# Effect of Container Type on the Nursery Growth of Kentia Palms and King Palms

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**Palms are amenable to container culture because of the nature of their adventitious, fibrous root systems – all primary roots arise independently from one another at the root initiation zone near the base of the trunk. Nurseries, palm collectors and hobbyists commonly grow palms in containers for future potting-up, sales or outplanting in the landscape. Several new, non-traditional, air-root-pruning container types or designs are available to growers and hobbyists that manufacturers claim enhance growth of shrubs and trees by manipulating soil aeration and root growth to produce a better root system, primarily for outplanting in the landscape but also for potting up into larger containers. In a two-year study at a California nursery, we found that three non-traditional, root-pruning container types produced mixed results but none produced significantly greater root mass, leaf or stem growth and overall quality than a standard, traditional nursery container during production of kentia palms (*Howea forsteriana* (F. Muell.) Becc.) and king palms (*Archontophoenix cunninghamiana* (H. Wendl.) H. Wendl. & Drude). However, one of the air-root-pruning containers appeared to produce a more uniform root system with denser but shorter secondary roots.**

In 2007 Sarah Wilcox, co-owner of Keeline Wilcox Nurseries, a long-time grower of kentia palms and other palms and ornamentals primarily for the interior trade, asked Don Hodel for assistance in evaluating three new, non-traditional, root-pruning container types for production of kentia palms from 1-liter containers to approximately 30-liter containers. Two manufacturers promoted these root-pruning containers, stating they enhanced growth of trees and shrubs through their perforated side walls that improved soil aeration and drainage and redirected and air-pruned roots, helping to make a stronger, denser root system for outplanting. In earlier work with non-palm trees, Fitzpatrick et al. (1994) found that mahogany (*Swietenia mahagoni*) grown in root-pruning containers had lower root mass and higher shoot to root ratios compared to trees grown in standard black plastic containers. Similarly, Marshall and Gilman (1998) found that red maple (*Acer rubrum*) grown in root-pruning containers had reduced root mass and fewer roots deflected by the container sidewalls compared to trees grown in standard black plastic containers. Arnold and McDonald (1999) also observed long lateral roots deflected by the walls of standard containers compared to shorter sections of root circling when using root-pruning containers. They also found that seedlings of Chinese pistache (*Pistacia chinensis*) and American sycamore (*Platanus occidentalis*) grown in root-pruning liners had greater height and trunk diameter compared to those grown in standard liners after each was transplanted to larger containers (Arnold & McDonald 1999).

For other woody plant species growth after transplanting from root-pruning or standard containers was similar. For example, Marshall and Gilman (1998) found no growth differences in red maple grown in root-pruning containers compared to standard containers five months after outplanting in the landscape. Similarly, although 0.45-liter root-pruning liners reduced growth of southern live oak

1 (right, top). A non-traditional 11.4-liter nursery container, the RootBuilder® 3 (RB 3) used in the study (D.R. Hodel). 2 (right, middle). A non-traditional 25.4-cm nursery container, the RootMaker® 10 (RM10) used in the study and planted with a kentia palm (D.R. Hodel). 3 (right, bottom). A non-traditional 30.5 cm nursery container, the Accelerator® (NS 12) used in the study. Note the slits in the side wall through which potting soil was lost during irrigation. (D.R. Hodel).

(*Quercus virginiana*) compared to black plastic liners of the same volume initially, growth was similar between the two container types once the trees were transplanted to larger containers (25-liter root-pruning and standard containers) (Arnold & McDonald 1999). Growth in the larger root-pruning containers was also similar to conventional containers for Chinese elm (*Ulmus parviflora*) and velvet ash (*Fraxinus velutina*) (Arnold & McDonald 1999).

Sarah wanted to know if these types of containers would be more beneficial and advantageous for growth of kentia palms than the traditional nursery containers that Keeline Wilcox Nurseries was using. Thus, we conducted a two-year study to determine the effectiveness of these newer, non-traditional, root-pruning containers and compared them to traditional containers in promoting better growth and better root systems for potting up and/or outplanting.

**Materials and Methods**

We conducted this study from May 2008 to April 2010 at Keeline Wilcox Nurseries in Oxnard, California, using kentia palms grown in 1-liter containers provided by the nursery and king palms grown in 3.8-liter containers provided by ABC Nursery in Gardena, California. Initial overall heights ranged from 0.6 to 1.4 m for kentia palms and 1.2 to 1.7 m for king palms. Initial basal stem diameters, measured at the soil line, ranged from 25 to 40 mm for both species. In May 2008 nursery staff potted the palms singly into seven different containers (four container types and two sizes each for three of the types (Table 1, Figs. 1–3) using their standard kentia palm potting mix: equal parts of sandy loam soil, fine pumice rock, sharp sand, decomposed and nitrogen-stabilized fir bark, and 5 kgs of dolomite lime per cubic m of mix. Keeline Wilcox Nurseries and the container manufacturers (Nursery Supplies, Inc., Orange, CA and Rootmaker Products Company, Huntsville, AL) provided the containers.

