2010 GREAT SOUTHERN TREE CONFERENCE

RESEARCH REPORT

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FNGLA FLORIDA NURSERY, GROWERS AND LANDSCAPE ASSOCIATION
Leading Florida's Green Industry

December 1 – December 3, 2010

UNIVERSITY OF FLORIDA
Environmental Horticulture Department
GAINESVILLE, FLORIDA 32611

Great Southern Tree Conference results help growers, arborists, and landscapers grow, plant, and manage trees more efficiently

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2010

Professionals in the nursery, landscape, and arboriculture industries have made enormous progress in efficiently growing and caring for trees in urban and suburban landscapes. Efficiency continues to increase in the last 12 months; however, it comes at the expense of quality. We, and our colleagues that should be present at this conference today, are selling and planting trees that should not be planted due to poor quality root systems. To say trees are cheap understates the current situation.

Most people would attribute this decline in price and quality to market forces in play in the last 24 months. There are many more trees available for sale than there are ready and willing buyers - basic economics the story would go. When prices drop staff is laid off to remain a viable organization. This hurts.

How will this change our profession? Although no one knows for sure, I often wonder if we are "shooting ourselves in the foot". A look back 5 and 6 years ago reminds us of the massive cleanup required after so many trees rotated out of the ground or broke in the historic 2004 – 2005 hurricane seasons due to deformed root systems. Will the next storm be any different with so many ridiculously overgrown trees going into the ground today? With this experience, will county commissions, homeowner associations, and those who write ordinances requiring tree planting be reluctant to embark on a massive tree replanting effort, or will some on these boards ask the question "why should we plant trees when they simply pull out of the ground when the wind blows?" Maybe the nursery and landscape profession gets lucky and no one asks this obvious question. Maybe.

We can control this, but only through education based on current research. That is what the Great Southern Tree Conference is all about. I know of no other way. At this time we must redouble our efforts to teach what quality looks like and why it's important. We cannot let up at a time when our industry has the best quality tops in the nation. We were on the verge of producing the best quality root systems. The best nurseries are doing it despite the chaos; are you one of them?

Please thank our 2010 Great Southern Tree Conference Partners

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Great Southern Tree Conference: Live oak cultivar demonstration.

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, FL

Objective: Demonstrate growth habits of clonal live oak cultivars produced from cuttings.

What we did: One 2.5-inch caliper tree of the cultivars Highrise®, Millennium Oak® or Cathedral Oak® were planted in the year 2000 in an open sunny location to evaluate growth form. The trees were irrigated for the first year only. Mulch has been maintained around the tree, except none was placed on the root ball. The trees were fertilized 3 times in 2005, 2006, 2007 and 2008 with 3.1 lbs of 16-4-18 per thousand square feet applied under the canopy. All trees were structurally pruned and canopy lifted in July 2006. In November 2006, two additional cultivars (Boardwalk® and Parkside®) were planted as 4-inch caliper trees, mulched, and irrigated regularly for one year. In December 2007, Sky Climber™ was planted as a 3-inch caliper tree, mulched, and irrigated regularly for one year. All trees were fertilized twice in 2009 and 2010 at a rate of 3.1 lbs of 16-4-18 per thousand square feet applied under the canopy. Caliper, height and spread were recorded in September 2010 for all trees.

What we found as of November 2010: The six live oak cultivars have different growth and canopy forms (Table 1 and photos on following page). All trees are taller than they are wide so far. Height to spread ratios are 1.01 for Millennium Oak®, 1.49 for Highrise®, 1.13 for Cathedral Oak®, 1.44 for Boardwalk®, 1.43 for Parkside® and 1.97 for Sky Climber™.

Millennium Oak® has large foliage reminiscent of shade grown live oak. Branches are well spaced along the trunk and the tree is easy to prune into a strong structure. Highrise® has dark green foliage with upright branches. Subordinate competing stems aggressively to allow sunlight to reach lateral branches along the leader. Cathedral Oak® has a dense canopy with closely spaced branches when shipped from most nurseries. Subordinate lateral branches aggressively and thin crowded branches as you develop structure in the landscape. Boardwalk® and Parkside® have kept good central leaders, with well spaced branches that have somewhat of a horizontal growth. Parkside® has more of a triangular shape when compared to Boardwalk®. Sky Climber™ was aptly named with its branches growing very upright. All live oak cultivars are expected to require regular pruning in the landscape to develop good structure, just like the acorn-grown species until proven otherwise. All three cultivars planted in 2000 and pruned in 2006 require structural pruning again.

Table 1. Growth and canopy forms of five live oak cultivars planted in 2000 as 2.5” caliper trees, 2006 as 4” caliper trees, and 2007 as a 3” caliper tree.

Cultivar	Caliper (in)	Height (ft)	Spread (ft)
Planted 2000, 2.5” cal			
Highrise®	10.87	34.5	23.2
Millennium Oak®	13.65	35.0	34.6
Cathedral Oak®	11.95	30.0	26.6
Planted 2006, 4” cal			
Boardwalk®	8.02	26.8	18.6
Parkside®	7.12	24.0	16.8
Planted 2007, 3”cal			
Sky Climber™	5.60	26.0	13.2

'First generation' live oak cultivars 10 years after planting.

Cathedral Oak®

Highrise®

Millennium Oak®

'Second generation' live oak cultivars 4 and 3 years after planting.

Boardwalk®

Parkside®

Sky Climber™

Great Southern Tree Conference: Elm species and cultivar demonstration.

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, FL

Objective: Develop a collection of native and introduced elm trees, including cultivars, to demonstrate suitability for street tree and landscape plantings.

What we did: In April 2007, eight of the nine elms were planted in an open sunny location to evaluate growth form and adaptability to north central Florida. The species and cultivars planted are listed in Table 1. *Ulmus parvifolia* ‘Everclear’ was planted in April 2008. All of the trees were about 3”caliper, except Cedar elm which was 2.5”. Trees were mulched (no mulch was placed on root ball surface) at planting and irrigated for most of the year, except in the winter. The trees were fertilized with 1.76 lbs of 16-4-18 per tree under the canopy twice a year in 2008, 2009 and 2010. Caliper, height and spread were recorded in September 2010 for all trees.

What we found as of November 2010: The nine elms have different growth and canopy forms (Table 1, see photos below and on following page). All trees are much taller than they are wide. ‘Everclear’ and the American Elms are columnar in shape, while the rest are more spreading. It’s important to note that the Cedar Elm was obtained sheered in the shape of a cone. The tree is now growing out of this artificial shape. All elms require regular pruning to develop strong structure in the landscape.

Table 1. Growth and canopy forms of nine elms planted in 2007 and 2008.

Elm species/cultivar	Caliper (in)	Height (ft)	Spread (ft)
Ulmus parvifolia ‘Bosque®’	4.73	23.2	15.8
Ulmus parvifolia ‘Allée®’	4.84	20.8	18.2
Ulmus parvifolia ‘Burgundy’	4.83	19.1	12.4
Ulmus parvifolia ‘Athena® Classic’	4.40	19.4	13.0
Ulmus parvifolia ‘Everclear®’	3.65	23.5	5.4
Ulmus americana ‘Creole Queen’	4.62	22.6	7.5
Ulmus americana ‘Princeton’	5.53	23.4	9.2
Ulmus alata	6.55	23.2	20.1
Ulmus crassifolia	3.22	15.6	8.8

Chinese elm (*U. parvifolia*) cultivars

Bosque®

Allée®

Burgundy

Chinese elm (*U. parvifolia*) cultivars

		**Your cultivar here**
Athena® Classic	**Everclear®**	

American elm (*U. americana*) cultivars

	
Creole Queen	**Princeton**

Winged (*U.* alata) and Cedar (*U. crassifolia*) elm

	
Winged Elm	**Cedar Elm**

Great Southern Tree Conference: Southern magnolia cultivar demonstration.

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, FL

Objective: Demonstrate growth habits of southern magnolia cultivars in the landscape.

What we did: Eleven southern magnolia cultivars were planted in spring 2006 in an open sunny location to evaluate growth form. 'Little Gem' was planted several years prior. The cultivars planted are listed in Table 1. Soil surrounding the root balls was mulched at planting and trees are being irrigated once daily. The trees were fertilized 3 times in 2007 with 0.88 lbs of 16-4-18, 3 times in 2008 with 1.76 lbs of 16-4-18, twice in 2009 with 1.76 lbs of 16-4-18, and twice in 2010 with 1.76 lbs of 20-0-8 per tree applied under the canopy. Caliper, height and spread were recorded in September 2010 for all trees.

What we found as of November 2010: The eleven southern magnolia cultivars have different growth and canopy forms (Table 1, see photos below and on following page). They also have different leaf shapes and amount of brown on the underside of leaves. All trees are taller than they are wide. Miss Chloe® had to be replaced in 2008 because the first tree was infested with soft scale. To avoid contamination to the other cultivars, it was pulled out and burned.

Table 1. Growth and canopy forms of eleven southern magnolia cultivars planted in 2006.

Southern Magnolia Cultivars	Caliper (in)	Height (ft)	Spread (ft)
Claudia Wannamaker	6.48	24.9	9.7
Green Giant	5.16	17.8	11.6
Coco	5.08	19.7	11.7
Edith Bogue	5.48	17.7	10.8
Greenback™	6.85	22.4	9.6
Bracken's Brown Beauty™	5.27	19.6	9.6
Teddy Bear®	5.25	16.9	8.4
Alta®	5.42	15.7	8.7
Little Gem	6.52	22.2	13.2
D.D. Blanchard	5.10	20.0	10.9
Miss Chloe®	3.34	12.3	12.4

Southern magnolia cultivars 4 years after planting.

Claudia Wannamaker

Green Giant

Coco

 **Edith Bogue**	 **Greenback™**	 **Bracken's Brown Beauty™**
 **Teddy Bear®**	 **Alta®**	 **Little Gem**
 **D.D. Blanchard**	 **Miss Chloe®**	**Your cultivar here**

Great Southern Tree Conference: Holly species and cultivar demonstration.

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, FL

Objective: Demonstrate growth habits of holly species and cultivars in the landscape.

What we did: Thirteen species and cultivars of holly were planted in March 2008 in an open sunny location to evaluate growth form. The species and cultivars planted are listed in Table 1. *Ilex attenuata* 'Miss Priss' was planted in March 2009. Soil surrounding the root ball was mulched at planting and trees are being irrigated three times daily. The trees were fertilized in August 2008 with 0.88 lbs of 16-4-18, twice in 2009 with 1.76 lbs of 16-4-18, and twice in 2010 with 1.76 lbs of 20-0-8 per tree applied under the canopy. Caliper, height and spread were recorded in September 2010 for all trees.

What we found as of November 2010: The fourteen species and cultivars have different growth and canopy forms (Table 1, see photos on following pages). Most trees were sheered regularly in the nursery prior to arrival and are in various stages of growing out of that artificial shape, reverting back to their natural habit. Most trees are taller than they are wide, except 'Pride of Houston' and 'Lib's Favorite'. 'East Palatka', 'Aspire', and 'Eagleston' are columnar in shape. 'Mary Nell', 'Emily Brunner', 'Wirt L Winn' and 'Dark Green' were obtained tightly sheered in a cone shape. It will be interesting to see how and in what time period the trees grow out of this shape, and what form they will take in the landscape with no maintenance of this shape.

Table 1. Growth and canopy forms of fourteen holly species and cultivars planted in 2008 and 2009.

Holly species/cultivar	Caliper (in)	Height (ft)	Spread (ft)
Ilex opaca	2.98	13.6	7.9
Ilex cassine 'Tensaw'	3.01	12.1	8.6
Ilex x *attenuata* 'East Palatka'	4.60	15.6	12.3
Ilex x 'STBB' Aspire®	4.69	13.5	6.4
Ilex x *attenuata* 'Eagleston'	4.86	21.0	13.2
Ilex vomitoria 'Pride of Houston'	Multi-Trunk	11.4	15.4
Ilex cornuta 'Fine Line'	Multi-Trunk	12.4	10.3
Ilex x 'Mary Nell'	5.45	13.0	7.0
Ilex x 'Emily Brunner'	Multi-Trunk	12.0	8.4
Ilex x *koehneana* 'Wirt L Winn'	Multi-Trunk	14.4	9.4
Ilex latifolia 'Dark Green'	Multi-Trunk	8.1	7.0
Ilex x *attenuata* 'Fosteri'	3.20	13.1	5.1
Ilex cornuta 'Lib's Favorite'	Multi-Trunk	3.3	4.6
Ilex attenuata 'Miss Priss'	4.32	14.3	10.4

Holly species and cultivars.

