# Root and Shoot Growth of 'Coral Beauty' Cotoneaster and Leyland Cypress Produced in Porous and Nonporous Containers[1]

**Diane W. Privett and Rita L. Hummel[2]**
*Department of Horticulture and Landscape Architecture*
*Washington State University-Puyallup Research and Extension Center*
*Puyallup, WA 98371*

## Abstract

'Coral Beauty' cotoneaster and Leyland cypress rooted cuttings were grown in media of all fir bark or fir bark:peat moss (1:1 by vol) and plastic containers with varying wall designs (nonporous smooth-walls, nonporous ridge-walls, or porous walls). Results indicated no effect of the growing media on shoot or root growth of either species. Shoot growth of Leyland cypress was not affected by container design. 'Coral Beauty' cotoneaster shoot growth was greater in the porous container than in the nonporous smooth-walled container. Root circling of both species was greatest in the nonporous smooth-walled containers. Ridges in the nonporous ridge-wall containers generally directed roots to grow downward where some circling at the bottom of the root ball occurred. When roots in the porous walled containers reached the periphery of the root ball they stopped growing, resulting in a fine, fibrous root mass at the periphery of the rootball.

**Index words:** growing media, *Cotoneaster dammeri* 'Coral Beauty', X *Cupresso-cyparis leylandii*, root pruning, air pruning, nursery production



## Significance to the Nursery Industry

Container-grown nursery stock frequently develops kinked and circling root systems that can impair long-term plant growth. Correcting root defects at transplanting requires considerable time and effort thus adding to the cost of installing and maintaining plant material. In this experiment 3 types of plastic containers (nonporous smooth-walls, nonporous ridge-walls, or porous walls) were evaluated for their effect on shoot and root growth of 'Coral Beauty' cotoneaster and Leyland cypress. At the end of one growing season marketable plants were produced in all treatments. Shoot growth of 'Coral Beauty' cotoneaster was greater in the porous container than in the nonporous smooth-walled container while Leyland cypress shoot growth was not affected by container design. In the nonporous, smooth-walled containers, 'Coral Beauty' cotoneaster and Leyland cypress developed many circling roots. Ridges in the nonporous ridge-wall containers generally directed roots to grow downward where some circling at the bottom of the root ball occurred. At transplanting, removing the bottom-circling roots from the ridge-wall containers should be fairly simple and much less time-consuming than correcting the roots circling at all levels of the container in the nonporous smooth-walled containers. In the porous walled containers, when roots reached the outside edge of the growing medium, they stopped growing, resulting in a fine, fibrous root mass at the periphery of the rootball. In this experiment, increased aeration from the porous-plastic container walls seems to have had a pruning effect on root growth resulting in a fine, fibrous rootball that should transplant readily.

## Introduction

Container production of woody landscape plants is continuing to expand and has become a preferred production system for many nurseries. Containers have been developed that are attractive and durable, easy to handle, store and transport and are adaptable to automated systems. Far less attention has been devoted to how container design may affect plant growth and subsequent establishment into the landscape. Results are mixed with respect to the design of the container and its ultimate effects on shoot growth. Some researchers found little or no effect (2, 7, 15, 16, 20), while others saw much improved top growth in container designs which stimulated more fibrous root systems (3, 10, 22, 25). Root growth, on the other hand, is profoundly influenced by container design. Plants, particularly those with taproot systems, grown in standard round containers develop circling root systems that can impair plant growth. These root systems branch poorly and are therefore hard to establish in landscapes. Circling root systems commonly lead to girdling roots that cause the slow decline and death of plants, either directly or indirectly from problems associated with poor vigor (8, 9).

The recommended procedures for disrupting a circling root system at planting are to direct roots outward, and cut encircling roots to stimulate root branching (8, 9, 12, 21). These methods in practice are extremely laborious and time consuming. Therefore, efforts are being made to design a container that prevents root circling and stimulates fibrous root development. This type of root system can establish rapidly as the numerous root ends grow out into the surrounding soil/medium (3, 4, 22).