We placed the newly potted palms under 50% lath shade (Fig.4) and tagged the newest, fully emerged leaf of each palm for subsequent leaf counts. Nursery staff regularly irrigated the palms as part of their normal irrigation of nearby production plants. We hand weeded the containers as necessary and applied Best Palm Plus 13-5-8 controlled-release, palm-

4. The newly potted palms placed under 50% lath shade (D.R. Hodel).

**Table 1. Container characteristics used in evaluation of container types for palm production, Keeline Wilcox Nurseries, Oxnard, CA, 2008–2010.**

| Project Container Name | Trade Name/ Description | Dimension (H × W top, cm) | Volume (ml) | Manufacturer |
|---|---|---|---|---|
| KW 10 | standard 25.4-cm (10-inch) nursery container | 22.9 × 25.4 | 9700 | Nursery Supplies, Inc. |
| KW 14 | standard 35.6-cm (14-inch) nursery container | 30.5 × 33.7 | 22,800 | Nursery Supplies, Inc. |
| NS 12 | Accelerator®/ non-traditional 30.5-cm (12-inch) nursery container | 22.2 × 30.5 | 10,000 | Nursery Supplies, Inc. |
| RB 3 | RootBuilder®/ non-traditional 11.4-liter (3-gallon) nursery container | 29.2 × 26.7 | 15,453 | Rootmaker Products Co., LLC. |
| RB 5 | RootBuilder®/ non-traditional 19-liter (5-gallon) nursery container | 39.4 × 29.8 | 29,661 | Rootmaker Products Co., LLC. |
| RM 10 | RootMaker®/ non-traditional 25.4-cm (10-inch) nursery container | 24.1 × 27.1 | 10,750 | Rootmaker Products Co., LLC. |
| RM 13 | RootMaker®/ non-traditional 33-cm (13-inch) nursery container | 24.8 × 34.3 | 19,100 | Rootmaker Products Co., LLC. |

special fertilizer (J. R. Simplot, Boise, ID) at 20 g per palm in April, 2009. At roughly six-month intervals (November 2008, April 2009, December 2009, May 2010) we measured stem diameter and counted leaves produced. At the end of the study in May 2010, we randomly selected six replications, removed the palms from their containers, removed the soil from the roots, examined the roots, clipped them off, dried them at 65° C for five days, and then weighed them.

The experimental design was a randomized complete block with 20 replications. Each replication was a row consisting of two species of palms and seven different containers, all randomized within each row. We analyzed all data using the Mixed Procedure (v. 9.3, SAS Systems, Cary, NC) with the overall error rate for multiple comparisons controlled by Tukey-Kramer adjustment. Because the objective of this study was to compare the new, non-traditional, root-pruning container types with standard, traditional containers, we used container volume and initial palm stem caliper as covariates. This analysis enabled us to separate neatly the effect of container type on palm growth and thus, we report results for only the four container types, regardless of volume.

To examine treatment effects over time, we conducted repeated measures analysis of variance using the Mixed Procedure to address potential autocorrelation for stem calipers, which were measured on the same plants for multiple sampling dates. For this analysis, we selected the Compound Symmetry (CS) covariance model based on measures of relative fit of competing covariance models.

## Results and Discussion

None of the three non-traditional, root-pruning container types (RootMaker®, RootBuilder® and Accelerator®) produced significantly more new leaves, greater stem

5 (below, top). The RootBuilder® container tended to produce a more uniform root system with denser but shorter secondary roots (*Howea forsteriana*). 6 (below, bottom). The standard nursery container tended to produce a less uniform root system with fewer but longer secondary roots (*Howea forsteriana*). (D.R. Hodel)


**Table 2. Effect of container type on mean number of new leaves, stem caliper, root dry weight, and overall quality of kentia and king palms at Keeline Wilcox Nurseries, Oxnard, CA, May 2010.**

| Container | New leaves$^z$ | | Stem caliper, mm | | Root dry wt, g | | Quality, 1–5$^y$ | |
|---|---|---|---|---|---|---|---|---|
| | Kentia | King | Kentia | King | Kentia | King | Kentia | King |
| Standard | 3.1 a$^x$ | 3.2 a | 69 a | 65 a | 452 a | 403 a | 4 a | 3 a |
| RootMaker® | 3.1 a | 2.9 ab | 69 a | 64 ab | 337 a | 300 a | 4 ab$^w$ | 3 a |
| RootBuilder® | 2.4 b | 2.7 b | 62 b | 61 b | 520 a | 413 a | 3 bc$^w$ | 3 ab$^v$ |
| Accelerator® | 2.4 b | 1.8 c | 60 b | 47 c | 406 a | 393 a | 3 c | 2 b |
| *P* value | p | p | p | p | 0.57 | 0.13 | p | p |

p = <0.0001

$^z$Total new leaves from May, 2008 to May, 2010.

