, or 100% perlite. The substrate contained no fertilizer. Cuttings were collected June 30, 2003. The next day, they were treated with Hormex 3 prior to setting. The experimental design was a randomized complete block with 10 blocks, four substrate treatments, 40 plots, and 480 cuttings. Final evaluation occurred November 11, 2003.

Experiment 4 — Substrate fertility. Cuttings were collected June 30, 2003, and set the next day in a substrate of 1:2 peat:perlite (v/v). In addition to a nonfertilized control, two treatments contained Osmocote 15N–4.0P–10.0K (15N–9P_2O_5–12K_2O), 12–14 month southern formulation, with micronutrients (Scotts-Sierra Horticultural Products Co., Marysville, OH), incorporated at 1.8 or 3.6 kg/m^3 (4 or 8 lb/yd^3). Mist frequency was 15 sec every 5 min during daylight hours, and once hourly at night. The experimental design was a randomized complete block with eight replications, three fertilizer treatments, 24 plots, and 288 cuttings. Final evaluation was November 12, 2003. Roots were removed, bulked by plot, and dried to constant weight at 65C (149F) prior to weighing.

Experiment 5 — Type of cutting and auxin concentration. Cuttings were collected July 1, 2003, and set the next day. The rooting substrate was 1:2 peat:perlite (v/v) with no CRF. Five types of cuttings were evaluated: 1) tips from vigorous upright branches (primary axes) with tan bases, 2) tips from vigorous upright branches (primary axes) shortened so that the bases were green, 3) vigorous side shoots (1st-order laterals) with tan bases, 4) vigorous side shoots (1st-order laterals) shortened so that the bases were green, 5) smaller, less vigorous side shoots (1st-order laterals) shortened so that the bases were green. Each cutting was treated either with Hormex 3 or Hormex 8. In addition, there was a nontreated control treatment for each of the five types of cuttings. In general, cutting type 1 had the largest stem diameter, whereas cutting type 5 was smallest. Treatments were arranged in a 5 × 2 factorial. The experimental design was a randomized complete block with four blocks, 60 plots (4 blocks × 15 treatments), and 720 cuttings. Mist frequency was 15 sec every 5 min during the day, and once hourly at night. Final evaluation occurred November 12, 2003.

Statistical analyses. Each experiment was analyzed according to its experimental design using GLM procedures of SAS (8). Percentage data were subjected to various transformations prior to analysis. Certain *a priori* 1-degree of freedom contrasts were executed, and means were separated with Waller-Duncan ($P \leq 0.05$) or least squares procedures. In Experiment 2, the effect of 'concentration' was tested by assigning qualitative values of 'low' (Hormex 3 and IBA 2500) or 'high' (Hormex 8 and IBA 5000).

Results and Discussion

Experiment 1 — Date of collection, rooting substrate, and mist frequency. The bark/perlite substrate yielded unacceptable results, and would not be recommended, so those data have been omitted. To test the null hypothesis, H_o: May = June, only the data for 5- and 10-min mist intervals — common to both collection dates — were analyzed. Owing to the split plot design, with mist treatments as main-plots, the re-

Table 1. Rooting of stem cuttings of Leyland cypress as affected by date of collection and mist interval (Expt. 1).

Mist interval[z] (min)	Alive[y] (%)	Rooted[y] (%)	Usable[y] (%)	Mean root no.[x]
		May collection		
5	98a[w]	82a	56a	3.8a
10	69b	65a	44b	3.4b
		June collection		
5	99a	77a	46a	2.4a
10	88b	54b	36a	2.3a
Date	NS	NS	NS	**
Interval	*	*	NS	*
Date × Interval	NS	NS	NS	NS

[z]Time (minutes) between 15-sec mist treatments.

[y]Each value is based on 72 cuttings. Means are averaged over auxin treatments, including nontreated controls.

[x]Basis: the number of cuttings which rooted for a particular treatment.

[w]Within a collection date and column, pairs of means were separated by least squares analysis using arcsin transformed data for 'alive' and untransformed data for 'rooted' and 'usable'.

NS,*,** Nonsignificant or significant at $P < 0.05$ or 0.01.

sulting error term for testing mist treatments had only five degrees of freedom, which reduced the power of the tests for main plots.

The yield of rooted and usable cuttings was similar for May and June, but May yielded more roots per cutting (Table 1). In addition, the 5-min mist interval, when compared to 10 min, yielded a higher rooting percentage for both collections, and more roots per cutting for the May collection (Table 1). For the June collection, maximum rooting was 88% for the 7-min interval, and decreased sharply at longer intervals (Fig. 1). The yield of usable cuttings averaged 45 to 50% for mist intervals of 5 to 9 min, and decreased to 36% for 10 min, with no distinct relationship between mist interval and the percent usable cuttings (Fig. 1).

