



Growth of Ornamentals in Containers Shaped Like a Star

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A major concern when growing containerized ornamental plants is circling and girdling roots. Three experiments were conducted to compare shoot and root growth of different ornamental species in traditional round containers (round pot) and in containers shaped like a five-pointed star (star pot). In experiment 1, live oak (*Quercus virginiana*) and scrub oak (*Quercus ionpina*) shoot and root growth was greater in the star pots than in round containers. In experiment 2, hibiscus (*Hibiscus rosa-sinensis*) shoot growth and root growth also was greater in the star pots. In experiment 3, philodendron (*Philodendron* spp.) shoot and root growth showed the same trend as previously noted. However, there was no significant difference in dieffenbachia (*Dieffenbachia* spp.) shoot or root growth between the containers. Further research should be conducted on the transplant success of woody ornamentals grown in star pots.

Production of containerized ornamentals represents over one-half of all landscape plants sold in the United States (Warren and Blazich, 1991). Some of the major concerns for growers include optimization of plant container health, transplant success, and crop yield. Containerized ornamentals can become “pot-bound” quickly because as the root grows it contacts the sides of the container and is directed around the inner wall and downward thus developing circling roots which can become more pronounced with time (Whitcomb, 1988). Circling roots can cause the plant to establish or anchor poorly in the landscape (Whitcomb, 1988). In general, transplants with larger root systems suffer less post-planting shock and thrive better in the landscape (NeSmith and Duval, 1998).

Several studies have investigated the effect of container design (size and/or shape) on the quality and growth of the root system as well as the effect on shoot growth. Whitcomb (1988) reported that plants grown in a four point shaped polyethylene bag exhibited increased secondary root growth and decreased root circling. The roots reached the bottom of the four folds in the polyethylene bag and were unable to elongate (or circle). Secondary roots quickly formed in response to the loss of apical dominance (Whitcomb, 1988). Latimer (1991) also reported higher lettuce and leek shoot dry weight for plants grown in pyramid shaped containers as compared to round or square (Latimer, 1991).

Limited research has been published on using star-shaped containers to grow containerized ornamentals. The objective of this study was to compare the growth of containerized ornamental plants grown in a five point shaped star pot vs. a traditional round container of the comparable volume.

Materials and Methods

Three experiments were conducted at the University of Florida’s Fort Lauderdale Research and Education Center in Davie from May 2010 to Feb. 2012. All experiments were conducted in an open-sided greenhouse with an average daily maximum and minimum

temperature range of 32.4 °C to 14.6 °C and an average relative humidity at 76.6% [Florida Automated Weather Network (<http://fawn.ifas.ufl.edu>) station located 100 ft from the greenhouse]. All plants were watered with overhead irrigation (Roberts® #45, sprinkler heads), every 2 d for 30 min, delivering approximately 172 mL (catch can) of water [pH = 7.0, electrical conductivity = 0.16 mmhos/cm, 4 ppm nitrogen, 0 ppm potassium, 32 ppm calcium, and 1 ppm magnesium].

For each experiment, rooted liners were transplanted into either traditional round containers (round) or black plastic containers shaped like a five-pointed star (star) (Fig. 1). Container volume was measured for round and star containers, prior to starting experiments. Containers were filled with Atlas Mix [sedge peat : bark : sand] from Atlas Peat and Soil (Boynton Beach, FL) and all plants were top-dressed with Osmocote® 15N–9P₂O₅–12K₂O, 8–9 month release formula (Scotts Co., Marysville, OH). For each experiment, plants were harvested when they reached a marketable size.



Fig. 1. This picture shows a 1000-mL volume five-pointed star container (star pot, left) and a traditional 900-mL volume round container (round pot, right).

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EXPERIMENT 1. In May 2010, fifteen rooted liners of live oak (*Quercus virginiana*) and scrub oak (*Quercus ionipina*) were transplanted into 900-mL round pots or 1000 mL star-shaped containers filled with 800 mL (volume) of Atlas mix. The plants were grown on greenhouse benches and watered every 2 d. At planting, 10 g of 15N-9P₂O₅-12K₂O Osmocote (8- to 9-month release rate) was top-dressed onto all containers. At 6 months, in Nov. 2010, the plants were transplanted into 3.8-L round or 4-L star containers filled with 3 L of Atlas mix and fertilized with 20 g of 15N-9P₂O₅-12K₂O Osmocote. Plants were fertilized again in May 2011 and Nov. 2011 with 20 g of Osmocote.

The plants were harvested in Feb. 2012. Shoots were cut at the soil surface. Pictures were taken of the root systems and the growing substrate was removed from the roots. Roots and shoots were oven dried at 93 °C for 48 h, to obtain dry weights.

EXPERIMENT 2. Twenty-four rooted liners of hibiscus (*Hibiscus rosa-sinensis*) were transplanted into either 900-mL round or 1000-mL star containers filled with 800 mL (volume) of Atlas mix in Apr. 2011. At planting, all plants were top-dressed with 10 g of Osmocote 15N-9P₂O₅-12K₂O (8- to 9-month release rate). The plants were grown on benches in the greenhouse (maximum and minimum temperatures of 35.9 °C and 20.26 °C, respectively; average relative humidity of 76.6%). The plants were harvested after 4 months in Aug. 2011, using the same techniques as described in experiment 1.