One strategy to prevent root circling has been to trap root tips when they reach the container walls. These container designs include ribs or "stair-steps" attached to the inner walls, and polyethylene bags (1, 3, 7, 15, 16, 20, 23, 24). The effectiveness of each of these designs often depended on how strongly the roots grew or whether the roots found a "bypass route". Milbocker (13, 14) also found that trees grown in low profile containers produced fibrous root systems that did not circle. Another effective strategy for the control of root circling and stimulation of root branching is

[1]Received for publication December 30, 1991; and in revised form April 15, 1992. Horticulture/Landscape Architecture paper No. 91-34.
[2]Research Technologist and Associate Professor.

to kill the root tips with toxic coatings on the container walls, mesh cloth liners, or exposure to air (2, 3, 4, 5, 7, 10, 18, 19, 22).

The purpose of this experiment was to examine a novel container design with porous plastic walls to air prune roots over the entire rootball and compare it with two commercially available containers, a nonporous ridge-walled and a nonporous smooth-walled design.

## Materials and Methods

In April 1989, uniform rooted cuttings of 'Coral Beauty' cotoneaster (*Cotoneaster dammeri* Schneid. 'Coral Beauty') and Leyland cypress [*X Cupresso-cyparis leylandii* (Jacks. & Dallim.) Dallim.] were potted into square plastic containers, one cutting per container. Three types of nursery containers were used—nonporous smooth-walled plastic, nonporous ridge-walled plastic, and porous plastic containers (Fig. 1).

The nonporous smooth container had a top side width of 13.3 cm (5.24 in), a bottom-side width of 10.6 cm (4.17 in) and a height of 15.1 cm (5.94 in). There was one 1.9 cm (0.75 in) square hole on each side that drained both the side and bottom of the container. The container volume was 2.25 l (0.59 gal).

The nonporous ridged container had a top-side width of 14.0 cm (5.51 in), a bottom side width of 10.2 cm (4.0 in) and a height of 16.2 cm (6.38 in). Each container side had five vertical ridges spaced 2.2 cm (0.87 in) apart. These ridges were triangular in cross section and projected 0.5 cm (0.20 in) into the interior of the container. Each side had two 1.3 cm (0.51 in) square holes to drain the sides. There was also one 1.9 cm (0.75 in) diameter round hole in the center of the bottom for drainage. The container volume was 2.50 l (0.66 gal).

The porous-walled container was manufactured from recycled plastic. The container was punctuated with many randomly placed pin-hole perforations (Fig. 2). It had a top-side width of 13.3 cm (5.24 in), a bottom width of 9.5 cm (3.74 in) and a height of 15.6 cm (6.14 in). In the middle of each side were eight very small vertical corrugations spaced 0.8 cm (0.31 in) apart. These corrugations were half circles in cross section and projected 0.1 cm (0.04 in) into the interior of the container. In the center of the bottom was one 1.0 cm (0.39 in) diameter round drainage hole. There was also considerable drainage through the porous plastic material making up this container. The container volume was 2.10 l (0.55 gal).

**Fig. 1. The three types of containers used in this experiment are from left to right: nonporous smooth-walled, nonporous ridge-walled, and porous plastic. Root development of a representative 'Coral Beauty' cotoneaster from each container is shown at the top of the photo.**

**Fig. 2. Porous-walled container manufactured from recycled plastic. A 60 watt light bulb was placed inside this container and the light shining through the container walls illustrates how the plastic walls are perforated throughout with tiny holes.**

Half of the plants were potted in a fir bark medium while the other half were planted in a fir bark:peat moss medium (1:1 by vol). Both growing media were amended with 4.7 kg/cu m (8 lb/cu yd) dolomite and 1.0 kg/cu m (1.75 lb/cu yd) Micromax. Slow release fertilizer, Woodace 18N-3.5P-7.5K (18-8-9), was applied by topdressing at the rate of 1.8 kg N/cu m (3 lb N/cu yd). Plants were grown on a gravel nursery bed and watered by overhead irrigation as needed. The experiment was conducted as a 2 × 3 factorial with the containers arranged in randomized complete blocks with eight replications.