American Holly

Tensaw

East Palatka

Aspire®

Eagleston

Fine Line

Mary Nell

Emily Brunner

Wirt L Winn

Dark Green

Fosteri (street tree grown)

Miss Priss

Lib's Favorite

Pride of Houston

Your cultivar here

Great Southern Tree Conference: Evaluation of initial liner size and root pruning at planting of live oak into a field nursery.

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, FL

Objective: Evaluate root pruning strategies when planting live oak liners into a field nursery.

What we did and will do: In February 2007, 40 Cathedral Oak® live oaks were obtained in #3 Accelerators, all with an average 0.5" caliper. Twenty trees were shifted into #10 Accelerators and the other twenty were shifted into #15 Accelerators. Trees were root pruned when shifted from #3 by radially slicing 2" deep into the side of the root ball in 5 equidistant places from the top of the root ball to the bottom. The top of the #3 root ball was washed for 10 seconds to expose root defects (kinks, descending, ascending, and circling roots). Defective roots were pruned at the point just before they were deflected by the #3 container wall. Essentially, the top inch or two of the root ball edge was pruned away. Trees shifted into the #10 containers were planted into the field nursery 8 months later in October 2007, when the trunk caliper averaged 1". The #15 containers were field planted when trunks reached a caliper of about 1.3" in January 2008.

Before field planting, #10 and #15 root balls were either 1) sliced as described above, or 2) the outer inch of the sides and bottom shaved off (see photos next page) using a digging shovel. All 40 trees were planted into the same field with 12 ft between rows and 8 ft between trees and were irrigated three times per day in the growing season. Trees were fertilized with 115 g per tree of 16-4-8 in April 2008, 210 g of 16-4-8 in July 2008 and 400 g of 16-4-8 in September 2008, March 2009 and June 2009. Trees from #10 containers were staked in November 2007 and #15 trees at planting.

Caliper and height were recorded in October 2009 for all trees. Trees were dug with a 36 inch diameter tree spade November 2009. Trees were lifted and slowly placed back in the ground in the same hole. Trees were then rocked back and forth by one person three times in the north-south direction, then three times in the east-west direction to determine firmness. Root development was measured December 2009 to show influence of root pruning strategies on root ball quality. Root data collected included: percent of the trunk circled by roots; root distribution along the root ball; diameter of the 5 largest roots inside #3, and diameter of these 5 largest roots right outside the #3 and whether they were straight; diameter of the 10 largest roots outside original container size (#10 or #15); number of straight roots from the trunk greater than 5 mm in diameter and diameter of these roots.

What we found as of November 2010: The type of root pruning (root ball shaving vs. slicing) when planting #10 and #15 containers into field soil had no effect on caliper. Sliced trees were slightly taller than shaved trees, but this 8 inch difference may be insignificant to a grower (Table 1). Root pruning at field planting had no effect on root parameters measured. But trees which were shaved were firmer immediately following digging than those which were sliced before planting (Table 1). Although the #15 trees were larger (1.3" caliper) than the #10 trees (1" caliper) when planted into the field, #10 trees had slightly larger caliper and height when finished at 3" caliper trees (Table 2). Trees from #10 were planted into the field 3 months before #15 trees, which probably explains why these trees were larger at the end of the second growing season in the field. Also, trees from # 10 had larger roots than those from #15, as well a greater number of straight roots (Table 3).

Conclusion: Field grown trees planted from #10 containers had better root systems than trees planted from #15 liners; shaving at planting into the field resulted in firmer root balls than slicing.

Table 1. Caliper and height of field nursery-grown trees with container root ball sides either sliced or shaved at planting.

Root pruning	Caliper (in)	% caliper increase	Height (ft)	% height increase	Firmness in the root ball[1] (1-5)
Root ball sliced	2.98	186	14.6 a[2]	79	1.9 b
Root ball shaved	2.94	184	13.9 b	72	2.8 a

[1]Firmness ratings 1=loose; 5=firm.
[2]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 20 trees per root pruning averaged across #10 and #15 container sizes at planting.

Table 2. Caliper and height of field nursery-grown trees planted from #10 or #15 containers[1].

Container Size	Caliper (in)	% caliper increase	Height (ft)	% height increase
#10	3.11 a[2]	193 a	14.9 a	78
#15	2.81 b	176 b	13.6 b	73

[1]Trees were in #3 containers prior to shifting into #10 or #15 containers.
[2]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 20 trees per container size averaged across root pruning treatments.

Table 3. Root development of field nursery-grown trees planted from #10 or #15 containers[1].

Container Size	Diameter of 5 largest roots just inside #3 container wall (mm)	Diameter of 5 largest roots just outside #3 container wall (mm)	% straight roots outside #3 growing from the 5 largest roots	Diameter of 10 largest roots outside original container (mm)	Number of straight roots from trunk > 5 mm
#10	33.4 a[2]	19.7 a	58.0 a	16.3 a	3.8 a
#15	29.3 b	16.5 b	51.2 b	12.6 b	2.2 b

[1]Trees were in #3 containers prior to shifting into #10 or #15 containers.
[2]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 20 trees per container size averaged across root pruning treatments.

Slipping the root ball out of the container shows that there are few roots visible on the outer surface.

A gentle washing of the outer surface shows that root defects are beginning to form just back from the periphery of the root ball.

A light washing of the outer surface of the root ball reveals that some roots are beginning to circle, dive, and kink. Some of these will grow to become large root defects at this position.

A blade is used to shave off the outer inch or so of the root ball before shifting to the larger container.

Shaving the root ball in this fashion should remove enough substrate so remaining roots are oriented straight out from the trunk.

Removed roots are not large in diameter, but there are many of them. If left unpruned, some of these will grow to become permanent circling or descending roots. Non-pruned root ball is shown on left; shaved root ball on right.

Great Southern Tree Conference: Effect of initial liner size and season of root pruning on live oak root systems in a field nursery

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, FL

Objective: Determine effects of live oak liner size and season of field root pruning on root system quality in field grown nursery stock.

What we did and will do: In February 2007, 120 Cathedral Oak® live oaks averaging 0.5" caliper were obtained in #3 Accelerator containers. The treatments were: (1) 40 trees planted directly into field soil; (2) 40 trees shifted into #10 Accelerators; or (3) 40 trees shifted into #15 Accelerators. Half of the trees (20 for each liner size) were root pruned when planting to the field or shifting to the larger container size. Trees were root pruned by cutting 2" deep into the side of the root ball in 5 equidistant places from the top of the root ball to the bottom. Tops on root pruned trees were washed for 10 seconds to expose and remove circling and potentially girdling roots on the top 1 to 2". The other half of the trees per treatment was not root pruned at field planting or shifting. The trees shifted into the #10 containers were planted into the field nursery October 2007, when the trunk caliper averaged 1". The #15 containers were field planted when the trunks reached a caliper of about 1.3" in January 2008. Root balls that were sliced when shifted were again sliced at planting into field soil, while those not pruned when shifted were not pruned when planted to field soil.

All trees were planted in the same field with 12 ft between rows and 8 ft between trees and were irrigated three times per day during the growing season through drip emitters. Trees in the field were root pruned in the following manner: 1) half were root pruned in the dormant season (Feb, Apr, Oct, Dec 08 and Feb, Apr 09); or 2) the other half were root pruned in the growing season (Apr, June, Aug, Oct 08 and Apr, June 09). At each root pruning, two 1/8 circumference sections opposite one another were cut with a sharp 12" long digging shovel starting 8" from trunk; each subsequent root pruning was about 1" farther from the trunk and rotated another 1/8 around circumference. Trees were fertilized three times a year with 115 g of 16-4-8 and were staked in November 2007 for #3 and #10, and at planting for #15. The experimental design was 3 liner sizes x 2 root pruning at shifting and field planting x 2 field root pruning seasons x 10 replicates = 120 trees.

Half of the trees for each treatment combination (5 trees in each of 12 treatment combinations = 60 trees) were dug with a 36 inch tree spade November 2009. Trees were lifted and placed back in the ground in the same hole. Trees were then rocked back and forth by one person three times in the north-south direction, then three times in the east-west direction to determine firmness. Root development was measured on these 60 trees December 2009 to show influence of root pruning strategies on root ball quality. Root data collected included: percent of the trunk circled by roots; root distribution; diameter of the 5 largest roots inside the #3 container, and diameter of these 5 largest roots just outside the #3 and whether they were straight or not; diameter and depth of the 10 largest roots outside original container size (#5, 10 or 15); number of straight roots from the trunk greater than 5 mm in diameter and diameter of these roots; and number of new roots generated 0 to 2 inches behind field root pruning cuts.

The other half of the trees left in the field (5 trees in each of 12 treatment combinations = 60 trees) were all moved in March 2010 with a 36 inch diameter tree spade without wire basket or burlap. Caliper and tree height was recorded. Once moved, trees were watered in by hand. Trees are now being irrigated every other day with periodic dry days to measure stress caused by water deficit. In September 2010 all trees were fertilized with 300 g of 20-0-8, and caliper and heights were recorded again.

What we found as of November 2010: Root ball slicing at planting or field root pruning season during production had no impact on tree caliper and height (data not shown). Trees planted from #3 and #15 containers were tallest, but all trees grew in caliper and height at a comparable rate (Table 1). Trees planted from #15 containers were loosest in the root ball immediately after digging (Table 1). Root pruning at planting reduced culls (from 100% of the crop to 67%), reduced percent of the trunk circled with roots (from 64 to 43%), slightly increased root diameter of the largest roots on the tree (from 14.3 to 15.8 mm), and increased the number of new roots (from 193 to 216) produced after field pruning (Table 2). Root ball slicing when planting into the field reduced root defects without affecting tree size three years later. Field pruning in the growing season increased the percentage of the 5 largest roots in the original #3 root ball that generated straight roots to the edge of the 36 inch finished field grown root ball. Field pruning in the growing season decreased by about 15% the number of roots generating new roots and the number of these new roots produced 0 to 2 inches behind the field root pruning cuts (Table 3).

Liner container size impacted characteristics of finished root balls (Table 4). Overall, trees grown from #3 and #10 had larger, straighter, and shallower roots when compared to those planted from #15 (Table 4). Trees from the larger containers were more congested with more circling roots and fewer roots growing out away from the trunk than trees planted from smaller containers. Trees from the larger containers had fewer roots at the edge of the root ball which means there were fewer ready to grow into landscape soil after transplanting. We think this is because trees from the larger containers were in a container for a longer period, so there was more time for roots to deflect. When roots are deflected by the container wall, more length remains in the original root ball. These deflected roots produce some lateral roots which grow into the root ball interior instead of growing away from the trunk in a radial like manner. This data shows that trees remaining in a container for a longer period generate a greater portion of their root system in a small soil volume close to the trunk. This process results in a congested root ball that provides less anchorage for the tree. A more aggressive root pruning (root ball shaving) is likely to improve root systems for trees that spend more time in containers prior to planting.

Table 1. Caliper and height 6 months after transplanting (September 2010) field nursery-grown live oaks initially planted from #3 (Feb 07), #10 (Oct 07) or #15 (Jan 08) containers.

Container Size (beginning caliper)	Caliper (in)	Caliper increase 6 months after transplanting from field nursery (in)	Height (ft)	Height increase 6 months after transplanting from field nursery (ft)	Firmness[1] (1-5)
#3 (0.5”)	3.44	0.33	15.4 a[2]	0.2	4.4 a
#10 (1.0”)	3.30	0.32	14.4 b	0.1	3.6 a
#15 (1.3”)	3.46	0.35	15.2 a	0.3	2.4 b

[1]Firmness ratings 1=loose; 5=firm.
[2]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 20 trees per container size averaged across root pruning at planting and field root pruning season.

Table 2. Effect of root ball slicing #3, #10, or #15 containers at planting into the field nursery on root balls of field nursery-grown live oaks.

Root pruning at planting	% Culls	% trunk circled	Diameter of the 10 largest roots outside original container (mm)	Total roots 0 to 2” behind field pruning cuts
Slicing	67 b[1]	43 b	15.8 a	216 a
None	100 a	64 a	14.3 b	193 b

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 30 trees per root pruning averaged across container size and field root pruning season.

Table 3. Effect of field root pruning season on root systems of live oak planted from #3, #10, or #15 containers.

Root pruning season	% straight roots outside #3 container growing from the 5 largest roots	# roots with new roots 0 to 2" behind field cuts	Total roots 0 to 2" behind field pruning cuts
Dormant	54 b[1]	48 a	228 a
Growing	61 a	42 b	180 b

[1]Means in a column with a different letter are statistically different at P < 0.05. Based on 30 trees per field root pruning season averaged across container size and root pruning at planting.

