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Evaluation of Nursery Container Designs for Minimization or Prevention of Root Circling[1]

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Abstract

Six different container designs were evaluated for their effectiveness in minimizing or preventing the development of circling roots around the sides and/or bottoms of containers. While both shrub and tree species were tested, the roots of the shrubs were generally small and fibrous enough that selection of a container to minimize or prevent circling roots was not an important consideration. For the tree species, the greatest amount of circling reduction was achieved with the soft polybags and the rigid stepped-pyramid containers. Because considerable difference exists in the cost of the newly-designed containers, both cost and root-modifying effectiveness should be considered if root modification is deemed important.

Index words: root modification, girdling roots, container-grown trees, poly bags, stepped-pyramid pot, low profile container, ribbed container

Species used in this study: goldenraintree (*Koelreuteria paniculata*); black willow (*Salix nigra*); white pine (*Pinus strobus*); American boxwood (*Buxus microphylla*); azalea (*Rhododendron obtusum* 'Hershey's Red'); honeysuckle privet (*Lonicera pileata*).

Introduction

Design and appearance are factors considered when a grower selects containers for nursery stock production, although the three major selection criteria are generally ease-of-handling, rugged construction and price (5, 10). In addition, features receiving considerable attention lately include color (4), pot lip shape (15), and design for improved winter protection (11).

All aspects of container design influence plant development and growth (and possibly sales). The number of different containers introduced onto the market in recent years has raised the questions of whether standardization of containers is needed, and whether standardization would be beneficial to both wholesale growers and retailers (1, 2, 3, 7). If an effort to standardize is started it could influence the willingness of growers to purchase containers with special design features unless these features are shown to be beneficial to the production of high quality nursery stock.

An additional reason container design, and more specifically side wall configuration, is considered by growers is because of the circling and potentially girdling roots that may develop on certain plants when they are grown in conventional round, smooth, straight-walled rigid containers. Circling roots formed during production have the potential, especially on trees, to enlarge to the point that they may shorten a plant's life span by girdling its stem (6). In addition, circling roots may fail to adequately anchor plants, and may restrict water and nutrient absorption (13).

Research has demonstrated that certain modifications of the container side wall will minimize or prevent circling roots (5, 13, 14). The purpose of this research was to compare the ability of several new container designs to minimize or prevent root circling.

Materials and Methods

Rooted liners of American boxwood (*Buxus microphylla*), black willow (*Salix nigra*), 'Hershey Red' azalea (*Rhododendron obtusum* 'Hershey Red'), and privet honeysuckle (*Lonicera pileata*), and seedlings of goldenraintree (*Koelreuteria paniculata*) and Eastern white pine (*Pinus strobus*),

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were potted in Pro-Gro 330S (Pro-Gro Products, Inc., Elizabeth City, NC) medium in one of five or six container designs (all #1 size). The six container designs were a conventional straight-walled round container (Poly-tainer, Nursery Supplies, Inc.[3]), a vertically-ribbed round container (Zarn 400, Zarn, Inc.), a square container with corner holes (ARP-tainer, Nursery Supplies), a round container with stepped-pyramid profiles (Rootpruning Pot, Imperial Plastics) (12), a round "low profile" container[4] (a large Classic container cut to 7.6 cm (3 in) height with a volume equal to a #1 container (8), and a poly bag (Polybags, Tilden Lawn Nursery). The first five containers were all rigid plastic, the sixth a "soft" or flexible thin plastic bag gusseted at the bottom like a paper bag.

All plants were topdressed with 18N-2.6P-9.9K (18-6-12) Osmocote at the rate of 5.5 g (0.01 lb) per container, and Ronstar 2G was applied for weed control at the rate of 1.36 kg/1,000 sq ft (3.0 lb/1,000 sq ft). Plants were grown for 2.5 to 6 months (depending on species growth rate) on a plastic-covered container bed with overhead irrigation. All container designs were replicated 5 times in a randomized complete block design by species.

Root circling (defined as roots wrapping more than half way around the side or bottom of the container) was visually rated on a scale of 1 to 5 (1 = no circling, 3 = moderate circling, 5 = extensive circling). The same rating scale was used to rate all roots whether growing around the container side or inward along the bottom. Root rating data were subjected to analysis of variance with mean separation using the Least Significant Difference Test at the 1% level.