$^y$1=dead, 5=perfect.

$^x$Means followed by the same letter within a column are not significantly different at $P<0.05$ (overall error rate controlled by Tukey-Kramer adjustment).

$^w$Means for statistical separation were 3.7 and 3.2 for RootMaker® and RootBuilder®, respectively.

$^v$Mean for statistical separation was 2.9.

calipers, more root mass or higher quality plants for both palm species than the traditional, standard nursery container (Table 2). Although previous researchers observed reductions in root mass for woody ornamentals using root-pruning containers (Fitzpatrick et al. 1994, Marshall & Gilman 1998, Arnold & McDonald 1999), we found no statistically significant reduction of root mass in either palm species with any of the root-pruning containers. However, an examination of the root systems showed that RootBuilder® containers tended to produce a more uniformly distributed root system and denser but shorter secondary roots than the standard nursery containers (Figs. 5 & 6). These observations are similar to those of other studies with oak species where root pruning encouraged growth of shallow, small diameter roots instead of large diameter roots, resulting in reduced water stress following transplanting (Gilman & Anderson 2006) and better survival compared to trees with unpruned roots (Gilman et al. 2002, Gilman & Anderson 2006). It is unknown, though, whether the uniform and dense root system observed in RootBuilder containers® may afford a planting survival advantage in palms similar to that conferred by root-pruning of oaks. However, studies with other non-palm, woody species generally showed that there was no advantage (Arnold & McDonald 1999, Marshall & Gilman 1998).

RootMaker® was equivalent to the standard nursery container for leaf and stem growth and quality for both palm species. RootBuilder® produced significantly fewer leaves and smaller stem calipers for both species and poorer quality for kentia palms than the standard nursery container but similar quality for king palms as the standard nursery container. Accelerator® produced significantly fewer leaves, smaller stem calipers and lower quality than the standard and RootMaker® containers for both species, and fewer leaves and smaller stem calipers than all other containers for king palms.

Because the new container types with slits and holes in the side walls expose more surface area to evaporation, it is possible they dried out significantly between irrigations scheduled for standard, solid-wall containers. Perhaps this drying accounted for some of the different growth responses but was not quantified in this study. Arnold and McDonald (1999), however, observed that more frequent irrigation was required to prevent wilting in root-pruning containers, possibly resulting in increased water use. We observed that the slits in the sidewalls of Accelerator® containers led to significant soil loss during irrigation, reducing soil mass and moisture, carrying away fertilizer and exposing roots, and was likely responsible for the poorer growth and quality of both species in some instances. Substrate loss was also observed with the Accelerator® prototype root-pruning container (Arnold & McDonald 1999).

Generally, palms in larger containers tended to produce more growth and were of higher quality than those in smaller containers (data not shown). When examining treatment effects over time, we also found no advantages of using root-pruning containers for early leaf or stem caliper growth (data not shown).

One other consideration was that the RootBuilder® containers required assembly, which may be tedious, laborious and time-consuming: side and bottom pieces were pulled together with plastic cinch ties. Also, the assembled RootBuilder® containers have straight sides, unlike the other containers with tapered sides, precluding them from being stacked in a nested fashion to save space.

## Conclusions

None of the new, non-traditional container types produced significantly more growth, higher quality palms or greater root mass than the traditional standard container. Although the RootBuilder® containers tended to produce a more uniformly distributed root system and denser but shorter secondary roots than the standard nursery container, these differences did not affect palm growth, overall quality or root mass.

The girdling, kinking or circling seen in woody root systems in container-grown stock generally does not occur in palm roots, which are adventitious, independently arising, and fibrous. Root-pruning containers may, therefore, be less important for development of an optimal palm root system for outplanting than for woody plants, although previous studies with several woody species mostly indicate no advantage to using root-pruning containers, except for some oak species (Gilman et al. 2002, Gilman & Anderson 2006). Whether root system uniformity and density and length of secondary roots in palms impact establishment in the landscape needs to be determined. Other factors, however, such as time of year, planting depth, soil type and porosity, and post-planting care, including irrigation, nutrition, mulching and weed control, likely play a more significant role in successful and rapid establishment of palms in the landscape.

## Acknowledgments

Keeline Wilcox Nurseries donated the kentia palms and some of the containers, allowed us to conduct this experiment at their facility and irrigated and otherwise maintained the research plot. ABC Nursery donated the king palms. Nursery Supplies, Inc. and Rootmaker Products Company, LLC donated containers. We thank an anonymous reviewer whose comments greatly improved this paper. All have our sincere thanks.

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