Table 4. Effects of liner container size on root balls of field grown live oaks.

Container Size	Diameter of 5 largest roots inside #3 (mm)	Diameter of 5 largest roots outside #3 (mm)	% straight roots outside #3 from 5 largest roots	Diameter of 10 largest roots outside original container (mm)
#3	34.9 a[1]	19.4 a	54 b	19.7 a
#10	32.9 ab	18.1 a	64 a	14.1 b
#15	29.4 b	13.9 b	49 c	10.9 c

[1]Means in a column with a different letter are statistically different at P < 0.05. Based on 20 trees per container size averaged across root pruning at planting and field root pruning season.

Table 4 Continued

Container Size	Depth of 10 largest roots outside original container (in)	# straight roots from trunk > 5 mm	# roots with new roots 0 to 2" behind field pruning cuts	Total roots 0 to 2" behind field cuts
#3	4.6 b[1]	3.6 a	47 a	241 a
#10	5.6 b	3.0 a	49 a	198 b
#15	6.8 a	1.8 b	38 b	162 c

[1]Means in a column with a different letter are statistically different at P < 0.05. Based on 20 trees per container size averaged across root pruning at planting and field root pruning season.

Great Southern Tree Conference: Effect of planting depth in containers and in the landscape on growth after field planting Cathedral Oak® live oak.

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1– December 3, 2010
Gainesville, FL

Objective: Determine how planting depth in the root ball and planting depth in the landscape influence Cathedral Oak® live oak following landscape planting.

What we did: In July 2006, 144 Cathedral Oak® live oaks about 2.7" caliper were planted to a Bahia grass field in Citra, FL (20 miles south of Gainesville) from #45 containers. Twenty-four trees were planted on 50-foot centers and the remaining 120 trees were planted on 25-foot centers. Portions of the site were poorly drained. Trees were produced in containers from rooted cutting liners with the following planting depth treatments: (1) top-most root at soil level into #3, #15 and #45; (2) 2.5" below grade in #3 and #15, level into #45; (3) 4.5" below grade into #3 and #15, level into #45; or, (4) 2.5" below grade in #3, #15 and #45. Trees from each of these four depths in the containers were planted into the landscape at three different depths for a total of twelve treatment combinations. Landscape planting depths were: (1) 0", media surface level with landscape soil; (2) 4" below grade; (3) 8" below grade. Half of the trees were root pruned at planting (trees were root pruned by cutting 4-5" deep into the side of the root ball in 5 equidistant places from the top of the root ball to the bottom using a sharp balling spade), whereas the other half was planted without root pruning. Following transplanting, all trees were mulched and irrigated with 34 gallons/day for approximately 2 ½ weeks. At the end of July 2006, irrigation was reduced to 7.5 gallons/day for two weeks. In mid-August 2006, irrigation was once more reduced to 7.5 gal every other day for 3 weeks and reduced further to 7.5 gal every three days for two weeks. Trees are now irrigated when they show signs of stress, which is usually in the spring. Trees were fertilized April 2007 with 340 g of 12-2-14, 400 g of 16-4-8 in July 2008, and 800 g of 16-4-8 in July 2009. Caliper and height were measured in September 2010.

What we found as of November 2010: Trunk caliper and tree height four years after landscape planting were not affected by planting depth in the nursery container (Table 1). Tree height 4 years after planting appeared to be affected by landscape planting depth and root pruning at planting (Table 2 and 3). Trees that were planted into the landscape deeper were slightly shorter than those planted even with landscape soil probably because they were shorter at planting due to the deeper planting. Trees that were root pruned by slicing the root ball when planted into the landscape were slightly shorter than trees that were not root pruned, but this difference was less than 6 inches. Although tree height was affected by landscape planting depth and root pruning, the relative growth of all trees has been similar for all treatments.

Table 1. Caliper, height and growth of live oak, produced at different nursery planting depths at each shift to larger container, 4 years after landscape planting.

Nursery planting depth	Caliper (in)	Caliper growth in 4 years (in)	Height (ft)	Height growth in 4 years (ft)
Level in #3, #15, #45	5.41[1]	2.58	18.46	5.30
2.5" deep in #3 and #15, level in #45	5.28	2.40	17.85	5.12
4.5" deep in #3 and #15, level in #45	5.33	2.45	17.75	5.21
2.5" deep in #3, #15, #45	5.24	2.39	17.78	5.24

[1]Means averaged across landscape planting depths and root pruning treatments.

Table 2. Caliper and height of live oak produced at different nursery planting depths 4 years after landscape planting at three different landscape planting depths.

Landscape planting depth	Caliper (in)	Caliper growth in 4 years (in)	Height (ft)	Height growth in 4 years (in)
Level (at grade)	5.44	2.58	18.6 a[1]	5.2
4" Below landscape surface	5.20	2.34	17.6 b	5.0
8" Below landscape surface	5.30	2.44	17.8 b	5.5

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 48 trees per treatment, averaged over nursery planting depth and root pruning treatment.

Table 3. Caliper and height of live oak that were root pruned or not root pruned at planting four years ago.

Root pruning	Caliper (in)	Caliper growth in 4 years (in)	Height (ft)	Height growth in 4 years (ft)
Yes	5.24	2.37	17.8 b[1]	5.0
No	5.39	2.54	18.2 a	5.4

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 72 trees per treatment, averaged over nursery and landscape planting depth.

What's next: Caliper, heights and root system quality will continue to be collected to determine the effect of planting depth on landscape live oak growth. In coming years, trees will be pulled over and roots will be excavated to measure root structure, tree health and tree stability.

Here is a correctly planted tree with substrate surface slightly above surrounding soil. Root pruning (white lines) at planting cut several inches inside the root ball all the way to the bottom of the root ball. This root pruning does not correct any defects further inside the root ball.

Conclusion: Root pruning at planting had no impact on growth the first four years after planting.

Great Southern Tree Conference: Impact of pruning dose on codominant stem growth of Highrise® live oak

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
Jason Grabosky, Dept of Ecology, Evolution and Natural Resources, Rutgers University
December 1 – December 3, 2010
Gainesville, FL

Objective: Determine the impact of amount of foliage removed from a codominant pruned stem on subsequent growth rate of Highrise® live oak.

What we did: In July 2007, 48 Highrise® live oaks were pruned to reduce the biomass of the largest diameter branches by one of four targeted pruning doses: 0% (control), 25%, 50%, or 75% foliage removed. On each tree, the diameters of the largest branches were measured at the base just above where it met the trunk. These were pruned according to the prescribed dose; the main trunk was not pruned (termed the leader stem). To calculate the exact amount of biomass removed, the cross-sectional area of each pruning cut was measured and added together to give the total area of pruning cuts on that stem. Dose (as a percentage) was calculated as the total cross-sectional area of pruning cuts divided by the cross-sectional area at the base of pruned branches just above the point where they joined the leader stem. One to four pruning cuts were made on each pruned branch to attain the targeted dose; some cuts were reduction cuts and some removal cuts. All trees were fertilized in a 12 ft x 16 ft plot with 2.4 lbs of 16-4-8 three times a year in 2007 and 2008. In July 2007 and September 2010, the pruned and un-pruned stems of each tree were measured to determine stem diameter growth.

What we found as of November 2010: Pruned stems grew slower than stems that were not pruned in the first 3 years after administering the pruning (Figure 1). Increasing the pruning dose by removing more foliage and branches reduced growth in a more-or-less linear fashion. Pruned stems grew slower than stems that were not pruned (Figure 1). Furthermore, 3 years following pruning, the cross-sectional basal area of the non-pruned leader stem grew more for the target dose of 50% than trees pruned with the 75% dosage or non-pruned trees (Figure 2). Pruning at the 50% dose shifted (increased) growth to the leader compared to the leader on trees not pruned or pruned at the 75% dosage. Furthermore, pruning dose also had an effect on trunk diameter (Figure 3). Trees that received 25% pruning dose on the codominant stem grew more in trunk diameter (caliper) beginning in the first year following pruning than trees that were not pruned and trees that were pruned more severely (Figure 3).

Conclusion: Pruning reduced cross-sectional area growth on pruned branches compared to the leader stem that was not pruned. Increased pruning dose reduced cross-sectional area growth on the pruned branches in proportion to amount of foliage removed. In the three years following pruning, cross-sectional area of the unpruned leader stem increased more on trees receiving targeted pruning doses of 50% than trees pruned with the 75% severity or trees not pruned. Shift in growth from the pruned to unpruned portion of the tree reduced aspect (diameter) ratio between the pruned and unpruned stems which should make the unions stronger. Aspect ratio changed most for the 75% pruning severity. This supports the ANSI A300 pruning standard allowing more than 25% removal per stem, and provides guidelines for growers producing leaders when structurally pruning shade trees in a nursery, and for arborists pruning young trees in landscapes. It could also apply to younger outer portions of the crown of older trees where most structural pruning is conducted to resist storm damage.

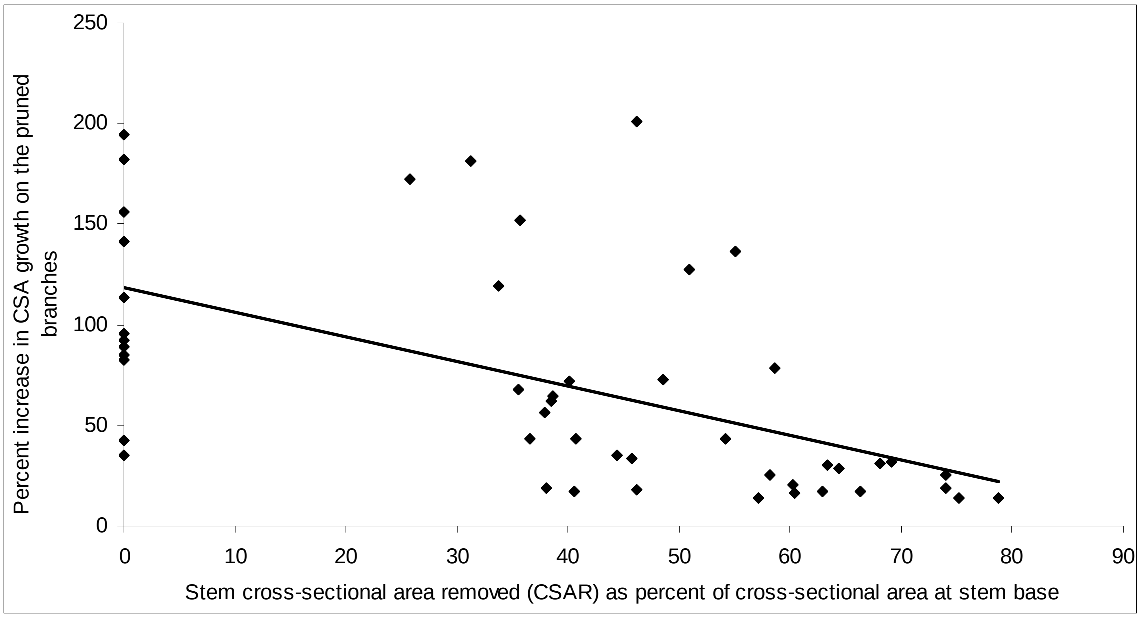

Figure 1. Percent increase in cross sectional area of pruned codominant branches averaged for each tree between July 2007 and September 2010 following removal of increasing amounts of stem cross-sectional area. Percent increase = 118.8 – 1.22 (CSAR), $r^2 = 0.31$, slope and intercept $P < 0.0001$.