Results and Discussion

No circling root ratings were assigned, and no data is presented, for the honeysuckle, privet, or azalea because their very fine, fibrous roots grew well and did not circle, exhibiting no response to the various container designs.

Significant root modification was obtained with the various container designs for the boxwood, willow, white pine and goldenraintree. The polybags and stepped-pyramid containers minimized or prevented root circling when root modification along both the sides and the bottom was considered (Tables 1 and 2).

While the square container with the corner holes was quite effective in minimizing or preventing root circling around the sides, the design encouraged roots to grow to the bottom where they often formed a "square" circle over and around the drainage holes along the bottom edge. An additional design flaw was revealed when the willow roots grew around a circle stamped in the bottom of the container and followed it in a tight circular pattern that could lead to a potentially harmful girdling root. In addition, a considerable number of weeds grew in the corner holes, increasing weed control problems (Fig. 1).

The author has also noticed two other design flaws that encourage circling root development. One flaw involves pots with horizontal ribs in the pot lip, as with the ribbed container used in this research. When these containers are overfilled with medium, circling roots that trace the horizontal lip ribs often develop (Fig. 2). A second design flaw involves horizontal ribs around the container sides, probably molded in for decorative or perhaps strengthening purposes, but which in fact also encourage circling root development (Fig. 3).

[3]Nursery Supplies, Inc., 250 Canal Rd., Fairless Hills, PA 19030; Zarn, Inc., Box 1350, Reidsville, NC 27320; Imperial Plastics, 101 Oakley St., Evansville, IN 47706-0958; Tilden Lawn Nursery, 1008 W. Central Ave., Davidsonville, MD 21035.

[4]Designed by Dr. D.C. Milbocker, Hampton Roads Agric. Exp. Station, 1444 Diamond Springs Road, Virginia Beach, VA 23455.

Table 1. Visual rating of root circling around container sides.

	Plant Species			
Container Design	boxwood	willow	white pine	golden-raintree
Straight	2.6[z]b[y]	2.8b	2.2bc	3.0a
Ribbed	2.6b	1.2a	—[x]	3.0a
Square	2.2ab	1.0a	2.2bc	2.2a
Stepped	1.6ab	1.4a	1.0a	2.6a
Low-profile	1.2a	—[x]	3.0c	3.8b
Poly bag	1.4a	1.2a	1.6ab	2.4a

[z]Visual root rating scale: 1 = no circling, 3 = moderate circling, 5 = extensive circling.

[y]Means within a column followed by the same letter or letters are not significantly different using LSD at the 1% level.

[x]These containers were not tested for these species.

Table 2. Visual rating of root circling around container bottom.

	Plant Species			
Container Design	boxwood	willow	white pine	golden-raintree
Straight	—[x]	3.4[z]bc[y]	3.0b	3.4bc
Ribbed	—	2.6ab	—[w]	3.8c
Square	—	3.8c	1.8ab	2.8abc
Stepped	—	2.2a	1.0a	2.4ab
Low-profile	—	—[w]	1.2a	3.2bc
Poly bag	—	2.2a	1.0a	2.0a

[z]Visual root rating scale: 1 = no circling, 3 = moderate circling, 5 = extensive circling.

[y]Means within a column followed by the same letter or letters are not significantly different using LSD at the 1% level.

[x]No boxwood roots had grown to the bottom of the container, therefore no rating could be assigned.

[w]These containers were not tested for these species.

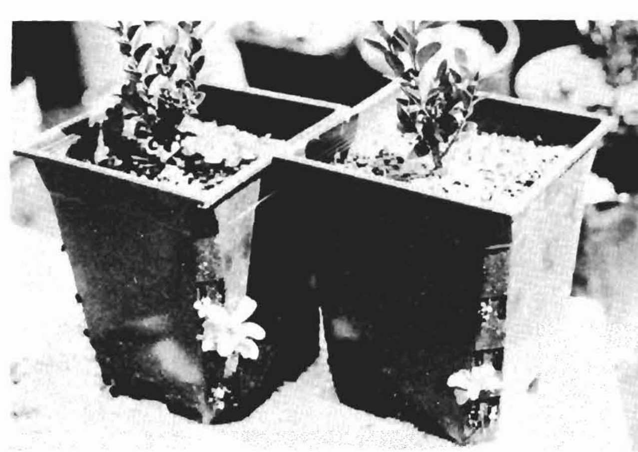

Fig. 1. Weeds growing in the corner holes of a container designed to help prevent circling roots.