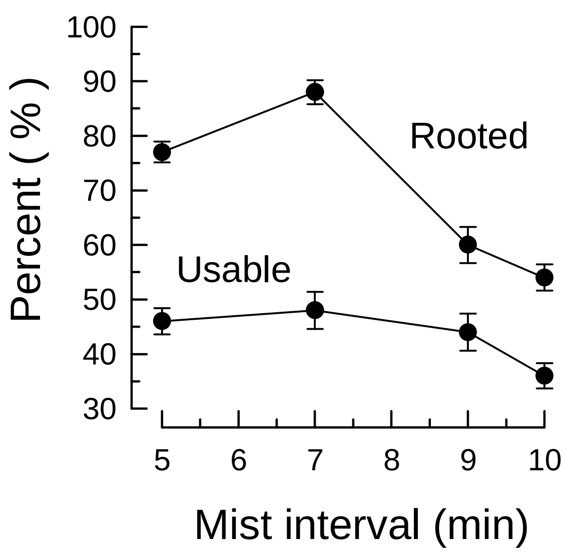

Fig. 1. Yield of rooted and usable stem cuttings of Leyland cypress misted at intervals of 5, 7, 9, or 10 min (Expt. 1). Basis: n = 72 for each mean. Vertical bars = ± 1 SE.

Experiment 2 — Auxin formulation and concentration. Seventy-four percent of the nontreated cuttings (June collection) rooted, but the yield of usable cuttings was only 38% (Table 2). Rooting was similar for both auxin formulations, but the lower concentrations yielded significantly higher percentages of rooted cuttings and usable cuttings, and greater root length (Table 2). The best treatment was Hormex 3 (89% rooting, 62% usable). Rooted cuttings averaged 2.3 to 2.6 roots regardless of treatment (data not presented), and higher concentrations of auxin reduced average root length, especially for Hormex (Table 2).

Experiment 3 — Rooting substrate. Results were similar for the three substrates containing some quantity of peat, where about 85% of those cuttings rooted, 73% were usable, and there was an average of 2.7 roots per rooted cutting (Table 3). In 100% perlite, the averages decreased *($P \le 0.01$)* to 38 and 29%, respectively, with two roots per rooted cutting.

Table 2. Rooting of stem cuttings of Leyland cypress as affected by auxin formulation and concentration (Expt. 2)[z].

Treatment[y]	Alive[y] (%)	Rooted[y] (%)	Usable[y] (%)	Mean root length[x] (mm)
Control (nontreated)	100a[w]	74ab	38a	78b
Hormex 8 (8000 ppm IBA)	100a	61b	25a	59b
Hormex 3 (3000 ppm IBA)	99a	89a	62b	102a
IBA (5000 ppm)	93b	60b	25a	71b
IBA (2500 ppm)	100a	65b	42ab	79b
Auxin = A	NS	*	NS	NS
Concentration = C	NS	*	**	**
A × C	**	NS	NS	*

[z]Cuttings were collected in June, rooted in a substrate of 1:2 peat:perlite (v/v), and misted 15 sec every 5 min.

[y]Basis: n = 144 cuttings for controls; n = 72 for other treatments.

[x]Basis: number of cuttings which rooted for a particular treatment.

[w]Mean separation within columns by Waller-Duncan at $P = 0.05$.

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

Analysis: 'alive' and 'rooted' were transformed with arcsin (square root). 'Usable' was not transformed. Values for concentration were 'low' and 'high'.

Table 3. Rooting of stem cuttings of Leyland cypress as affected by the rooting substrate (Expt. 3).

Substrate (v/v)	Rooted[z] (%)	Usable[z] (%)	Mean root no.[y]
1:1 peat:perlite	80a[x]	72a	2.7a
1:2 peat:perlite	87a	76a	2.8a
1:4 peat:perlite	88a	72a	2.7a
perlite	38b	29b	2.0b
Tmt	**	**	**

[z]Basis: n = 120 cuttings. Cuttings were treated with Hormex 3.

[y]Basis: number of cuttings which rooted for a particular treatment.

[x]Mean separation within columns by Waller-Duncan at $P = 0.05$.

NS,*,** nonsignificant or significant at $P = 0.05$ or 0.01, respectively. Percentage data were transformed with arcsin.

Table 4. **Rooting of stem cuttings of Leyland cypress as affected by substrate fertility (Expt. 4).**

Fertilizer rate (kg/m^3)	Alive[z] (%)	Rooted[z] (%)	Usable[z] (%)	Mean root mass[y] (g)
Control (none)	95a[x]	78ab	69	0.22a
1.8 incorporated	93a	85a	82	0.44b
3.6 incorporated	78b	66b	65	0.40b
Tmt	*	*	NS	**

[z]Basis: n = 96 cuttings. Cuttings were treated with Hormex 3. Percentages were transformed with arcsin.