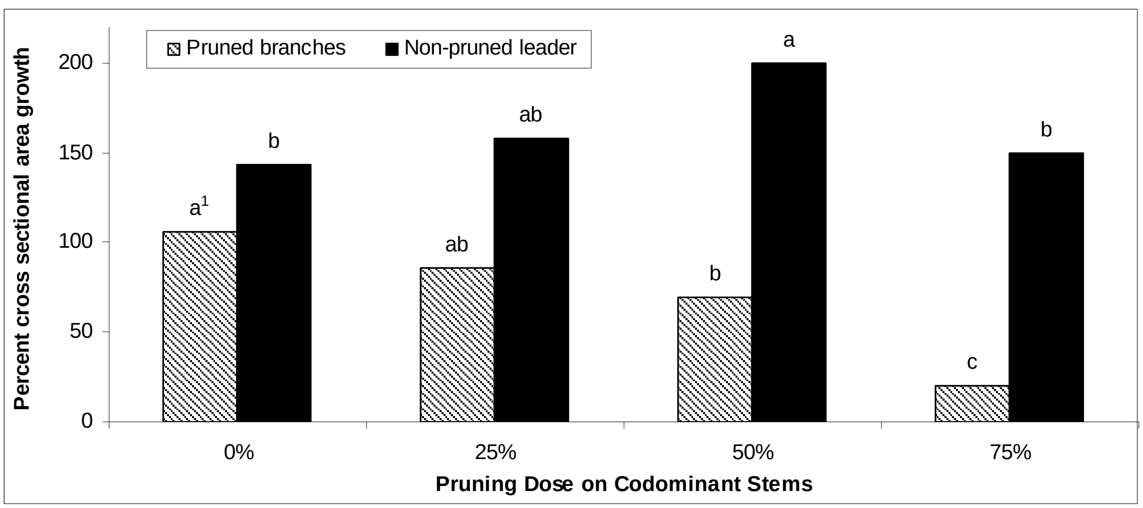

Figure 2. Cross sectional area growth in three years on pruned branches and non-pruned leader stem following removal of target pruning dose. [1] Bars for non-pruned leader or pruned branches with the same letter are not statistically different at $P < 0.05$. Pruned branches are not compared to non-pruned leader.

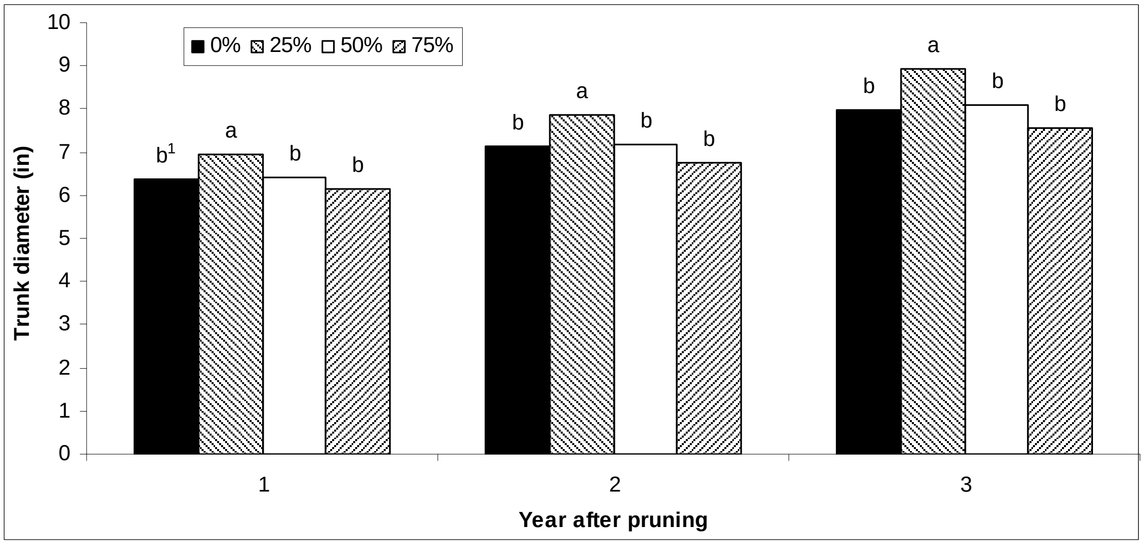

Figure 3. Trunk diameter 30 cm (12 in) from ground three subsequent years after pruning for four pruning severities (0, 25, 50 and 75%) from codominant stems. [1]Within a year, bars with the same letter are not statistically different at $P < 0.05$.

Codominant stems were reduced by removing branches from the ends with reduction and removal cuts.

Pictured at left is the typical amount removed from a stem in the 75% dose treatment. Removed branches range from ½ to about 2 inches diameter.

Great Southern Tree Conference: Effect of container type and root pruning on root quality of 'Florida Flame' maple.

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, FL

Objective: Determine impacts of container type and root ball shaving on root defects, including kinks, formation of stem girdling roots and diving roots, on 'Florida Flame' maple.

What we did and will do: In April 2008, 384 'Florida Flame' maple trees from liner containers were potted into eight different #3 container types with the top-most root planted right at soil level. The container types are smooth sided (Nursery Supplies, Inc., Chambersburg, PA), SmartPot® (Root Control, Inc., Oklahoma City, OK), RootBuilder® and RootMaker® (Rootmaker® Products Company, LLC, Huntsville, AL), Fanntum™ (Fanntum Products, Inc., Statesville, NC), Florida Cool Ring™ (The Florida Cool Ring Company, Lakeland, FL), Airpot™ (Caledonian Tree Company, Ltd., Scotland) or Jackpot™ (Legacy Nursery Products, LLC, Palm City, FL), and were placed pot to pot. Substrate was 20: 60: 20 (New Florida peat: pine bark: sand, by volume) for RootMaker®, RootBuilder®, Fanntum™, Florida Cool Ring™ and Jackpot™ , and 50: 40: 10 (New Florida peat: pine bark: sand, by volume) for Airpot™, SmartPot® and smooth sided. Volume of substrate in each container was similar except the Jackpot™, which was about 15% smaller in volume than others. Trees were irrigated 3 times daily and were staked in May 2008. Calipers and heights were collected in September 2008. Root balls on 9 trees of each container were excavated November 2008 and root balls evaluated. In February 2009, 288 trees total of the #3 container types were shifted to the same type of #15 containers with the same substrate. The RootMaker® was replaced by RootTrapper® (a type of fabric container from the same manufacturer) since the largest size RootMaker® is #5, and will be referred as the RootTrapper® in this report. Before shifting into #15 containers, root balls on half of the trees of each container type were pruned in one of two ways: a) no root pruning, or b) shaving off the outer root ball, which removes the peripheral and bottom one inch of the root ball. The remaining 24 trees (3 for each container type) were planted directly into the ground, with the root ball intact and planted even with the soil.

In November 2009, five trees of the #15 of each treatment combination (container type and root pruning – 80 trees total) were destructively harvested to evaluate root morphology. In February 2010, 10 trees for each treatment combination were shifted to the same type #45 containers with the same substrate. Roots were pruned before shifting following the same protocol described above. The remaining 48 trees (3 for each treatment combination) were planted directly into the ground, with the root ball intact and planted even with the soil in a randomized complete block design. In spring 2011, five trees of each treatment combination will be destructively harvested to evaluate root morphology. The rest of the trees (5 trees for each treatment combination) will be planted into the landscape. In spring 2012, and perhaps in subsequent years, stress required to pull trees to a 10 degree angle will determine landscape tree stability. After the last pulling, trees will be dug to characterize root systems; root form will be related to stability characteristics. This will help develop a better understanding of what root form makes trees stable.

What we have found as of November 2010: Caliper of red maples growing in smooth sided #45 containers were greater than for any other container type, except SmartPot®; however differences were small (Table 1). While those in either Jackpot™ had the smallest tree calipers (Table 1), Jackpot™ had 15% less substrate than other containers. Also, Jackpot™ produced shorter trees than four other containers probably for the same reason (Table 1). Root pruning prior to shifting to the next container size had no effect on caliper or height of trees (data not shown). This has typically been the case in our previous root pruning studies; trees may have been stunted had we not kept pace with irrigation needs. For #3 and #15 sized trees planted into landscape soil in November of 2008 and 2009, respectively, there was no difference in caliper or heights for the different container types (Table 2).

Root balls of #15 smooth sided pots had similar percent of trunk circled by roots at the position of the #3 container as RootBuilder® and RootTrapper®. Airpot™, Cool Ring™, Fanntum™, Jackpot™, and SmartPot® had fewer circling roots than smooth sided pots (Table 3). Container type had no effect on percent trunk circled by roots at the position of the #15 container (data not shown). There were other differences in root systems of maples in the various container types (Table 3).

Root ball shaving prior to shifting #3 containers into #15 dramatically improved root system quality by reducing the percentage of trees considered culls from 78 to 23% (Table 4). Shaving also reduced the percentage of trunk circling roots in the #3 from 57 to 16%, reduced the percentage of trees with roots growing over the flare, and reduced the percentage of circling and ascending roots at the edge of containers (Table 4). Root ball shaving increased the diameter of the five largest roots at the edge of the #15 on the north and south side of the ball, while decreasing the diameter of the 5 largest roots on the edge of the #3 (Table 4). For all container types (except Jackpot™), root ball shaving also increased the amount of radial roots > 2mm at the #15 (Figure 1). Jackpot™ probably did not respond because it had very few roots growing on the periphery of the root ball to begin with. Root ball shaving appears to improve tree quality while not affecting growth.

Conclusion: Shaving roots balls appears to have a greater impact on root system quality than container type.

Table 1. Caliper and height of 'Florida Flame' maples growing in eight different container types.

Container type	Finished #3 Containers Caliper (mm)	Finished #3 Containers Height (ft)	Finished #15 Containers Caliper (mm)	Finished #15 Containers Height (ft)	Finished #45 Containers Caliper (mm)	Finished #45 Containers Height (ft)
Airpot™	16.7 abc[1]	7.1 a	41.8 ab	9.5 a	61.76 bc	14.6 cd
Cool Ring™	15.8 c	6.4 b	38.3 d	9.0 b	59.69 cd	14.8 bcd
Fanntum™	17.4 ab	7.0 a	40.5 bc	9.3 ab	59.96 cd	15.1 abc
Jackpot™	14.6 d	6.5 b	37.8 d	8.7 b	58.29 d	14.6 d
RootBuilder®	17.7 a	7.2 a	40.1 c	9.0 b	58.78 d	15.1 abc
RootTrapper®	17.7 a	7.1 a	41.2 bc	9.3 ab	60.97 bc	15.2 ab
SmartPot®	16.6 bc	6.9 a	43.1 a	9.2 ab	62.31 ab	15.1 abc
Smooth sided	17.4 ab	7.1 a	43.0 a	9.2 ab	63.92 a	15.4 a

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 48 trees per treatment for #3, 36 trees per treatment for #15, and 20 trees per treatment for #45 averaged across root pruning treatment.

Table 2. Caliper and height of 'Florida Flame' maples planted to the landscape from #3 (Nov 2008) and from #15 (Nov 2009) containers.

Container type	#3 planted into landscape soil[1] Caliper (mm)	#3 planted into landscape soil[1] Height (ft)	#15 planted into landscape soil[1] Caliper (mm)	#15 planted into landscape soil[1] Height (ft)
Airpot™	61.0	14.8	59.4	14.8
Cool Ring™	69.2	16.4	58.2	14.3
Fanntum™	70.3	15.8	60.7	14.5
Jackpot™	62.8	14.5	57.6	14.0
RootBuilder®	65.4	15.5	57.9	13.7
RootTrapper®	65.3	14.6	61.1	15.2
SmartPot®	71.5	15.1	60.8	14.8
Smooth sided	63.8	15.2	59.7	14.1

[1]Based on 3 trees per container type for #3 and 6 trees per treatment for #15. There were no differences among treatments.

Table 3. Effect of container type on root ball characteristics of 'Florida Flame' maples finishing out in eight different #15 container types.

Container type	% trunk circled with roots at #3 position	% trees with roots > 5mm over flare	Diameter of 5 largest roots at edge on north side of container (mm)
Airpot™	31 bcd[1]	20 bc	5.8 abc
Cool Ring™	34 bcd	20 bc	6.1 ab
Fanntum™	28 bcd	50 abc	5.4 abcd
Jackpot™	18 d	10 c	4.5 cd
RootBuilder®	46 abc	20 bc	6.5 a
RootTrapper®	50 ab	80 a	4.1 d
SmartPot®	27 cd	60 ab	5.3 abcd
Smooth sided	56 a	40 abc	5.0 bcd

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 10 trees per container type averaged across root pruning treatment. Root circling appeared more prominent on the north side of most containers regardless of type.

Table 3. Continued

Container type	Diameter 5 largest roots on edge of #3 in the top half of root ball	% 5 largest root on edge of #3 that:	
		Descended	Ascended
Airpot™	12.5 abc[1]	76 a	2 b
Cool Ring™	12.7 ab	46 abc	2 b
Fanntum™	6.4 d	20 c	4 b
Jackpot™	5.7 d	33 bc	0 b
RootBuilder®	11.8 abc	56 ab	2 b
RootTrapper®	8.0 bcd	30 bc	13 a
SmartPot®	7.8 cd	49 abc	0 b
Smooth sided	13.5 a	60 ab	4 b

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 10 trees per container type averaged across root pruning treatment.