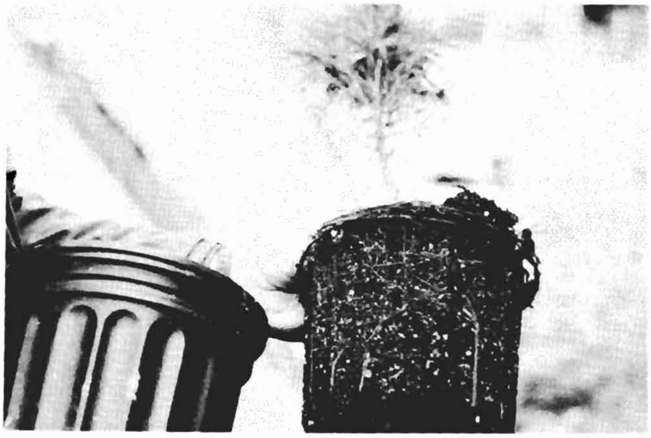

Fig. 2. **White pine planted in containers overfilled with medium have developed circling roots following the horizontal ribs in the container lip.**

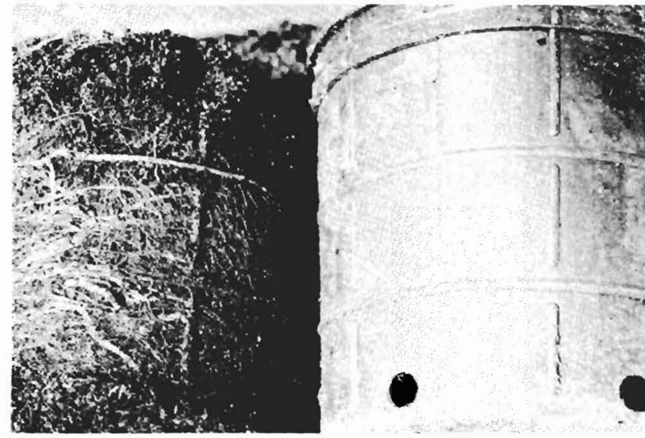

Fig. 3. **Circling roots that have developed by following the horizontal ribs of a container.**

Height and caliper measurements were also taken for the goldenraintree and white pine, but are not presented here. These significant data show, however, that goldenraintrees were tallest and had the largest calipers in the low profile and ribbed containers. The white pine were tallest and had the largest caliper in the ribbed and the stepped-pyramid containers. The best goldenraintree top growth was obtained with the containers that tended to encourage the most root circling. The opposite was true with the white pine—the best top growth was obtained with the containers that minimized root circling. Similar mixed results have been obtained when conventional straight-walled containers, bottomless waxed dairy cartons and the stepped-pyramid containers were used (9).

Significance to the Nursery Industry

The polybag containers generally sell for ⅓ to ½ the price of conventional rigid containers, and even less than the rigid containers designed to minimize or prevent circling roots. Polybags do, however, present a shipping problem because they cannot be stacked container-upon-container without considerable damage to the plant or container integrity. This would not be a problem for the increasing number of container growers who ship their plants one plant high on shelves or racks to minimize plant damage. In addition, polybags are easier to grasp and handle for many people, especially women who tend to have smaller hands and greater difficulty grasping and carrying many of the rigid containers (in this case due to the lip design of the stepped-pyramid and square containers).

The polybags should be given careful consideration under circumstances where they fit into a particular production and marketing regime. If specially designed containers (particularly the stepped-pyramid) can be obtained for a competitive price, their use may be helpful for growing certain trees whose roots tend to circle in conventional rigid containers (mainly trees with larger, fleshy roots or trees with very rapid root development). Individual species should be tested in the various designs under individual grower conditions before adopting one container type over another.

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