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Effect of Root Pruning and Planting Depth on Growth and Root Ball Quality in Container Production of Royal Poinciana (*Delonix regia*)

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Increasingly, producers and consumers are realizing that roots play a major role in tree quality and that quality begins in the nursery. To remain competitive, producers need to find economically viable methods of producing trees to meet rising quality standards, particularly with regard to root systems. Three different root pruning methods and two planting depths were evaluated as 1-gal container-grown Royal Poinciana *Delonix regia* were shifted into 7-gal containers. Root pruning had no impact on trunk caliper or tree height and no impact on primary root diameter. Root pruning increased the number of straight roots inside the root ball but had no impact on the percentage of the trunk encircled by roots. Trees planted with the topmost root 4 inches below the 7-gal substrate surface had more root defects than trees planted with roots close to the surface.

Background

In the aftermath of the 2004 and 2005 hurricanes that struck Florida, many questions were being asked about why so many trees failed. Limb breakage and blow-overs were cited as two of the most common causes of tree failure. Both are the result of poor structural integrity: weakly attached co-dominant leaders with bark inclusions and trees with circling/girdling roots that do not adequately anchor trees (Duryea, 2007). These defects can often be traced back to production problems in the nursery (Sellmer and Kuhns, 2007), poor planting technique (e.g., deep planting), and/or poor post-planting maintenance.

Poor root systems are not a new problem. They are referenced in *Florida Grades and Standards* (Anonymous, 1998), a regulatory document used for several decades by growers, contractors, and inspectors to produce, select, and inspect nursery stock in Florida. As tree production has shifted from field soils to containers, growers have become increasingly aware of the circling/girdling root problem that can create pot-bound conditions. This problem led to a myriad of container innovations (e.g., fabric containers, containers with perforated walls, copper-coated containers, etc.) developed as early as the mid 1980s (Sellmer and Kuhns, 2007) and during the 1990s (Appleton, 1993; Marshall and Gilman, 1998).

Despite these innovations and the improvements that have been made, root problems in production nurseries have persisted (Gilman et al., 2009), particularly when trees are not stepped up into larger containers in a timely manner. This led Gilman et al. to investigate various root ball manipulations timed to coincide when a tree is shifted into a larger container (Gilman et al., 2009). Working with *Quercus virginiana* 'SDLN' Cathedral Oak live oak and *Acer rubrum* 'Florida Flame' red maple, they found that shaving improved the quality of container-grown root balls significantly (Gilman et al., 2009; Gilman et al., 2009b.) To date, little work of this nature has been done with tropical trees.

Deep planting can also contribute to root problems. In production nurseries and in the landscape, excess soil on top of the root ball reduces available oxygen to the roots and can cause roots to ascend and circle (Gilman et al., 2009; Wells et al., 2006). Uncorrected, trees with this condition are more prone to stability problems and early decline after installation in the landscape (Figs. 1 and 2).

The purpose of this study was to evaluate the effects of different root ball manipulations and planting depths on growth and quality of a common tropical tree, Royal Poinciana (*Delonix regia*).

Fig. 1. Unstable tree in landscape due to poor quality root ball with many circling roots.

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Fig. 2. Close-up of circling and trunk wrapping root defects that renders trees culls, decreasing their value in the marketplace and their longevity in the landscape should they be planted.

Fig. 3. A sharp root saw can be a useful tool to shave the outer periphery of a root ball to remove circling roots and plunging roots that develop near the container wall.