EXPERIMENT 3. Eleven rooted liners of dieffenbachia (*Dieffenbachia* spp.) and philodendron (*Philodendron* spp.) were transplanted into either 900-mL round or 1000-mL star containers filled with 800 mL (volume) of Atlas mix in Oct., 2011. At planting, all plants were top-dressed with 10 g of Osmocote 15N-9P₂O₅-12K₂O (8- to 9-month release rate). Plants were grown on benches in the greenhouse (maximum and minimum temperatures were 30.8 °C and 12.6 °C, respectively; average relative humidity of 76.7%). The plants were harvested after 2 months in Dec. 2011, using the same techniques described in experiment 1.

DATA ANALYSIS. Each experiment was analyzed separately. All three experiments were completely randomized design using two container shapes. For each container shape, there were 15 replicates of each oak species in experiment 1, 24 replicates of hibiscus in experiment 2, and 11 replicates of dieffenbachia and philodendron in experiment 3. In experiments 1 and 3, the plant species also were analyzed separately. All data were analyzed using PROC ANOVA in SAS (SAS Institute, Inc.). The difference in shoot and root dry weight between the two container shapes was determined using Duncan's multiple range test at $P < 0.05$.

Results and Discussion

The shoot dry weight and root dry weight of scrub oak, live oak, hibiscus, and philodendron grown in star pots was greater than for plants grown in round pots (Table 1). However, there was no significant difference in dieffenbachia shoot or root dry weight between the two container shapes (Table 1). It is possible that the slightly larger container volume of the star pots contributed to increased root and shoot growth. Whitcomb (1988) reported a linear relationship between container size and plant size. If the container was too small, the plant became root-bound and ceased to grow. When roots are confined, this restricts root and shoot growth because roots are competing for essential resources like oxygen, water, and nutrients (NeSmith and Duval, 1998). For example, Keever et al. (1985) reported the shoot biomass of burford holly (*Ilex cornuta*) linearly increased with increasing container size.

Table 1. Shoot and root growth of live oak (*Quercus virginiana*), scrub oak (*Quercus ionipina*), hibiscus (*Hibiscus rosa-sinensis*), dieffenbachia (*Dieffenbachia* spp.) and philodendron (*Philodendron* spp.) grown in traditional round containers or in a 5-point star container. All containers were filled with the same volume of growing substrate and fertilized with top-dress applications of 15N-9P₂O₅-12K₂O (8- to 9-month release rate). Plants were harvested when they reached a marketable size. Means within a column for each species followed by a different letter are significantly different at $P > 0.05$ based on Duncan's multiple range test.

Container shape	Shoot dry wt (g)	Root dry wt (g)
	<i>Live oak</i> ^z	
Round	51.43 B	83.2 B
Star	82.92 A	211.6 A
	<i>Scrub oak</i> ^z	
Round	52.01 B	133.7 B
Star	88.27 A	300.9 A
	<i>Hibiscus</i> ^y	
Round	31.08 B	23.1 B
Star	34.89 A	27.8 A
	<i>Dieffenbachia</i> ^x	
Round	18.26 A	19.8 A
Star	18.75 A	19.4 A
	<i>Philodendron</i> ^x	
Round	16.06 B	18.7 B
Star	18.56 A	25.3 A

^zFifteen liners of both live oak and scrub oak were transplanted into either 900-mL round or 1000-mL star containers in May 2010; they were transplanted into either 3.8-L round or 4-L star containers in Nov. 2011 and harvested in Feb. 2012 (21 months).

^yTwenty-four hibiscus were transplanted into either 900-mL round or 1000-mL star containers in Apr. 2011 and harvested in Aug. 2011 (4 months)

^xEleven dieffenbachia and philodendron were transplanted into either 900-mL round or 1000-mL star containers in Oct. 2011 and harvested in Dec. 2011 (2 months).



Fig. 2. Scrub oak (*Quercus ionipina*) roots after 16 months in round (left) or star-shaped containers (right). The round pots showed evidence of root circling towards the bottom of the container (left), while the roots from the star-shaped container had a star pattern and evidence of more secondary roots (right).

Although the star pots had a slightly larger volume, we also observed more secondary root growth for all plant species grown in the star pots (Fig. 2). We did not quantify secondary root growth but we speculate that some roots were trapped in the points of the stars limiting root elongation and stimulating secondary root growth. Increased secondary root growth could have contributed

to increased root and shoot growth in the star containers.

The results from these experiments offer an alternative to traditional round pots for growing containerized ornamentals. The use of star pots also appears to result in less circling roots and more secondary root growth (Fig. 2). Warren and Blazich (1991) reported that polybag, square, and stepped-pyramid container designs minimized root circling when compared to the straight-walled round containers. Chinese cabbage transplant studies found that round container cells promoted root circling compared to square cells (Chen et al., 2002). They also speculated that lower oxygen levels from decreased internal cell surface resulted in reduced activity of transplants in round cells compared to square cells (Chen et al., 2002). Further research needs to be conducted to quantify secondary root growth in star pots as well as on the impact of using star pots on woody ornamental transplant success in the landscape.

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