Table 4. Effect of root pruning #3 root balls when shifting to #15 on root ball characteristics of 'Florida Flame' maples averaged over eight different #15 container types.

Root pruning	% trees graded as a cull[1]	% trunk with circling roots at #3	% trunk with circling roots at #15	% trees with roots > 5mm over flare	Diameter 5 largest roots on edge of #3 top half of root ball
None	78 a[2]	57 a	8 b	48 a	12.7 a
Shaved	23 b	16 b	16 a	28 b	6.9 b

[1]Based on Florida Grades and Standards for Nursery Stock.
[2]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 40 trees per treatment averaged across 8 container types.

Table 4. Continued

Root pruning	Diameter of 5 largest roots at edge on north side of #15 (mm)	Diameter of 5 largest roots at edge on south side of #15 (mm)	% 5 largest roots on edge of #3 that:	
			Circled	Ascended
None	4.5 b[1]	4.2 b	40 a	6 a
Shaved	6.1 a	5.4 a	12 a	1 b

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 40 trees per treatment averaged across 8 container types.

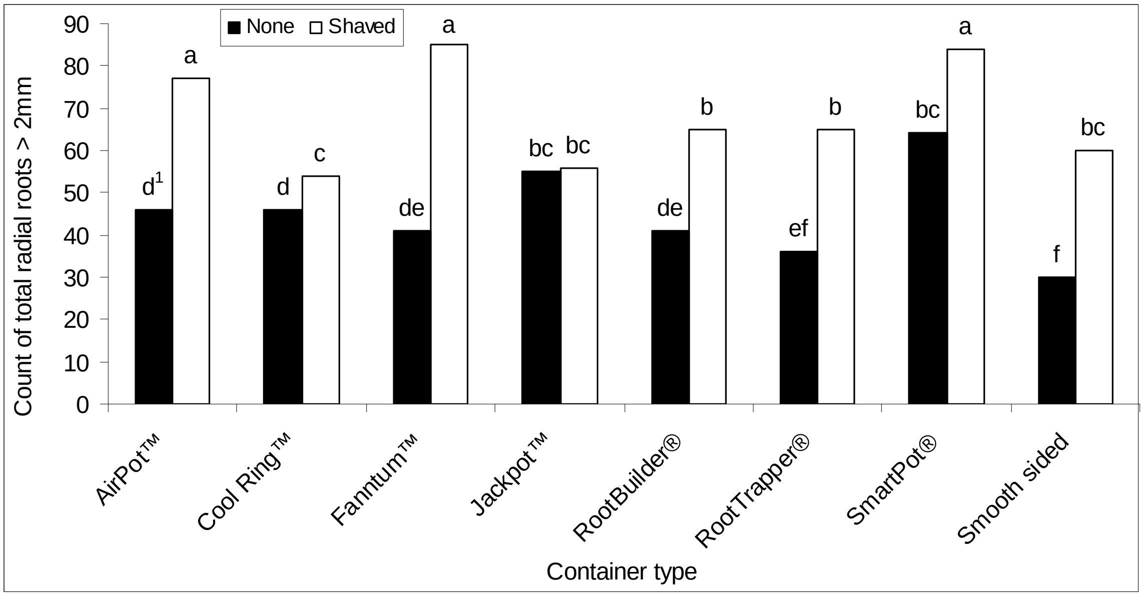

Figure 1. Count of radial roots (roots growing straight away from trunk) > 2mm diameter on trees where root balls were shaved or not in 8 different container types. [1]Bars with a different letter are statistically different at P < 0.05. Based on 5 trees per treatment.


AirPot™


Florida Cool Ring™


Fanntum™


SmartPot®


Jackpot™


RootBuilder®


RootTrapper®


Smooth sided

One #3 finished red maple root system from each of the 8 container types in the test.

Great Southern Tree Conference: Effect of tree size, mulch and irrigation on 'Florida Flame' maple landscape performance.

Ed Gilman, Maria Paz, Chris Harchick, and Richard Beeson, Environmental Horticulture, and
Central Florida REC, University of Florida
December 1 – December 3, 2010
Gainesville, Florida

Objective: Track growth, root characteristics, and stability of 'Florida Flame' maple planted in the landscape from various container sizes under two different irrigation and mulch treatments.

What we did: In February and March 2006, 16 red maples were planted into the landscape from #3, #25, #65 or #300 containers, for a total of 64 trees. Trees were irrigated daily from planting to the beginning of May 2006 (15 gallons per irrigation the first 3 weeks followed by 7 gallons thereafter for #300, 5 gallons for #65 and #25, and 2.5 gallons for #3). All irrigation was applied to the root ball only. This was followed with approximately 2 weeks of no irrigation. Irrigation resumed to every other day at the end of May 2006 with #300 receiving 18 gallons, #65 receiving 9 gallons, #25 receiving 6 gallons and #3 receiving 3 gallons of water each irrigation day. The weather remained dry so an exception to this schedule was made during 3 weeks in June, when irrigation was administered every day. Water was turned off in March 2007. In May 2007, half the trees (8) for each size were irrigated Monday, Wednesday and Friday. The other half of the trees (8) for each size were not irrigated ever again in the study. Also in May 2007 (one year after planting), half of the irrigated trees and half of the non-irrigated trees for each size were mulched up to the trunk with a 3" layer of shredded hardwood, while the other half was kept bare with periodic applications of Roundup. Roundup was also used to keep mulched plots clean of weeds. Trees have not been fertilized since planting. Caliper measurements were collected for all trees in September 2010.

What we found as of November 2010: Mulch and irrigation had a small growth enhancing effect on caliper four years after planting (Table 1 and 2). Trees appeared to grow in trunk caliper at the same rate regardless of initial tree size, with the larger tree sizes retaining greater calipers (Figure 1).

Table 1. Caliper (in) and caliper growth in four years (in) for mulched and non-mulched trees averaged over #3, #25, #65 and #300 container trees.

Mulch	Caliper (in)	Caliper growth in 4 years (in)
Yes	7.11 a[1]	3.71 a
No	6.55 b	3.20 b

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 32 trees per treatment.

Table 2. Caliper (in) and caliper growth in four years (in) for irrigated and non-irrigated trees averaged over #3, #25, #65 and #300 container trees.

Irrigation	Caliper (in)	Caliper growth in 4 years (in)
Yes	7.04 a[1]	3.63 a
No	6.64 b	3.28 b

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 32 trees per treatment.

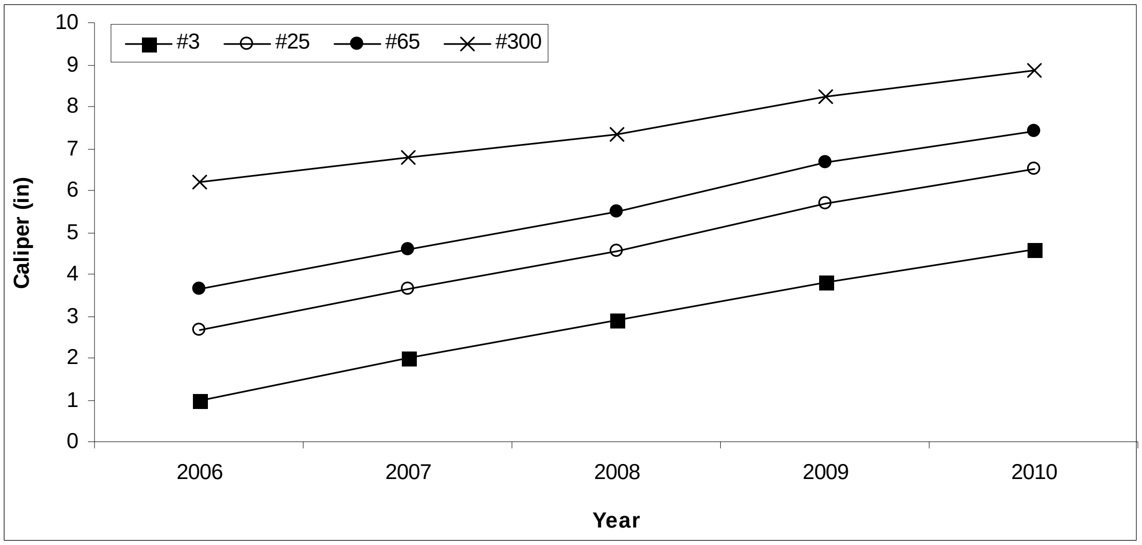

Figure 1. Caliper (in) of 'Florida Flame' maples from September 2006 to September 2010 planted from #3, #25, #65 and #300 containers.

Conclusions: Trees planted from small containers are growing at the same rate as trees planted from enormous containers. Mulch placed on and around the root ball one year after planting slightly increased growth. Irrigation applied to the root ball surface for four years after planting slightly improved growth compared to no irrigation.

Great Southern Tree Conference: Impact of root pruning techniques on root system quality of red maple and live oak in containers and landscape stability.

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, Florida

Objective: Demonstrate the effects of removing all roots on the outer one inch of #3 container root balls on top and root growth of red maple and live oak.

What we did: In April 2008, 40 #3 container-grown 'Florida Flame' maples and 40 Cathedral Oak® live oaks were potted into #15 containers. Twenty trees of each species were root pruned by shaving about one inch from the outer root ball and bottom from #3 Airpots before shifting into #15 smooth sided pots. The other twenty trees were potted without disturbing the root balls. Trees were irrigated three times daily and pruned and staked in June 2008. In September 2008, ten maples of each treatment were destructively harvested to dissect the root balls. Root ball data was collected and results included in the 2009 GSTC Report. Twenty trees of each species (10 per treatment) were planted in the field in November 2008 for the maples and January 2009 for the live oaks, to compare tree stability in the landscape resulting from root pruning treatment against root balls intact. When the trees were in containers, north was marked on all trees and the mark was placed either north or south when field planting, to test whether heat from direct sun exposure on the south side of container affects root distribution and tree stability after landscape planting. Trees are being watered three times a week and were fertilized with 200 g of 16-4-8 on March and June 2009, and 400 g of 20-0-8 on March and May 2010. Trees were pulled until the trunk base tilted 5 degrees to test stability on August 2009 and 2010 for the maples, and October 2009 and 2010 for the live oaks. Moment was calculated as pulling force x distance between ground and pulling point. Tree caliper and height were collected September 2010.

What we found as of November 2010: Tree caliper and heights in #15 containers were not affected by root pruning for either species (2008 GSTC Report). For maples, shaving root balls reduced culls, produced higher quality root balls and a greater number of lateral roots. For live oaks, root ball shaving also improved root ball quality and increased number of roots growing out into the #15 substrate (2009 GSTC Report). Root pruning as trees were shifted from #3 into #15 containers had no effect on caliper and height two years after landscape planting (Table 1). Bending moment required to tilt trunks to 5 degrees one and two years after landscape planting was not affected by root pruning (Table 2). Orientation at planting in the landscape has had no effect on parameters measured (data not shown).

Conclusion: Shaving off root defects from the outer periphery of the root ball when trees were shifted from #3 to #15 containers in the nursery removed root defects without compromising growth or stability two years after planting into the landscape.

Table 1. Caliper and height two years after landscape field planting of 'Florida Flame' maples and Cathedral Oak® live oaks root pruned by shaving the outer inch of the root ball or not root pruning when shifted from #3 to #15 container. #15 containers were planted into landscape without root pruning.

Species	Root Pruning	Caliper[1] (in)	Height[1] (ft)
Maples	No pruning	3.32	17.4
	Root ball shaving	3.22	16.6
Live Oaks	No pruning	3.10	14.7
	Root ball shaving	3.20	14.6

[1] Based on 10 trees per species x root pruning combination (40 trees total). There were no differences among treatments.

Table 2. Trunk bending moment required to pull trees to 5 degree tilt, one and two years after planting into the landscape of 'Florida Flame' maples and Cathedral Oak® live oaks root pruned by shaving the outer inch of the root ball or not root pruning when shifted from #3 to #15 container. #15 containers were planted into landscape without root pruning.

Species	Root Pruning	Pulling moment one year after planting[1] (kNm)	Pulling moment two years after planting[1] (kNm)
Maples	No pruning	0.37	1.71
	Root ball shaving	0.33	1.62
Live Oaks	No pruning	0.21	1.31
	Root ball shaving	0.22	1.62

[1] Based on 10 trees per species x root pruning combination (40 trees total). There were no differences among treatments.

Shaving the root ball removes the outer edge and bottom of the root ball.

Shaved root balls are smaller after pruning (right) than before (left).