In late October 1989, shoot and root growth were evaluated. Height and width of the tops were measured and then combined into a growth index (height plus width divided by two). Each plant was removed from its container and grouped by species according to root development at the periphery of the growing media. The groups were then assigned numbers from 1 (indicating no roots visible) to 4 (indicating most roots circling) and the percentage of plants in each rating category was recorded (11). Analysis of variance (ANOVA) was conducted on shoot and root growth data and means were compared using a protected Tukey's studentized range test or HSD (17).

## Results and Discussion

ANOVA results indicated there were no significant interactions between the different container types and growing media. The two different growing media used did not significantly affect the growth of the 'Coral Beauty' cotoneaster or Leyland cypress (data not shown). This agrees with the fact that both of these plants are noted for easy culture and adaptability (6).

Cotoneaster top growth was greater in the porous container than in the nonporous smooth-walled container, but not different between the porous and nonporous ridge-walled containers (Table 1). Leyland cypress tops grew similarly in all container designs.

The primary effect of the different container designs was seen in root growth (Table 1, Table 2 and Fig. 1). All container types produced dense rootballs with rooting throughout the media volume. However, when roots reached the exterior walls, the container design greatly influenced

**Table 1. Effect of container on root circling and top growth of 'Coral Beauty' cotoneaster and Leyland cypress.**

| Container | *Cotoneaster dammeri* 'Coral Beauty' Root Rating[z] | *Cotoneaster dammeri* 'Coral Beauty' Growth Index[y] (cm) | X *Cupresso-cyparis leylandii* Root Rating | X *Cupresso-cyparis leylandii* Growth Index (cm) |
|---|---|---|---|---|
| Smooth | 3.9a[x] | 73.7a | 4.0a | 48.2a |
| Ridged | 3.0b | 83.9ab | 2.8b | 50.4a |
| Porous | 2.8b | 87.7b | 2.4b | 44.0a |

[z]Roots visible at the periphery of the gowing media were rated from 1–4 where 1 = no roots visible, 2 = extensive root development with few roots circling, 3 = extensive root development with moderate root circling, 4= extensive root development with most roots circling.

[y]Growth index = (height + width)/2.

[x]Means within columns followed by the same letter are not significantly different at the 5% level using Tukey's studentized range test (HSD).

**Table 2. Effect of container on the percentage of 'Coral Beauty' cotoneaster and Leyland cypress plants in each root rating category.**

| Root Rating Category[z] | *Cotoneaster dammeri* 'Coral Beauty' Container | | | X *Cuprresso-cyparis leylandii* Container | | |
|---|---|---|---|---|---|---|
| | Smooth | Ridged | Porous | Smooth | Ridged | Porous |
| 1 | 0% | 0% | 0% | 0% | 0% | 0% |
| 2 | 0 | 19 | 25 | 0 | 31 | 64 |
| 3 | 6 | 62 | 69 | 0 | 61 | 36 |
| 4 | 94 | 19 | 6 | 100 | 8 | 0 |

[z]Roots visible at the periphery of the gowing media were rated from 1–4 where 1 = no roots visible, 2 = extensive root development with few roots circling, 3 = extensive root development with moderate root circling, 4 = extensive root development with most roots circling.

subsequent root growth. The nonporous smooth-walled container produced the poorest quality root systems with extensive root circling at all levels of the container for both 'Coral Beauty' cotoneaster and Leyland cypress (Tables 1 and 2). The ridges of the nonporous ridge-wall container generally forced roots to grow downward until they reached the bottom of the container. At this point some roots began circling. The best rootballs developed in the porous-walled containers. As the root tips reached the side walls of this container, they were apparently air pruned (10) and quit elongating. Branching occurred behind the air-pruned root producing a fine, fibrous root mass at the periphery of the growing medium. If root circling was observed, it occurred in areas of the container where the plastic was denser and the container air porosity was poor.