Materials and Methods

In June 2008, 36 pot-bound, 1-gal Royal Poinciana liners were shifted into 7-gal plastic containers and placed in a randomized complete-block design. Prior to planting, trees were subjected to one of three cutting treatments: no-cut, slicing (a longitudinal cut from top to bottom through four sides of the root ball about 2 inches deep), and shaving (removing the entire outer ¾ inch from the root ball wall). Cuts were made using a Corona root saw (Figs. 3 and 4). In addition to cutting the sides of the root ball, the bottommost ¾ inch of the root ball was removed (Fig. 5) for both the sliced and shaved treatments. Trees were planted into a standard nursery mix, which consisted of approximately 30% pine bark, 30% sand, 30% soil, and 10% perlite. Trees were positioned such that the topmost root (first-order root) was ¾ inch below grade (proper container planting depth) or 4 inches below grade (deeply planted). Trees were placed in the nursery and watered daily using a standard overhead system. Approximately 1 month after planting, trees were fertilized with a standard rate of 3–4 month Osmocote 19–6–12 (84 g per 7-gal container). Trees were subsequently pruned and weeded as necessary and grew remarkably uniformly (Fig. 6). In Dec. 2008, trees were harvested, root balls were washed (Fig. 7), and growth measurements and root ball quality were evaluated (Fig. 8). Measurements that were taken included root condition rating, tree grade, straight root rating, diameter and directionality of the largest five roots at the 1-gal container wall (where roots were cut when shifted into 7-gal containers), percent trunk circled, tree caliper and height, number of roots >2 mm just outside the 1-gal wall (both the top and bottom halves of the root ball) and the number of adventitious roots >2 mm.

Fig. 4. A previously pot-bound 1-gal liner transformed via "root ball shaving" to create a high quality plant suitable for step-up free of defect.

Results and Discussion

The average tree height and caliper measured at harvest was 110.06 cm and 34.68 mm, respectively, and neither measure of growth was affected by any of the treatments. Similar results were reported by Gilman et. al working with Cathedral Oak and 'Florida Flame' red maple (Gilman et al., 2009a, 2009b).

Treatment means were compared using Duncan's multiple range tests. For a number of parameters evaluated, no statistically significant differences were observed. Only those parameters where significant differences were found will be reported on.

Fig. 5. Whether slicing or shaving, it is recommended that the root bound bottom ¾- to 1-inch root ball also be removed prior to step-up.

Fig. 6. Royal Poinciana trees arranged by treatments showing no differences in height or trunk caliper.

Fig. 7. Root wash—all soil was removed from each root ball using a high pressure hose end nozzle prior to evaluation and data collection.

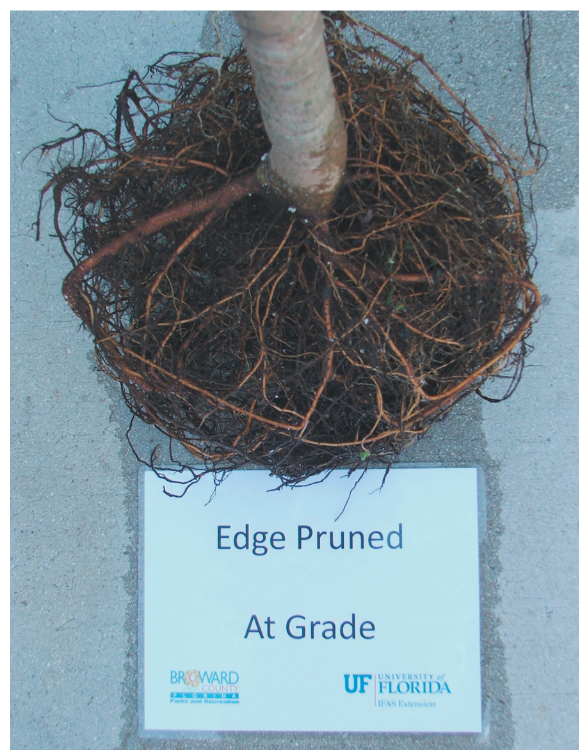

Fig. 8. Mass of washed roots ready for evaluation.

In our study, cutting root balls, either by slicing or shaving, improved the direction of their growth into the 7-gal substrate and resulted in higher straight root ratings relative to uncut root balls, which tended to circle or descend (Table 1) at the 1-gal container wall. These data suggest that both cutting techniques can improve root ball quality by removing root defects and encouraging the development of roots that grow straight into the larger soil volume when trees are shifted into larger containers.

Planting at the proper depth (first-order root ¾ inch below the soil surface) also improved straight root ratings (Table 1) relative to the deeply planted (first-order root 4 inches below the soil surface) treatment.

