2008
GREAT SOUTHERN TREE CONFERENCE

RESEARCH REPORT

December 3 – December 5, 2008

UNIVERSITY OF FLORIDA
Environmental Horticulture Department
GAINESVILLE, FLORIDA 32611

Great Southern Tree Conference helps growers and landscapers grow, plant, and manage trees more efficiently

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THE LAST FRONTIER?

Our profession has changed dramatically during the past ten years. Growers and arborists developed pruning strategies for tree canopies in nursery and landscape settings. Although most growers won't admit to selling Florida Fancy trees, many growers actually do. If you doubt this, take a peak at the photos in the Grades and Standards document published 11 years ago and compare them with the trees planted across the state.

Florida Grades and Standards for Nursery Stock is the heart of this change. In addition, growers and buyers have become more informed about what makes trees strong. Florida's nursery stock is no longer the laughing stock of the US. In fact several other states have used our model to develop their own standards and this process continues today. Any of us can drive through almost any community from Jacksonville south and see trees planted with fabulous trunk and canopy quality.

Now we focus on roots, and there is great news. You will be the first to see and here about this. Through cooperation with our conference Partners and hard work by the Great Southern Tree Conference staff at the University of Florida we think we have figured out how to produce quality trees in containers and in the field. Just as most growers produce quality trunks and canopies with appropriate management strategies, we've come to realize that roots must be managed as well. Five years from now when most quality growers routinely practice root management we will wonder why this didn't happen sooner. There are many reasons I suppose but suffice to say that we have good reason to be cautious.

Field nurseries in Florida discovered in the 1980s that root pruning hardens-off trees. This allows trees to acclimate better to their ultimate landscape setting. Ironically, root pruning has been around for centuries; its time tested. Whether we tease roots of tiny liners apart when shifting to #3 containers, or slice the roots balls from top to bottom, or shave off the entire outer edge, our practices surely will be changing for the better as we learn together how to grow better trees. Please thank Chris Harchick, Maria del Pilar ("Pili") Paz, Christine Weise, and Jake Miesbauer for their hard work this year conducting studies, collecting data and writing this report.

Please thank our 2008 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 4 – December 5, 2008
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®, Millenium™ or Cathedral Oak® were planted in the year 2000 in an open sunny location to evaluate growth form. The trees were irrigated and mulched for the first year only. The trees were fertilized 3 times in 2005, 2006 and 2007 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 three times in 2008 at the same rate as above. Caliper, height and spread were recorded in September 2008 for all trees.

What we found as of November 2007: 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 1.06 for Millenium™, 1.35 for Highrise®, 1.07 for Cathedral Oak®, 1.6 for Boardwalk™, 1.4 for Parkside™ and 1.87 for Sky Climber.

Millenium™ 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 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 and thin crowded branches as you develop structure in the landscape. Boardwalk™ and Parkside™ are both new to the site so we have little experience with it. Both were shipped to our facility with good central leaders. It is too early to say much about Sky Climber since we have observed it for only one year. All live oak cultivars are expected to require regular pruning in the landscape to develop good structure, just like the acorn-grown species.

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 3” caliper trees.

Cultivar	Caliper (in)	Height (ft)	Spread (ft)
Planted 2000, 2.5” cal			
Highrise®	8.99	28.2	20.9
Millenium™	11.0	30.2	28.5
Cathedral Oak®	9.65	25.6	23.9
Planted 2006, 4” cal			
Boardwalk™	6.09	21.6	13.5
Parkside™	5.72	18.4	13.1
Planted 2007, 3”cal			
Sky Climber	3.67	19.3	10.3

‘First generation’ live oak cultivars 7 years after planting.

		
Cathedral Oak®	**Highrise®**	**Millennium®**

‘Second generation’ live oak cultivars 2 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 4 – December 5, 2008
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. 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 the first year only. The trees were fertilized with 1.76 lbs of 16-4-18 per tree under the canopy. Caliper, height and spread were recorded in September 2008 for all trees.