Great Southern Tree Conference: Root defect removal and mulch effects on landscape performance of elm and maple.

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, Florida

Objective: Determine how planting depth in containers, root defect removal when planting, and mulch over root balls affects landscape performance of recently planted elms and maples.

What we did: In February 2008, 40 elms and 40 maples were planted in the landscape from #45 smooth-sided containers raised from cuttings. Cuttings were potted into #3 Airpots either with the top-most root even with the surface or 2.5" deep; then they were shifted to #15 Airpots even with the surface or another 2.5" deep; then they were shifted into smooth-sided #45 containers even with the substrate surface. Before planting into the landscape, ten trees of each planting depth and species (40 trees total) were air spaded to expose the root flare. Roots growing over the root flare were removed to the edge of the root ball. Time required to air spade and remove root defects was recorded for each tree. The other twenty trees of each species were left untouched. Trees were planted into the landscape with the top of the root ball an inch or two above surrounding landscape soil. Mulch 4" deep was applied around the root ball but not over the root ball on half the trees; the other half of the trees were mulched up to the trunk. There are a total of 8 treatments (2 planting depths in containers x 2 root removal treatments x 2 mulch treatments) combinations for each species, with 5 replicate trees for each treatment. All trees are being irrigated three times a week. Trees were fertilized with 400 g of 16-4-8 on March and June of 2008 and 2009, and with 400 g of 20-0-8 on March and May 2010. All trees were staked with the Terra Toggle root ball stabilization system in June 2008, which was removed in June 2009. Tree caliper were collected September 2010.

What we found as of November 2010: Trees of both species that were planted deeply in the container took much longer to remove substrate and root defects at planting than trees planted at the appropriate depth in containers (Table 1). Elm trunk caliper three growing seasons after landscape planting was not affected by planting depth in the nursery container, root removal treatments or mulch treatment (data not shown). Maple caliper was affected by the interaction of root removal and mulch over the root ball (Table 2). For trees with no mulch placed over the root ball, trees that had root defects removed prior to planting have larger calipers than trees without root pruning at planting (Table 2). This difference in caliper is small (less than half an inch), but it will be interesting to see how trees keep growing. This project is ongoing. Trees will be pulled laterally to trunk or root failure to evaluate stability in the next year or two.

Conclusion: Keeping mulch off the root ball surface had no detrimental effects on trees in the first 28 months after planting. Mulch placed over the root ball did not improve growth or health on elm or maple trees. Planting trees deeply in the root ball in the nursery makes it very difficult to plant trees correctly into the landscape due to the enormous amount of roots growing over the flare. These must be removed at planting.

Table 1. Time required to remove root defects of even or deep planted maples and elms finished in #45 containers.

Species	Planting Depth in #15	Air spade time (sec)	Root prune time (sec)	Total time (sec)
Elms	Level	70 b[1]	185 b	255 b
	2.5" deep	102 a	328 a	430 a
Maples	Level	98 b	380 b	478 b
	2.5" deep	153 a	756 a	909 a

[1]Means in a column within species with a different letter are statistically different at $P<0.05$. Based on 10 trees per treatment per species (40 trees total).

Table 2. Effect of root defect removal prior to planting and placement of mulch over the root ball or not on caliper of maples 28 months after planting.

Root defect removal at landscape planting	Mulch over root ball at planting	Caliper 28 months after planting(in)	Caliper growth 28 months after planting (in)
Yes	Yes	4.95 ab[1]	2.07
	No	5.22 a	2.17
No	Yes	5.03 ab	2.03
	No	4.79 b	1.98

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 10 trees per treatment combination (40 trees total).

Substrate removed from top of root ball exposed roots so root defects could be removed. Roots that were kinked, circled, diving or crossing roots were removed to the first major roots shown above.

Roots were cut and removed if they circled over the major flare roots. Note the two visible cuts above. Another set of trees was planted without removing root defects (these trees are not shown here).

Great Southern Tree Conference: Container planting depth, root shaving and landscape planting depth effect on Miss Chloe® magnolia landscape performance

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, Florida

Objective: Determine how planting depth in containers, root ball shaving when planting, and landscape planting depth affects landscape performance of recently planted Miss Chloe® magnolia.

What we did: In September 2008, 48 Miss Chloe® magnolias were planted in the landscape from #45 smooth-sided containers raised from cuttings. Cuttings were potted into #3 Airpots either with the top-most root even with the surface or 2.5" deep; then they were shifted to #15 Airpots even with the surface or another 2.5" deep; then they were shifted into smooth-sided #45 containers even with the substrate surface. When planted into the landscape, half of the trees were either planted 2 inches above the soil surface, or 4 inches below the soil surface. After the trees were set in the ground, half of each of the treatment combinations was either planted with no root shaving, or the root balls were shaved before completely filling the landscape planting hole. Root balls were shaved by edge pruning to remove approximately 2 inches of the outer edge of the entire root ball. There are a total of 16 treatments (4 planting depths in containers x 2 landscape planting depths x 2 root shaving treatments) combinations, with 3 replicate trees for each treatment. Trees were mulched immediately after planting with mulch to the trunk. Trees that were planted high were mulched with 2 inches of mulch on the root ball and 4 inches outside the ball, while those planted deep, had 4 inches of mulch over ball and outside the ball. All trees are being irrigated once a day. Trees were fertilized with 400 g of 16-4-8 on November 2008, and March and June of 2009, and with 400 g of 20-0-8 on March and May 2010. Radius of the root system was measured by gentle excavation on May and November 2009 and compared to tree canopy radius to determine root to shoot ratio. Caliper and height were collected September 2010.

What we found as of November 2010: Planting depth in the nursery container and root ball shaving at planting had no impact on any measurements (data not shown). Only landscape planting depth had an effect on root system radius and root to shoot ratio of magnolias (Table 1). Eight months after planting, roots of magnolias that were planted high in the landscape have extended farther into the landscape than those planted deeply, thus the root to shoot ratio was higher. But 14 months after planting, the difference was no longer significant (Table 1). About one year after landscape planting, magnolias roots had extended past the tree canopy (root to shoot ratio November 2009).

Landscape planting depth also had an effect on tree caliper two years after planting (Table 2). Trees that were planted high in the landscape had a larger caliper than those planted deeply, but trees grew at a comparable rate in the 2 years since planting. Tree height was not affected by landscape planting depth (Table 2). No other treatment had an effect on caliper or height. Trees continue to be monitored to determine effect on growth. Trees will be pulled in the future to determine the effect of planting depth and root ball shaving on magnolia tree stability in the landscape.

Conclusion: Root ball shaving to reduce root defects when planting #45 containers into the landscape did not impact root system expansion into landscape soil or top growth of Magnolia. Planting deeply may slow establishment and growth rates.

Table 1. Effect of landscape planting depth on root radius and root to shoot ratio of Miss Chloe® magnolias in May and November 2009.

Landscape planting depth	Root radius May 09 (in)	Root:Shoot ratio[1] May 09	Root radius Nov 09 (in)	Root:Shoot ratio[1] Nov 09
2 inches high	30.1 a[2]	0.71 a	48.6	1.09
4 inches deep	23.3 b	0.56 b	45.1	1.03

[1]Root:shoot ratio of 1 means the longest root has reached the dripline.
[2]Means in a column with a different letter are statistically different at P<0.05. Based on 24 trees per treatment averaged across root pruning at planting and planting depth in containers.

Table 2. Effect of landscape planting depth on caliper and height of Miss Chloe® magnolias two years after planting

Landscape planting depth	Caliper (in)	Caliper growth in 2 years (in)	Height (ft)	Height growth in 2 years(ft)
2 inches high	4.22 a[1]	1.36	16.8	5.46
4 inches deep	3.89 b	1.28	16.2	5.65

[1]Means in a column with a different letter are statistically different at P<0.05. Based on 24 trees per treatment averaged across root pruning at planting and planting depth in containers.

Shaving the root ball at planting reduced root defects without any negative impacts on survival, health, or growth the first two years after landscape planting.

Great Southern Tree Conference: Impact of length in nursery containers on Miss Chloe® magnolia, 'Florida Flame' maple and Allée® elm quality.

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, Florida

Objective: Demonstrate the impact of the time magnolias, maples and elms are left in #3 and #15 containers in the nursery on subsequent root quality on finished trees in #45 containers and field performance.

What we did and will do: In February 2007, eighty liners of each species (Miss Chloe® magnolia, 'Florida Flame' maple and Allée® elm) were potted into #3 black nursery containers. Thirty two (32) elms died from freezing damage and subsequent water stress. Twenty magnolia and maples, and twelve elms were: (1) potted June 2007 into #15 after 4 months in #3, and then potted Feb 2008 into #45 after 8 months in #15; or (2) potted Sept 2007 into #15 after 7 months in #3, and then potted July 2008 into #45 after 10 months in #15; or (3) potted Nov 2007 into #15 after 9 months in #3, and then potted Nov 2008 into #45s after 12 months in #15; or (4) potted Feb 2008 into #15 after 12 months in #3, and then potted April 2009 into #45 after 6 months in #15. Trees were finished in #45 containers in October 2009, when 5 trees of each treatment were harvested and root balls dissected for data collection. Root balls were not pruned when shifted to a larger container and were planted even with the substrate in the larger container.

In May 2010, the remaining trees were planted in the landscape. Twenty elms were planted into the landscape with root balls undisturbed and planted even with the landscape soil. For the magnolias and maples, the root balls of half of the trees for each species were either: 1) left intact; or 2) after placing in the planting hole, the balls were shaved with a balling shovel to remove approximately 2 inches of the outer periphery of the entire root ball. All trees were planted even with the landscape soil. All trees are being irrigated every other day (threes times a day on these days). Trees were fertilized with 800 g of 20-0-8 in June 2010. Caliper and height for all trees were collected September 2010. Trees were rated for active growth and wilting in May 2010, and for foliage density in September 2010.

What we found as of November 2010: Caliper and height growth on elms and magnolias planted into the landscape was not affected by time spent in either size nursery container (Table 1). Maples that spent less time in #3 and #15 and more time in #45 had larger calipers when compared to the other times in these sizes (Table 1). Maples and magnolias that spent less time in #3 and #15 and more time in #45 were less wilted (Table 2). Active growth rating or foliage density for all species was not affected by time in pot (Table 2). Root pruning at planting had no effect on caliper, height or ratings.

Elms that spent less time in #3 had fewer circling roots touching the trunk when compared to those that spend the most time in #3 (Table 3). Elms that spent the most time in #3 has less straight roots inside #15 and smaller roots between #15 and #45 (Tables 3 and 4). Maples that spent the most time in #3 had more circling roots touching the trunk and larger roots inside #3 (Table 3); while maples that spent the least time in #3 has larger roots inside #45 and between #15 and #45 (Table 4). Magnolias that spent the least time in #3 has a greater number of straight roots inside #45 (Table 3) and larger roots inside #45 (Table 4).

Conclusion: Overgrowing trees in containers is detrimental to root quality. Overgrowing trees in the smaller sizes seems to be the most detrimental. Trees that spent the least amount of time in #3 and #15 containers had the least amount of circling roots and they had straighter roots. There is some evidence that planting trees that were retained in #3 and #15 container sizes for 12 and 14 months, respectively, prior to shifting were more stressed after landscape planting than trees held in these container sizes for a shorter time period.

Table 1. Caliper and height of elms, maples and magnolias grown for different time periods in #3, #15, and #45 containers, then planted into landscape field soil May 2010.

Treatment	Caliper before planting (in)	Caliper 4 months after planting into landscape (in)	Height before planting (ft)	Height 4 months after planting into landscape (ft)
		Elms		
4 mo #3; 8 mo #15; 20 mo #45	2.63 a[1]	3.05	12.9 b	15.2
7 mo #3; 10 mo #15; 15 mo #45	2.66 a	3.09	14.1 a	14.5
9 mo #3; 12 mo #15; 11 mo #45	2.52 a	2.96	14.8 a	16.0
12 mo #3; 14 mo #15; 6 mo #45	2.36 b	2.92	13.7 ab	15.4
		Maples		
4 mo #3; 8 mo #15; 20 mo #45	2.57 b	3.11 a	14.7 ab	16.4
7 mo #3; 10 mo #15; 15 mo #45	2.80 a	3.52 b	15.4 a	16.8
9 mo #3; 12 mo #15; 11 mo #45	2.74 a	3.39 b	14.6 b	15.9
12 mo #3; 14 mo #15; 6 mo #45	2.71 a	3.38 b	15.5 a	16.5
		Magnolias		
4 mo #3; 8 mo #15; 20 mo #45	2.42 a	2.88	11.0 a	12.6
7 mo #3; 10 mo #15; 15 mo #45	2.44 a	2.82	10.3 b	12.2
9 mo #3; 12 mo #15; 11 mo #45	2.20 b	2.81	10.5 b	12.3
12 mo #3; 14 mo #15; 6 mo #45	2.02 b	2.88	10.2 b	12.0

[1]Means in a column within species with a different letter are statistically different at $P < 0.05$. Based on 20 trees per treatment for magnolia and maple, and 12 trees per treatment for elm for data before planting. Based on 10 trees per treatment for magnolia and maple, and 5 trees per treatment for elm in September 2010.