Trees planted at the proper depth in the container had significantly fewer problems with trunk circling roots relative to deeply planted trees. The data in Table 2 show a dramatic increase in the percentage of the trunk that became circled when trees were planted deeply. Values shown describe the average percentage of trunk circled with roots at least one-tenth the diameter of the trunk, a measurement that is referenced in the *Florida Grades and Standards*.

Relative to the unpruned control, root pruning resulted in a greater percentage of good root systems. A good root system was

Table 1. Effect of root pruning type (averaged over both planting depths) and planting depth (averaged over three pruning types) on straight root rating[z] of Royal Poinciana.

Pruning type	N	Straight root rating
No pruning	12	2.17 b[y]
Sliced	12	3.17 a
Shaved	12	3.75 a
Planting depth	N	Avg rating
0.75 inch	18	3.6 a[y]
4.00 inch	18	2.4 b

[z]1 = poor form (roots greatly deflected at container edge); 5 = excellent form (roots very straight from container edge out into new media);
[y]Numbers within a column followed by different letters are statistically different (Duncan's multiple range tests, $P = 0.05$).

Table 2. Effect of planting depth on percent of trunk circled[z] with roots of Royal Poinciana averaged over all three pruning treatments.

Planting depth	N	Trunk circled (%)
0.75 inch	18	7.8 b[y]
4.0 inch	18	34.7 a

[z]Percentage of trunk circled with roots at least one-tenth the diameter of the trunk.
[y]Numbers within a column followed by different letters are statistically different (Duncan's multiple range tests, $P = 0.05$).

Table 3. Effect of root pruning type and planting depth on percent good root systems[z] in Royal Poinciana averaged over both planting depths.

Pruning type	N	Good root systems (%)
No pruning	12	8 b[y]
Sliced	12	50 a
Shaved	12	50 a

[z]Good root systems were considered acceptable or correctable root systems capable of providing good form and function.
[y]Numbers within a column followed by different letters are statistically different (Duncan's multiple range tests, $P = 0.05$).

Table 4. Effect of planting depth on percent good root systems[z] and percent culls[y] of Royal Poinciana[y] averaged over all three pruning treatments.

Planting depth	N	Good root systems (%)	Culls (%)
0.75 inch	18	61 a[x]	6 b
4.0 inch	18	11 b	59 a

[z]Good or correctable root systems deemed capable of providing good form and function.
[y]Percentage of trees that would grade out as culls according to *Florida Grades and Standards*.
[x]Numbers within a column followed by different letters are statistically different (Duncan's multiple range tests, $P = 0.05$).

defined as a root system having abundant roots relatively evenly distributed throughout the root ball and growing in directions that could sufficiently anchor the tree, or if necessary, be corrected (Table 3). Although pruning improved the percentage of good root systems, there were no significant differences between slicing and shaving.

Proper planting depth also improved the percentage of trees with good root systems—root systems with few or no defects or with defects that can be easily corrected with pruning. Likewise, proper planting dramatically decreased the number of root systems which graded out as culls at harvest (see Table 4). Interestingly, planting depth appeared to have a greater influence on the percent culls than did pruning—root balls that were sliced or shaved and then planted deeply had very high percentages of culls.

These results corroborate with the work of others (Gilman et al., 2009a) that has shown a benefit to cutting roots and planting trees at the proper depth. Additional study is needed with other species of tropical trees and should be continued on into larger container sizes to assess how these techniques might affect older, larger trees. Ultimately, such information could be used to assist producers of container tropical trees with species specific step-up schedules.

The results of this study suggest that cutting the root balls of pot-bound trees early in the production cycle, either by slicing them or by shaving them, can be an effective way to eliminate certain root defects and improve quality. The study also demonstrates the importance of proper planting depth at step-up time, and suggests that proper planting may be even more important than cutting roots when it comes to minimizing defects that can render trees culls. Further, these results show that removing root defects—either by slicing or by shaving, is not stressful and does not negatively affect the growth rate of trees or their marketability under the conditions of this study.

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