[y]Based on the number of cuttings which rooted for a particular treatment.

[x]Mean separation within columns by Waller-Duncan at $P = 0.05$.

NS,*,** nonsignificant or significant at $P < 0.05$ or 0.01, respectively.

Experiment 4 — Substrate fertility. Incorporating fertilizer into the substrate had little effect on the yield of rooted or usable cuttings, but almost doubled root mass ($P \leq 0.01$) (0.43 g per rooted cutting vs. 0.22 g in controls) (Table 4). Root mass was similar for both fertilizer rates (0.40 to 0.44 g per rooted cutting), and the quality of fertilized cuttings was much better than controls (Fig. 2).

Experiment 5 — Type of cutting and auxin concentration. Cuttings which received no auxin treatment rooted well, especially the larger cuttings with green bases (79 to 94% usable) (Table 5). Small cuttings with green bases were the least productive (48% usable). Cuttings with green bases (immature) rooted best and were most responsive to Hormex 3, whereas those with tan bases (more lignified) rooted best when treated with Hormex 8. Rooting of vigorous shoots (primary axes) and side-shoots (1st-order laterals) were similar. As in control treatments, the least rooting occurred for small side shoots with green bases. The highest yield of usable cuttings was 85 to 88% for vigorous shoots (primary axes)

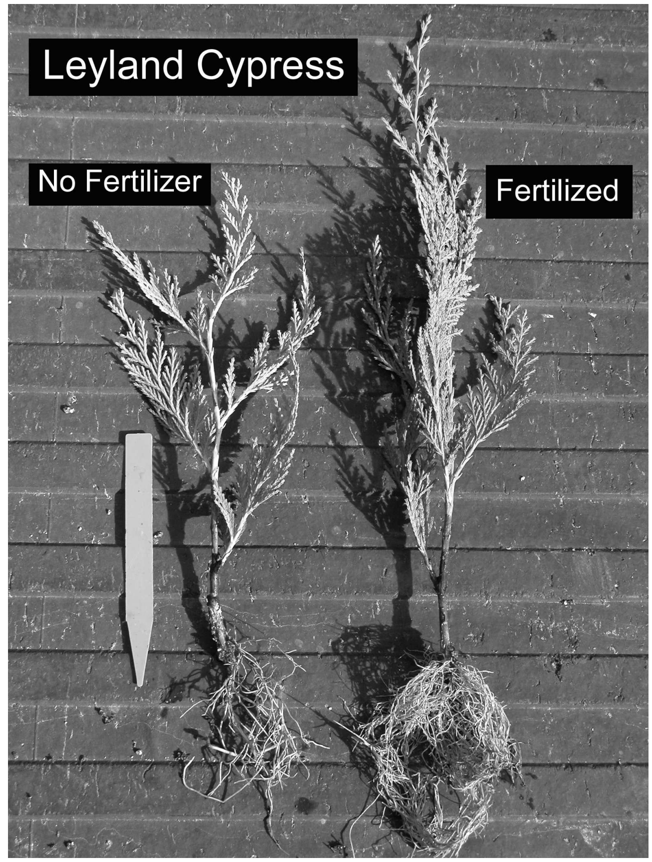

Fig. 2. **Comparison of liners of Leyland cypress rooted with or without fertilizer in the rooting substrate (Expt. 4). The plant on the right was rooted in a substrate incorporated with 1.8 kg/m^3 (4 lb/yd^3) of Osmocote 15N–4.0P–10.0K (15N–9P$_2$O$_5$–12K$_2$O), 12–14 month southern formulation, with micronutrients. The plant on the left was typical of cuttings rooted without fertilizer in the substrate. Pot label = 15 cm.**

Table 5. **Rooting of stem cuttings of Leyland cypress as affected by cutting type and auxin treatment (Expt 5).**

Cutting type	IBA in talc (ppm)[z] 0	3000	8000	Mean root no.[y]
	(%)			
Large tip, tan base	57c[x]	69c	83	2.6b
Large tip, green base	94a	100a	71	2.7ab
Large lateral, tan base	75b	71bc	81	2.6ab
Large lateral, green base	79ab	88b	88	2.8a
Small lateral, green base	48c	67c	75	2.3c
Type	**	**	NS	**
green vs. tan base	**	**	NS	*
large tip vs. large lateral	NS	NS	NS	NS
large lat. vs. small lat.	**	*	NS	**
Auxin concn.	—	—	—	NS
Type × auxin concn.	—	—	—	NS

[z]Means are for usable cuttings (%). Each mean is based on 48 cuttings. There was a significant interaction for cutting type × IBA concentration. Cuttings were treated with Hormex 3 (3000 ppm IBA) or Hormex 8 (8000 ppm IBA).

[y]Based on the number of cuttings that rooted for a particular treatment.