Results of this research indicate the porous-walled containers offer good potential for producing quality plants with fibrous rootballs that should establish better, faster and with reduced labor.

## Literature Cited


1. Appleton, B.L. 1989. Evaluation of nursery container designs for minimization or prevention of root circling. J. Environ. Hort. 7:59–61.

2. Arnold, M.A. and E. Young. 1991. $CuCO_3$-painted containers and root pruning affect apple and green ash root growth and cytokinin levels. Hortscience 26:242–244.

3. Birchell, R.S. and C.E. Whitcomb. 1977. Effects of container design on root development and regeneration. Okla. Agr. Expt. Sta. Res. Rpt. P-760, 39–45.

4. Dickinson, S. and C.E. Whitcomb. 1977. Effects of container design on root quality. Okla. Agr. Expt. Sta. Res. Rpt. P-760, 47–48.

5. Dickinson, S. and C.E. Whitcomb. 1982. Root development of transplanted seedlings initially in bottomless milk cartons. J. Arboriculture 8:323–324.

6. Dirr, M.A. 1983. Manual of woody landscape plants: their identification, ornamental characteristics, culture, propagation and uses. Third edition. Stipes Publishing Company, Champaign, IL. pp. 222, 237–238.

7. Furuta, T. and R. Autio. 1988. Observations on container design. Amer. Nurs. 168(5):94–95.

8. Gouin, F.R. 1983. Girdling roots, fact or fiction. Proc. Intern. Plant Prop. Soc. 33:428–432.

9. Harris, R.W. 1983. Arboriculture: care of trees, shrubs, and vines in the landscape. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, pp. 62–66, 547–549.

10. Huang, B.K. and P. Liang. 1987. Effects of air-pruning on cutting and seedling growth in container tree propagation. Proc. Southern Nur. Res. Conf. 32:134–139.

11. Lipton, W.J. 1992. Science Editor's Soapbox. ASHS Newsletter 8(1):9.

12. Maleike, R. and R.L. Hummel. 1990. Planting landscape plants. Wash. State Univ. Ext. Bull. 1505, 6 pp.

13. Milbocker, D.C. 1987. Growing trees in low profile containers. Proc. Southern Nur. Res. Conf. 32:127–128.

14. Milbocker, D.C. 1991. Low-profile containers for nursery-grown trees. Hortscience 26:261–263.

15. Newman, S. and M. Follett. 1987. Effects of container design on growth of *Quercus laurifolia* Michx. Miss. Agri. Expt. Sta. Bull. 12(7):1–3.

16. Newman, S. and M. Follett. 1987. Effects of three container designs on growth of *Quercus laurifolia* Michx. Proc. Southern Nurs. Res. Conf. 32:128–131.

17. SAS Institute Inc. SAS User's Guide: Statistics, Version 5 Edition. Cary, NC: SAS Institute Inc., 1985. 956 pp.

18. van de Werken, H. 1982. Effects of physical and chemical root barriers on growth of *Koelreuteria bipinnata*. Proc. Southern Nurs. Res. Conf. 27:74.

19. van de Werken, H. 1987. Nursery container design for improved root environment. J. Environ. Hort. 5:146–148.

20. Warren, S.L. and F.A. Blazich. 1991. Influence of container design on root circling, top growth, and post-transplant root growth of selected landscape species. J. Environ. Hort. 9:141–144.

21. Weed, J. 1989. Getting to the roots of the problem. Nursery Manager 5(3):82–86.

22. Whitcomb, C.E. 1981. A vertical air-root-pruning container. Proc. Intern. Plant Prop. Soc. 31:591–597.

23. Whitcomb, C.E., 1984. Container design: problems and progress. pp. 107–130. In: Plant Production in Containers. Lacebark Publications, Stillwater, OK.