Table 2. Active growth, wilt and foliage density ratings of elms, maples and magnolias grown for different time periods in #3, #15, and #45 containers, then planted into landscape field soil May 2010.

Treatment	Active growth rating[1] (0-3)	Wilt rating[1] (0-3)	Foliage density rating[1] (0-3)
	Elms		
4 mo #3; 8 mo #15; 20 mo #45	1.7	1.1	2.3
7 mo #3; 10 mo #15; 15 mo #45	0.9	0.6	2.2
9 mo #3; 12 mo #15; 11 mo #45	0.8	0.8	1.7
12 mo #3; 14 mo #15; 6 mo #45	0.4	0.7	2.1
	Maples		
4 mo #3; 8 mo #15; 20 mo #45	1.3	1.4 b[2]	1.7
7 mo #3; 10 mo #15; 15 mo #45	1.3	2.2 a	2.2
9 mo #3; 12 mo #15; 11 mo #45	0.9	2.1 a	2.4
12 mo #3; 14 mo #15; 6 mo #45	0.8	2.3 a	1.6
	Magnolias		
4 mo #3; 8 mo #15; 20 mo #45	2.8	1.2 c	2.5
7 mo #3; 10 mo #15; 15 mo #45	2.8	1.4 bc	2.6
9 mo #3; 12 mo #15; 11 mo #45	2.9	1.8 ab	2.7
12 mo #3; 14 mo #15; 6 mo #45	2.5	2.0 a	2.8

[1]Rating scale 0=none; 1=little; 2=moderate; 3=mostly

[2]Means in a column within species with a different letter are statistically different at $P<0.05$. Based on 10 trees per treatment for magnolia and maple, and 5 trees per treatment for elm.

Table 3. Percent of trunk circumference touched by roots and root counts of elms, maples and magnolias grown for different times in #3, #15, and #45 containers harvested October 2009.

Treatment	% trunk touched by roots	# straight roots inside #15	# straight roots inside #45
	Elms		
4 mo #3; 8 mo #15; 20 mo #45	8.8 c[1]	6.6 a	0.6
7 mo #3; 10 mo #15; 15 mo #45	16.8 ab	6.2 a	0.8
9 mo #3; 12 mo #15; 11 mo #45	14.6 b	4.0 ab	0.8
12 mo #3; 14 mo #15; 6 mo #45	21.6 a	3.2 b	0
	Maples		
4 mo #3; 8 mo #15; 20 mo #45	8.7 b	5.4	1.4
7 mo #3; 10 mo #15; 15 mo #45	0 c	7.0	2.0
9 mo #3; 12 mo #15; 11 mo #45	12.1 ab	4.6	0.6
12 mo #3; 14 mo #15; 6 mo #45	16.7 a	6.6	0.6
	Magnolias		
4 mo #3; 8 mo #15; 20 mo #45	0	9.4	3.2 ab
7 mo #3; 10 mo #15; 15 mo #45	4.4	10.4	4.4 a
9 mo #3; 12 mo #15; 11 mo #45	0	8.2	1.8 bc
12 mo #3; 14 mo #15; 6 mo #45	0	7.6	0.8 c

[1]Means in a column within species with a different letter are statistically different at $P<0.05$. Based on 5 trees per treatment.

Table 4. Root diameter of finished elms, maples and magnolias in #45 containers grown for different times in #3, #15, and #45 containers harvested October 2009.

Treatment	Diameter of roots ≥ 5 mm: Inside #3[1]	Inside #15[1]	Inside #45[1]	Diameter 5 largest roots between #15 and #45
		Elms		
4 mo #3; 8 mo #15; 20 mo #45	13.9	8.6	1.2 b	4.8 a
7 mo #3; 10 mo #15; 15 mo #45	13.3	9.0	4.9 a	4.5 a
9 mo #3; 12 mo #15; 11 mo #45	13.8	8.1	1.0 b	2.8 ab
12 mo #3; 14 mo #15; 6 mo #45	12.7	7.8	0 b	1.7 b
		Maples		
4 mo #3; 8 mo #15; 20 mo #45	11.7 b[2]	9.6	4.6 ab	5.1 a
7 mo #3; 10 mo #15; 15 mo #45	12.0 b	11.1	6.6 a	5.0 a
9 mo #3; 12 mo #15; 11 mo #45	15.9 a	9.0	1.5 bc	3.3 b
12 mo #3; 14 mo #15; 6 mo #45	14.2 ab	9.3	0 c	3.6 b
		Magnolias		
4 mo #3; 8 mo #15; 20 mo #45	15.2	11.7 a	7.9	6.7
7 mo #3; 10 mo #15; 15 mo #45	15.5	11.6 a	7.8	7.7
9 mo #3; 12 mo #15; 11 mo #45	15.0	11.1 a	7.5	5.4
12 mo #3; 14 mo #15; 6 mo #45	12.6	7.6 b	6.6	4.8

[1]Average diameter of all roots ≥ 5mm measured just inside the former position of the container wall.
[2]Means in a column within species with a different letter are statistically different at $P < 0.05$. Based on 5 trees per treatment.

Great Southern Tree Conference: Interaction of fertilization and pruning in sabal palms.

Tim Broschat, Fort Lauderdale Research and Education Center (REC)
Ed Gilman, Maria Paz, and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, FL

Objective: To demonstrate the interactive effects of fertilization and pruning on health and appearance of sabal palms.

What we did: Ten sabal palms spaced 20 feet apart with 24" deep plastic root barriers between trees received no fertilizer, ten received 0.12 lbs N/100 ft^2 from a 16-4-8 turf fertilizer every 3 months, and ten received the same amount of N from an 8-2-12-4Mg palm fertilizer every 3 months. Beginning March 2008, the 16-4-8 turf fertilizer was replaced with 16-0-8 due to availability. Fertilizer was spread over a circular 100 sq. ft. area. Half of the palms in each fertilizer treatment had only dead leaves removed once per year, while the other half had all but the 4 youngest leaves removed once per year. The trees were fertilized and pruned in March 2006, 2007, 2008, and 2009. Palms were fertilized again in July and November of each year. Total number of leaves, number of green leaves, and severity of potassium (K)-deficient leaves were recorded in March 2007, 2008 and 2009. A similar experiment was initiated at the Fort Lauderdale REC on January 2006 with data collected in October 2007, 2008, and 2009. Number of dead leaves attached to the tree were counted at the Gainesville site on September 2010.

What we found as of November 2010: For both locations, fertilizer type had no effect on total number of leaves, number of green leaves, or potassium deficiency symptoms, and on number of dead leaves for the Gainesville site (Table 1 and 2). However, at Ft. Lauderdale, fertilization with either product slightly increased leaf blade length (not measured in Gainesville) over that of unfertilized palms (Table 2). For both locations, severe pruning resulted in fewer living leaves one year later and no dead leaves at the Gainesville site (not measured in Ft Lauderdale) two years later (Table 3 and 4). Since there were fewer leaves in severely pruned palms when compared to palms which had only dead leaves removed, the proportion of leaves that were green was much greater for the severely pruned palms. Also, potassium deficiency scores were higher for severely pruned palms than for palms with only dead leaves removed (Table 3 and 4). These results have been consistent for four years on both sites.

Conclusions: Severe pruning reduced number of leaves in the canopy so that the potassium reserves were distributed among fewer leaves. This resulted in a smaller canopy and less visible potassium deficiency symptoms, as well as no dead leaves counted two years after the end of treatment application at the Gainesville site.

Table 1. Effect of fertilizer type on number of total and green leaves, percent green leaves, and K deficiency score for sabal palms in Gainesville on March 2009, and dead leaves on September 2010

Fertilizer	Total living leaves	Green leaves	% Green leaves	K deficiency score*	Dead leaves 2010
None	29	14	57.0	4.40	6.5
16-0-8	27	14	57.8	4.25	6.5
8-2-12+4	29	14	57.2	4.32	8.9

*0 = dead, 1 = severe K deficiency, 3 = moderate K deficiency, 5 = no deficiency symptoms. There were no differences among treatments.

Table 2. Effect of fertilizer type on number of total and green leaves, percent green leaves, and K deficiency score for sabal palms in Fort Lauderdale, October 2009.

Fertilizer	Total living leaves	Green leaves	% Green leaves	K deficiency score*	Leaf blade length (cm)
None	15	2	13.1	3.9	45.0 b[1]
16-4-8	17	4	22.0	4.0	49.5 a
8-2-12+4	17	4	22.9	4.1	47.5 a

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 5 trees per treatment.
*0 = dead, 1 = severe K deficiency, 3 = moderate K deficiency, 5 = no deficiency symptoms.

Table 3. Effect of leaf pruning on number of total and green leaves, percent green leaves, and K deficiency score for sabal palms in Gainesville on March 2009, and dead leaves on September 2010

Pruning	Total living leaves	Green leaves	% Green leaves	K deficiency score*	Dead leaves 2010
Dead only	39 a[1]	14	36.3 b	3.89 b	14.6 a
Severe	18 b	14	78.3 a	4.76 a	0 b

[1]Means in a column with a different letter are statistically different at $P<0.05$. Based on 5 trees per treatment.
*0 = dead, 1 = severe K deficiency, 3 = moderate K deficiency, 5 = no deficiency symptoms.

Table 4. Effect of leaf pruning on number of total and green leaves, percent green leaves, and K deficiency score for sabal palms in Fort Lauderdale, October 2009.

Pruning	Total living leaves	Green leaves	% Green leaves	K deficiency score*
Dead only	22 a[1]	5	22.9 b	3.96 b
Severe	12 b	8	64.5 a	4.89 a

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 5 trees per treatment.
*0 = dead, 1 = severe K deficiency, 3 = moderate K deficiency, 5 = no deficiency symptoms.

Potassium deficiency symptoms.

Sabal palm in March after removing only dead leaves.

The same palm in November.

Great Southern Tree Conference: Propagation tray type and time in tray affects root development of red maple

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, Florida

Objective: Determine impact of propagation tray type and time in tray on root development of red maple.

What we did and will do: In August 2008, red maple cuttings were stuck in six different propagation tray types: smooth, Elle pot to pot, Elle spaced, Elle in a smooth liner tray, Accelerator, or RootMaker®. Cuttings were held at the greenhouse for either 2 (Oct 2008) or 6 (Feb 2009) months. After each of these time periods, ten liners of each propagation tray treatment were destructively harvested and root balls (roots > 2 mm diameter) characterized. Another 45 liners for each tray type were potted into smooth sided #3 containers. Root balls shifted to #3s October 2008 were left intact; whereas those shifted February 2009, half of the root balls were left intact and the other half were shaved with a sharp scissor. Five trees of each treatment were destructively harvested to characterize root balls after 10 months of growing in the #3 containers. At the same time, thirty trees of each treatment were planted into field soil and thirty were planted into #15 smooth sided containers. Half of the trees planted in field soil were left untouched and for the other half, the root balls were shaved at planting. Field trees are being irrigated every day and were fertilized with 65 g of 20-08 on April 2010 and with 100 g of 20-0-8 on June 2010.

What we have found as of November 2010: Cuttings propagated in Elle Spaced and Elle in smooth had the greatest number of roots in the top half of the root ball, while Accelerators had the greatest number of roots in the bottom half of the root ball and the least in the top half (Table 1). Smooth sided propagation trays produced the largest root diameters in cuttings, which was only comparable to the number produced in Accelerator and RootMaker® (Table 1). All other propagation tray types had smaller root diameters. Smooth sided propagation trays also had the greatest number of roots deflected down, and RootMaker® had the least, but RootMaker® increased roots deflected around the edge of the tray (i.e. they had more circling roots) (Table 1). Holding cuttings in propagation trays longer increased root diameter and roots deflected by the edge of the trays (Table 2).