[x]Mean separation within columns by Waller-Duncan at $P = 0.05$.

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

Analysis: controls (nontransformed), 3000 ppm [arcsin (square root)], and 8000 ppm (square root).

and side shoots (1st-order laterals) with green bases (Table 5).

The ability to successfully regenerate Leyland cypress by rooting softwood cuttings collected in May and June (Expt. 1) greatly simplifies propagation and appears to eliminate inconsistent results which the authors have experienced when rooting semi-hardwood or hardwood cuttings. Propagating during late fall to late winter requires a heated greenhouse, which is energy intensive and costly. In contrast, propagating in May and June requires only shade and intermittent mist, which is cheaper and easier.

In Expt. 1, a mist interval of 5 min yielded better results than 10 min (Table 1). For the June collection, results were similar for 5- and 7-min intervals (Fig. 1), but we suggest the 5-min interval during the rooting period (late May through August) if daytime ambient temperatures (no shade) occasionally reach 35 to 38C (95 to 100F), as in Raleigh. At lower ambient temperatures, mist intervals and/or duration can be adjusted accordingly. Similarly, watering can be reduced after cuttings root.

The two auxin formulations provided similar results (Expt. 2, Table 2), but the lower concentrations yielded the highest percentages of rooted cuttings and usable cuttings as well as longer roots. In addition, there was an interaction between auxin concentration and stage of growth (Expt. 5, Table 5). Less mature cuttings (green bases) responded best to the lower concentrations (3000 ppm), whereas more mature cuttings (tan bases) rooted best at the higher concentration (8000 ppm) (Table 5). A traditional rule of thumb is to sever stem cuttings of Leyland cypress 'with brown wood at the base (4).' While those cuttings yielded good results, the highest rooting percentages and the highest yield of usable cuttings was realized when the bases were green (Table 3). In addition, cuttings with tan bases also required higher auxin concentrations for optimum rooting.

Substrates consisting of 50 to 80% perlite (v/v) yielded good results (Expt. 3, Table 3), whereas 100% perlite, which appeared wetter and firmer, was significantly worse. In Expt. 1, the 2:3 bark:perlite (v/v) substrate yielded unacceptable results (data not presented), possibly because the bark was not fully composted. As a safeguard, we suggest using only peat/perlite.

Stem cuttings of Leyland cypress often produce asymmetrical root systems in which one or two large roots grow in one direction away from the base of the stem. An ideal root system has roots equally distributed around the base of the cutting (radial symmetry). Although many cuttings of Leyland cypress with feeble root systems are adequate for potting, if they are too quickly transplanted into the landscape or into Christmas tree plantations, the root systems are often inadequate for firm anchorage. Consequently, plants are more likely to lean or become uprooted when subjected to wind, ice, or snow. Using fertilizers during propagation might reduce this problem by yielding a higher percentage of heavily rooted liners. Incorporating a CRF (Expt. 4, Table 4) greatly increased root mass and quality of woody stem cuttings (Fig. 1), as reported previously (6, 10). Differences in root mass were due mostly to greater lateral root development in the presence of fertilizer, and lack of effect on root length was likely the result of air pruning at the bottom of the containers. Rigorous grading, based on root ball quality, might also reduce the tendency to fall over after transplanting.

In summary, high quality liners of Leyland cypress can be produced outdoors under 50% shade and intermittent mist, as follows: A) collect vigorous, healthy cuttings in late May or June, B) use a rooting substrate of 1:1, 1:2, or 1:4 peat:perlite (v/v) amended with 2 kg/m^3 (4 or 5 lb/yd^3) of long-term CRF, C) size cuttings to a length of 15 to 25 cm (6 to 10 in), and if necessary, remove soft, succulent growth at the distal ends to provide straight cuttings; D) just before treatment with auxin, trim each cutting so that the base is green (preferable) or light tan, E) strip foliage from the lower 5 cm of the stem just above the basal cut, F) dip the base in water, shake off the excess, and treat the base with about 3000 ppm IBA in talc, G) set cuttings into the rooting substrate using a dibble, and H) mist 10 sec every 5 min during daylight hours and once hourly at night, using nozzles similar in output to small (color code 'green') Roberts spot-spinners. The rooting period can vary in length, depending on objectives, but 5 to 6 months is adequate to produce a high percentage of rooted cuttings with good root systems and vigorous shoot growth. When this protocol was applied to 6000 stem cuttings of Leyland cypress in year 2004, about 91% were moderately to heavily rooted after 6 months, with firm root balls, and many roots visible on the sides and bottoms of the root balls (personal observation). These cuttings could be field planted or potted in the fall, or maintained overwinter until the following spring. In addition, retaining only cuttings with robust root ball quality can ensure a high standard for all liners that are taken directly to the field or kept for potting.

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