What we found as of November 2008: 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. All the trees look thinner at the demonstration site and in the photos because we photographed them in fall. In May 2008, the water to all the elms was turned on again because of a very dry spring. The Cedar Elm looked especially stressed. 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 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'	3.59	19.8	12.4
Ulmus parvifolia 'Allee™'	4.03	20.2	12.2
Ulmus parvifolia 'Burgundy'	3.94	17.6	8.5
Ulmus parvifolia 'Athena Classic'	3.72	17.7	8.5
Ulmus parvifolia 'Everclear'	3.35	22.2	4.2
Ulmus americana 'Creole Queen'	4.01	22.9	5.6
Ulmus americana 'Princeton'	4.34	21.7	7.2
Ulmus alata	4.07	20.5	12.2
Ulmus crassifolia	2.78	14.0	7.6

Chinese elm (*U. parvifolia*) cultivars

Bosque

Allee™

Burgundy

Chinese elm (*U. parvifolia*) cultivars

Athena Classic

The times I was out taking pictures this tree was always in the shade. Do you have a good picture of it?
Everclear

Your cultivar here

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 4 – December 5, 2008
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. Trees were mulched at planting and are being irrigated once daily. The trees were fertilized 3 times in 2007 with 0.88 lbs and 3 times in 2008 with 1.76 lbs of 16-4-18 per tree applied under the canopy. Caliper, height and spread were recorded in September 2008 for all trees.

What we found as of November 2008: 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 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	4.98	18.0	8.2
Green Giant	4.15	13.2	9.2
Coco	4.20	16.0	9.1
Edith Bogue	4.51	12.8	8.4
Greenback™	4.86	16.2	7.2
Bracken's Brown Beauty™	3.54	14.1	6.7
Teddy Bear®	3.30	12.6	6.0
Alta®	4.08	11.5	6.0
Little Gem	6.17	20.2	12.2
D.D. Blanchard	3.34	14.3	6.6
Miss Chloe®	2.74	11.3	5.4

Southern magnolia cultivars 2 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 4 – December 5, 2008
Gainesville, FL

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

What we did: Twelve 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. The trees were mulched at planting and are being irrigated three times daily until established. The trees were fertilized in August 2008 with 0.88 lbs of 16-4-18 per tree applied under the canopy. Caliper, height and spread were recorded in September 2008 for all trees.

What we found as of November 2008: The twelve species and cultivars have different growth and canopy forms (Table 1, see photos below and on following pages). Most trees were sheered regularly in the nursery prior to arrival so the form you see has not yet reverted back to its natural habit. All trees are taller than they are wide. ‘East Palatka’, ‘Aspire’, and ‘Eagleston’ are columnar in shape. ‘Mary Nell’, ‘Emily Brunner’, ‘Wirt L Winn’ and ‘Dark Green’ were obtained sheered in a cone shape. It will be interesting to see how 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 thirteen holly species and cultivars planted in 2008.

Holly species/cultivar	Caliper (in)	Height (ft)	Spread (ft)
Ilex opaca	1.60	8.8	4.2
Ilex cassine ‘Tensaw’	1.73	7.7	5.0
Ilex X *attenuata* ‘East Palatka’	3.08	11.2	6.0
Ilex X ‘STBB’ (Aspire)	3.96	11.2	3.8
Ilex X *attenuata* ‘Eagleston’	3.02	11.7	6.4
Ilex vomitoria ‘Pride of Houston’	Multi-Trunk	10.2	9.9
Ilex cornuta ‘Fine Line’	Multi-Trunk	10.0	8.1
Ilex X ‘Mary Nell’	4.92	9.0	5.4
Ilex X ‘Emily Brunner’	Multi-Trunk	7.8	7.0
Ilex X ‘Wirt L Winn’	Multi-Trunk	9.2	6.8
Ilex latifolia ‘Dark Green’	Multi-Trunk	7.5	6.2
Ilex attenuata ‘Fosteri’	2.30	9.2	3.5

Holly species and cultivars 1 year after planting.

American Holly

Tensaw

East Palatka


Aspire


Eagleston


Pride of Houston


Fine Line


Mary Nell


Emily Brunner


Wirt L Winn


Dark Green


Fosteri (street tree grown)

Great Southern Tree Conference: Trees for small urban spaces.

Maria Paz, Chris Harchick, and Ed Gilman, Environmental Horticulture, University of Florida
December 4 – December 5, 2008
Gainesville, Florida

Objective: Evaluate whether 58 types of small trees are well suited for planting under power lines, focusing on tree habit and adaptation.

This project was funded by the Florida Department of Agriculture, Division of Forestry. Three trees of each of the 58 species were planted in August 2006 under the power lines that run through the Great Southern Tree Conference site, to test whether they comply with Florida legislation which does not allow large tree species to be counted toward planting in utility rights-of-way. Caliper, heights and spread are collected once a year in October and landscape performance evaluated. Calipers are not reported in this report because many of the trees have multiple trunks, thus calipers are not collected. Photos of each species are taken at each season to record performance. The hundreds of photos and much more information on this project can be found at https://treesandpowerlines.ifas.ufl.edu.