Red maples propagated in smooth sided trays and in Elle in smooth tray had the most visible liner when harvested from #3 containers (Table 3). These two propagation tray types also increased the number of roots deflected by liner sides and increased root depth after growing in #3 for 10 months (Table 3). Elle pot to pot and Elle spaced trays produced straighter roots in #3 containers (Table 3). Holding cuttings in propagation trays longer increased root diameter and length, and produced more straight root length in #3 possibly due to an increase in new roots generated close to the top of the propagation tray root ball (Table 4). Root pruning prior to potting up into #3 containers improved tree quality and produced straighter roots in the finished #3 containers (Table 5). Tree calipers and heights on finished #3 trees were not affected by propagation tray type, time in propagation trays, or root pruning prior to potting up into #3 (data not shown). The remaining trees were planted into field soil in late 2009 and early 2010 but no data is reported on these in this report.

Conclusions: Elle pots in an open tray either spaced apart or pot-to-pot produced root balls with the least amount of defects and better vertical root distribution than others without root pruning. Shaving liners from any tray type resulted in high quality root systems.

Table 1. Propagation tray type effect on red maple root counts and diameter.

Tray type	# of roots top half of root ball	#of roots bottom half of root ball	Diameter of largest roots (mm)	# roots deflected around edge	# of roots deflected down
Smooth	10.9 bc[1]	14.7 c	1.9 a	4.4 b	20.9 a
Elle pot to pot	9.2 c	14.5 c	1.5 b	0 d	0.5 d
Elle spaced	14.1 a	17.2 b	1.6 b	0.2 d	1.1 d
Elle in smooth	14.1 a	15.7 bc	1.5 b	3.3 bc	13.1 c
Accelerator	10.2 c	21.0 a	1.8 ab	2.1 c	17.0 b
RootMaker®	11.5 b	15.6 bc	1.7 ab	7.2 a	11.4 c

[1]Means in a column with a different letter are statistically different at P < 0.05. Based on 20 trees per treatment averaged across time in propagation tray.

Table 2. Time in propagation tray effect on roots of red maple cuttings harvested from propagation trays.

Time in propagation tray	Diameter of largest roots (mm)	# roots deflected around edge
2 months	1.43 b[1]	2.0 b
6 months	1.87 a	5.3 a

[1]Means in a column with a different letter are statistically different at P < 0.05. Based on 60 trees per treatment averaged across propagation trays.

Table 3. Effect of propagation tray type on root characteristics of red maples 10 months after shifting to #3 containers.

Tray type	Original liner visible (1-5)[1]	# roots deflected by liner sides > 2mm	Depth of roots (mm)	Diameter of roots 1 inch inside #3 container wall (mm)	Angle from horizontal of 5 largest roots
Smooth	4.9 a[2]	10.8 a	98.3 a	2.5 a	79.0 a
Elle pot to pot	1.6 c	2.3 d	75.1 bc	2.4 a	47.7 b
Elle spaced	2.9 b	4.5 c	71.3 c	1.9 b	45.5 b
Elle in smooth	4.6 a	11.1 a	92.6 a	2.2 ab	73.8 a
Accelerator	3.6 ab	7.3 b	89.9 ab	2.2 ab	67.1 a
RootMaker®	3.8 ab	8.1 b	85.8 abc	2.4 a	66.6 a

[1]1= Not visible; 5=Very visible.
[2]Means in a column with a different letter are statistically different at P < 0.05. Based on 62 trees per treatment.

Table 4. Red maple root characteristics in #3 containers from propagating cuttings held 2 or 6 months in six different propagation tray types

Time in propagation tray	Diameter of 5 largest roots at trunk (mm)	Angle from horizontal of 5 largest roots	Average length of straight roots (mm)
2 months	5.4 b[1]	67.5 a	70.0 b
6 months	7.1 a	57.8 b	93.7 a

[1]Means in a column with a different letter are statistically different at P < 0.05. Based on 30 trees per treatment averaged across tray types.

Table 5. Red maple root characteristics when liners were either pruned or not before shifting into #3 containers ten months earlier.

Pruning	% trunk circled by roots > 2mm	% Culls	Original liner visible (1-5) [1]	# roots deflected by liner sides > 2mm	Angle from horizontal of 5 largest roots
Yes	1.2 b[2]	0 b	1.4 b	1.9 b	42.1 b
No	21.5 a	23 a	3.7 a	7.3 a	57.8 a

[1]1= Not visible; 5=Very visible.
[2]Means in a column with a different letter are statistically different at P < 0.05. Based on 30 trees per treatment

Smooth liner into smooth #3

RootMaker® liner into smooth #3

Elle pot to pot liner into smooth #3

Accelerator liner into smooth #3

Great Southern Tree Conference: Mahogany root development and growth in different tray types and containers.

Ed Gilman and Maria Paz, Environmental Horticulture, University of Florida
December 1 – December 3, 2010
Gainesville, Florida

Objective: Determine the impact of propagation tray types and #1 container type on root development of mahogany.

What we did: In February 2009 seeds of mahogany were germinated in three different tray types: smooth, Elle, or Elle in a smooth pot. In July 2009, ten trees of each propagation tray were destructively harvested to characterize roots and tree growth. At this time, ten trees of each tray type were potted into two types of #1: smooth sided container or Pioneer Pot. In December 2009, all the #1 were destructively harvested to characterize roots.

What we have found as of November 2010: Mahogany propagated in smooth trays had slightly smaller calipers and were shorter than trees in Elle pots (Table 1). Elle trays increased the root length in top half of balls for mahogany liners, dramatically reduced the number of liners with deflected tap roots, and had less root growth at the bottom of root balls, when compared to smooth and Elle in smooth (Table 1). Smooth propagation trays increased the number of liner roots deflected down compared to Elle pots (Table 1).

Mahogany harvested from #1 that were propagated in Elle in smooth trays produced more culls, increased trunk circling roots, and the original liner was very visible when compared to smooth and Elle propagation trays (Table 2). Mahogany grown in #1 Pioneer Pot had larger caliper and were taller than #1 grown in smooth sided container (Table 3). Trees grown in Pioneer Pots were half as likely to produce culls due to root defects as smooth containers. Whereas trees in smooth #1 pot had an average of 5.8 roots deflected by container wall, Pioneer Pots had less than 1. In addition, Pioneer Pots produced root systems with more shallow structural roots than smooth sided pots (Table 3).

Table 1. Growth and root characteristics of mahogany harvested from three propagation tray types.

Tray type	Caliper (mm)	Height (in)	% Root length top half of ball	% Tap roots deflected	Number of lateral roots deflected down	% root growth at bottom of root ball
Smooth	3.1 b[1]	7.0 b	23 b	100 a	4.4 a	100 a
Elle Pot	3.8 a	8.7 a	55 a	10 b	0.4 b	50 b
Elle Pot in smooth pot	3.4 ab	6.2 b	18 b	100 a	0.2 b	100 a

[1]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 10 trees per treatment.

Table 2. Effect of propagation tray on root characteristics of mahogany harvested from #1 containers 5 months after shifting into #1 containers.

Tray type	% trunk circled (liner)	% Cull (liner)	Original liner visible (1-5)[1]	Depth of largest roots > 1mm beyond liner edge (mm)
Smooth	28.8 b[2]	20 b	2.6 b	47.3 b
Elle Pot	2.0 c	0 b	1.4 c	52.1 ab
Elle Pot in smooth pot	78.4 a	79 a	4.6 a	55.7 a

[1]1= Not visible; 5=Very visible
[2]Means in a column with a different letter are statistically different at $P < 0.05$. Based on 20 trees per treatment averaged across #1 type.

Table 3. Effect of #1 container type on top and root characteristics of mahogany.

#1 Type	Caliper (mm)	Height (in)	% Cull (liner)	# Roots > 1mm deflected by pot	Diameter of 5 largest horizontal roots (mm)	Depth of largest roots > 1mm beyond liner edge (mm)
Pioneer Pot	8.3 a[1]	40.1 a	19 b	0.7 b	2.4 a	48.1 b
Smooth	7.1 b	33.0 b	37 a	5.8 a	1.7 b	54.3 a

[1]Means in a column with a different letter are statistically different at P < 0.05. Based on 30 trees per treatment averaged across tray types.


Roots grew through Elle pot paper into #1 Pioneer Pot.


Roots deflected by smooth liner tray and smooth #1.

Great Southern Tree Conference: Impact of branch orientation on breaking stress in tulip-poplar

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December 1 – December 3, 2010
Gainesville, Florida

Objective: Determine how branch orientation affects breaking strength of tulip-poplar branches when loaded from multiple points.

What we did: A branch pulling methodology was designed to measure the impact of branch orientation on failure patterns of tulip-poplar. Twenty first-order branches were selected from 2 tulip-poplar trees. Branches averaging 4.4 m (14.3 ft) long and departing from the trunk at 40-50 degrees from horizontal were selected to minimize variability in wood properties of branches. Branches were cut from the main trunk just beyond the branch collar and mounted on a vertical pole in a custom made bracket mimicking a branch collar. Branches were pulled from three points spaced along the branch. The most basal pull point was set immediately proximal to the first lateral branch whose diameter was at least one-third of the main branch. The most distal pull point was positioned where main branch diameter was 1-in. The middle pull point was set at the mid-point between proximal and distal. Branch diameter, distance from pull point to branch base, and branch length were measured. Pulleys were attached to the branch at each pull point using 0.5-in wide webbing slings. Slings were girth hitched a minimum of 2 times to prevent them from sliding along the branch when pulled. Prior to start of the experiment a 12 x 12 ft platform was situated on the ground at the base of the post. Angle iron was secured to the platform and ran linearly below where branches would be mounted. Holes were predrilled at 2-in spacing along the entire length of angle iron. Once each branch was mounted to the post, pulleys were attached by carabiners to holes in the angle iron. A 0.5-in rope was tied to a hole in the angle iron below the most proximal branch pulley. The rope was run up through the branch pulley and back down to the first ground pulley secured to the adjacent hole on the angle iron. The middle and distal branch pulleys each had 2 corresponding ground pulleys. The rope ran from the basal ground pulley horizontally to the first middle ground pulley, up to the middle branch pulley and down to the second middle ground pulley. It then ran horizontally to the first distal ground pulley, up to the distal branch pulley, and down to the second distal ground pulley (see pictures). The rope then ran horizontally in the distal direction through a pulley (end pulley), turned 90 degrees and was then attached to a cable that was pulled by an electric winch. Rope ran through a total of 9 pulleys. Ground pulleys were connected to the angle iron in a location estimated to be directly below where corresponding branch pulleys would be at time of failure. The winch was then activated, pulling the branches until they failed.

What we found: There was a significant difference between stress (force x length normalized for branch diameter) to failure for horizontal and vertical branches (Table 1). Stress to failure for horizontal branches was 101.8 MPa and 45.9 MPa for vertical branches. Additionally, diameter at the point of failure was significantly larger in horizontal branches than in vertical branches (Table 1). Length-to-failure was nearly 6 times greater for vertical branches. This dramatic difference appeared to correspond with a difference in location of failure. Seven of ten vertical branches broke between basal and middle pull point. Only 1 out of 10 horizontal branches broke between basal and middle pull point. Of the 7 vertical branches that failed between the basal and mid pull point, 5 of them failed at or within 2.5 cm of a codominant lateral branch where there was an abrupt change in taper.

Conclusions: When loaded with a distributed downward force, vertical branches failed at a much lower force than horizontal branches. Vertical branches tended to break further from the branch base and at a point of abrupt taper, often at or near a codominant branch. Horizontal branches usually broke within the first several inches from the base.

Table 1. Measurements of branches by orientation.

Branch Orientation	Mean branch diam (cm)	Mean branch length (cm)	Mean break diam (cm)	Distance to break (cm)[1]	Break Stress (MPa)	Proximal angle change	Mid-point angle change	Distal angle change[2]	Breaks occurring at or near laterals[3]
Horizontal	4.88a[4]	452.37a	4.69a	12.77a	101.8a	41.96 a	59.25a	59.80a	0
Vertical	4.96a	425.96a	4.00b	74.55b	45.9b	26.19 b	71.39b	75.20b	5

[1] Distance to break = Length from edge of mounting bracket to point of failure.
[2] Distal angle change = Change in branch angle from start to break measured at pulling points.
[3] Breaks occurring at or near laterals = Number of branches that failed at a branch union where lateral was at least 1/3 diameter of main branch.
[4] Means in a column with different letters are significantly different at $P < 0.05$.

Branch with a horizontal orientation mounted on post.

Horizontally oriented branches typically failed within the first several inches from the branch base.

Branch with a vertical orientation mounted on post.

Vertically oriented branches typically failed beyond the first pulley at or near a branch union.