24. Whitcomb, C.E. 1987. Root development and plant growth. Proc. Southern Nurs. Res. Conf. 32:131–132.

25. Whitcomb, C.E. and J.D. Williams. 1985. Stair-step container for improved root growth. HortScience 20:66–67.

# Postemergence Applied Herbicides for Use On Ornamental Grasses[1]

**Charles H. Gilliam, Gary J. Keever, D. Joseph Eakes, and Donna C. Fare[2]**
*Department of Horticulture*
*Alabama Agricultural Experiment Station*
*Auburn University, AL 36849*

## Abstract

Postemergence-applied, grass-active herbicides registered for use in the landscape were applied over-the-top of four ornamental grass species to evaluate tolerance in 1990 and 1991. All herbicides caused some injury to all grass species. Growth indices of dwarf fountain grass (*Pennisetum alopecuroides* L.K. Spreng. 'Hameln)' and pampas grass (*Cortaderia selloana* Schult. & Schult. f. Asch & Graebn. 'Rosea') treated with the low rate of Poast (sethoxydim) was similar to that of the nontreated plants in both years. Acclaim (fenoxaprop-ethyl) caused less injury to purple maiden grass (*Miscanthus sinensis* Anderss. 'Purpurescens') and maiden grass (*M. sinensis* Anderss 'Gracillimus') than Poast and Fusilade 2000 (fluazifop). Both Acclaim rates resulted in similar growth indices to that of nontreated plants. Flowering was reduced in three of the four grass species with all grass active herbicide treatments; the fourth species did not flower.

**Index words:** weed control, grass control, phytotoxicity

**Herbicides used in this study:** Fusilade (fluazifop), (R)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]propanoic acid; Poast (sethoxydim), 2-[1-ethoxyimino)butyl]-5[2(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one; Acclaim (fenoxaprop-ethyl), (±)-ethyl-2-[4-[(6-chloro-2-benzoxazolyl)oxy]phenoxy]propanoate.

**Species used in this study:** dwarf fountain grass (*Pennisetum alopecuroides* L. K.Spreng. 'Hameln'); pampas grass (*Cortaderia selloana* Schult. & Schult.f. Asch. & Graebn. 'Rosea'); maiden grass (*Miscanthus sinensis* Anderss. 'Gracillimus'); and purple maiden grass (*M. sinensis* Anderss. 'Purpurescens').

### Significance To The Nursery Industry

Application of a postemergence, grass-active herbicide to ornamental grasses will likely cause significant injury. The amount of injury varies with herbicide, rate, and grass species. Poast (sethoxydim) and Acclaim (fenoxaprop-ethyl) herbicides caused less injury than Fusilade 2000 (fluazifop) to most of the grasses. Pampas grass and dwarf fountain grass treated with the low rate of Poast (0.25 lb ai/A) began to outgrow injury symptoms about 60 DAT and had similar growth to the nontreated plants by the end of the growing season. The maiden grasses had less injury when treated with Acclaim, and growth indices at the end of the season were similar when comparing either Acclaim application rate with nontreated plants. While not evaluated, it appears that postemergence herbicide application made later in the season could be detrimental to ornamental grasses because of the time needed for recovery. Postemergence-applied herbicides should be a last line of defense in controlling weeds in ornamental grasses; however, when their use is required nurserymen and landscape maintenance personnel should anticipate plant injury and reduced flowering during the growing season of application.

### Introduction

Demand for ornamental grasses in the landscape has been increasing. Competition from annual and perennial grasses reduces growth of ornamentals and detracts from the aesthetic value of a landscape. Three postemergence-applied herbicides, Poast (sethoxydim), Fusilade (fluazifop), and Acclaim (fenoxaprop-ethyl) have undergone extensive evaluation for use in landscape plantings (2, 3, 5, 6) and are registered for a wide range of landscape plants for annual and perennial grass control. In addition, Poast is registered for selective use in some turf species. The labels of the aforementioned grass-active herbicides did not specify ornamental grasses as tolerant crops, and information is lacking on the response of ornamental grass species to

[1]Received for publication December 6, 1990; in revised form April 23, 1992.

[2]Professor, Associate Professor, Assistant Professor and Research Associate, respectively.