Table 1. Growth, canopy forms and landscape performance of small trees fro urban spaces.

Small Tree Species/Cultivar	Height (ft)	Spread (ft)	Landscape performance
Acacia farnesiana	13.0	16.6	√*
Acer buergerianum 'Streetwise'	15.8	13.6	√
Aesculus pavia	6.0	1.8	~
Amelanchier arborea	8.6	5.4	~
Callistemon citrinus	6.8	7.4	√
Carpinus caroliniana	12.1	4.4	√
Cercis canadensis	10.8	10.4	√
Cercis canadensis 'Forest Pansy'	10.3	11.0	√
Chionanthus retusus	10.1	12.2	√
Chionanthus virginicus	10.8	8.6	√
Cornus florida 'Weavers White'	12.9	8.8	√
Cornus foemina	8.8	10.7	√
Cornus mas 'Spring Glow'	8.5	4.6	√
Crataegus flava	8.6	7.4	√
Crataegus viridis	8.7	7.4	√
Elaeocarpus decipens	11.5	10.9	√
Eriobotrya japonica	11.2	9.1	√
Forestiera segregata	6.1	8.1	√
Halesia diptera	6.4	5.0	√
Hamamelis mollis	2.4	1.4	X
Ilex 'Savannah'	17.9	11.9	√
Ilex cassine	11.3	6.8	√
Ilex cornuta 'Burfordii'	9.6	8.8	√
Ilex myrtifolia	7.5	5.6	√
Ilex 'Nellie R Stevens'	8.1	5.7	√
Ilex vomitoria 'Dodds Cranberry'	11.4	13.2	√
Ilex vomitoria 'Pendula'	11.2	8.2	√
Juniperus chinensis 'Spartan'	11.1	4.9	√
Juniperus chinensis 'Torulosa'	10.2	6.6	√
Liriodendrum tulipifera 'Ardis'	18.8	9.4	√
Loropetalum chinensis 'Zhuzhou'	10.5	12.7	√

Small Tree Species/Cultivar	Height (ft)	Spread (ft)	Landscape performance
Magnolia stellata	4.0	2.9	~
Myrcianthes fragrans	6.9	5.3	√
Myrica cerifera	12.8	12.8	√
Nyssa ogeche	8.8	6.2	~
Osmanthus fragrans	5.8	4.4	~
Ostrya virginiana	12.0	8.6	√
Oxydendrum arboreum	5.5	3.0	~
Pinus glabra	12.0	10.2	√
Planera aquatica	8.8	10.3	√
Prunus angustifolia	12.7	16.3	√
Prunus campanulata	10.5	7.7	√
Prunus caroliniana	11.8	8.6	√
Prunus cerasifera 'St Lukes'	12.0	16.9	√
Punus 'Okame'	9.4	4.8	√
Prunus persica 'Florida Home'	14.1	17.4	√
Prunus persica 'Martha Jane'	13.9	12.4	√
Prunus umbellata	8.2	8.1	~
Quercus prinoides	8.2	4.4	~
Rhamnus caroliniana	7.0	7.0	√
Sapindus saponaria	12.2	8.2	√
Stewartia malacodendron	Dead	Dead	X
Tabebuia chrysotricha	9.6	7.6	√
Tabebuia umbellata	8.6	10.2	√
Ternstroemia gymnanthera	6.6	6.0	√
Vaccinium arboreum	4.4	3.0	~
Viburnum obovatum	10.0	7.5	√
Vitex agnus-castus 'Shoals Creek'	9.5	14.4	√

*√=Good landscape performance; ~ = Ok landscape performance; X = Poor landscape performance.

What we found as of November 2008: Many of these trees were difficult to find in large numbers and large sizes. This obviously restricts their usefulness in urban planting projects. Root systems were not good on many trees due to trees over-grown for their container size. We made no attempt to correct root defects. Also, the growers producing some of these trees appeared to make little if any attempt to develop Grades and Standards compliant trees. It seems like we have some work to do reaching growers of these uncommon trees.

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 4 – December 5, 2008
Gainesville, Florida

Objective: Evaluate root pruning strategies when planting 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 #3s 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. 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 sides was shaved 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 the trunks reached a caliper of about 1.3" in January 2008.

Before field planting, 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). All the trees were planted in the same field with 12 ft between rows and 8 ft between trees and are being irrigated three times per day in the growing season. Trees were fertilized with 115g per tree of 16-4-8 in April 2008, 210g of 16-4-8 in July 2009 and 400g of 16-4-8 in September 2008. Trees from #10 containers were staked in November 2007 and #15 trees at planting. Caliper and height were recorded in October 2008 for all trees. Trees will be root pruned in the field nursery during their last year of production which is 2009. Growth, tree quality and root development will be measured at the end of 2009, and trees dug for the 2009 GSTC conference to show influence of root pruning strategies on root ball quality.

What we found as of November 2008: The type of root pruning (edge shaving vs. slicing) when planting #10 and #15 containers into field soil had no effect on caliper or height of field grown trees (Table 1). This in encouraging because it means that the more aggressive (and we think more effective) root ball shaving does not slow growth compared to the more traditional root ball slicing technique. Although the #15 trees were larger (1.3" caliper) than the #10 trees (1" caliper) when planted into the field, #10 trees ended the first growing season with slightly larger caliper and height (Table 2). Trees from #10 were planted into the field 3 months before #15 trees; this probably explains why these trees were larger at the end of the first growing season in the field.

Table 1. Caliper and height on field nursery-grown trees with #3 root ball sides either sliced or shaved at planting.

Root pruning	Caliper (in)	% caliper increase	Height (ft)	% height increase
Slicing root ball sides	1.87	79	10.4	27
Edge shaving	1.83	76	10.0	24

Table 2. Caliper and height on field nursery-grown trees planted from #10 or #15.

Container Size	Caliper (in)	% caliper increase	Height (ft)	% height increase
#10	1.91 a[1]	81	10.6 a	27
#15	1.78 b	75	9.9 b	25

[1]Means in a column with a different letter are statistically different at P<0.05. Based on 20 trees per container size.

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 inside the surface.

A light washing of the outer surface of the root ball reveals that some roots are beginning to circle, dive, and kink.

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 root pruning on live oak root systems in a field nursery

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 4 – December 5, 2008
Gainesville, Florida

Objective: Determine the best way to develop quality roots on 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) planted directly into field soil; (2) shifted into #10 Accelerators; or (3) shifted into #15 Accelerators. Half of the trees 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 planting or shifting. The trees shifted into the #10 containers were planted into the field nursery October 2007, when the average trunk caliper averaged 1". The #15 containers were 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 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 are being irrigated three times per day by drip emitters. Trees in the field are being root pruned in the following manner: 1) half are root pruned in the dormant season (Feb, Apr, Oct, Dec 08 and Feb and Apr 09) or 2) the other half are root pruned in the growing season (Apr, Jun, Aug, Oct 08 and Apr, June 09). Trees were fertilized three times a year with 16-4-8 and were staked in November 2007 for #3 and #10, and at planting for #15. Caliper and height were recorded in October 2008 for all trees. Growth, tree quality and root development will be monitored through 2009 and trees dug for the 2009 GSTC conference.

What we found as of November 2008: Root ball slicing had no impact on tree growth the first growing season meaning that root pruning at planting did not slow down tree growth (Table 1). Trees pruned during the growing season were slightly shorter than those pruned in the growing season (Table 2) (but note the study is very young-more next year). Trees planted from #3 containers had slightly larger caliper than trees planted from #15 containers (Table 3). There was no difference in tree height, but trees grown from #3 containers have increased the most in height. This project is still ongoing so meaningful conclusions can not be drawn yet based on this data. It will be interesting to see the effect of root pruning timing on root ball quality.

Table 1. Caliper and height in October 2008 on field nursery-grown trees planted from #3 (Feb 07), #10 (Oct 07), or #15 (Jan 08) containers either sliced or not sliced at planting.

Root pruning at planting	Caliper (in)	% caliper increase	Height (ft)	% height increase
Not sliced	1.96	78	10.3	29 b[1]
Sliced	1.91	82	10.2	35 a

[1]Means in a column with a different letter are statistically different at P<0.05. Based on 60 trees per root pruning type averaged across initial container sizes.

Table 2. Caliper and height on field nursery-grown trees planted from #3 (Feb 07), #10 (Oct 07) or #15 (Jan 08) containers and field root pruned in the dormant or growing season.

Pruning season	Caliper (in)	% caliper increase	Height (ft)	% height increase
Dormant	1.95	81	10.5 a[1]	33
Growing	1.92	80	10.1 b	31

[1]Means in a column with a different letter are statistically different at P<0.05. Based on 60 trees per pruning season averaged across initial container sizes.

Table 3. Caliper and height October 2008 on field nursery-grown trees planted from #3 (Feb 07), #10 (Oct 07) or #15 (Jan 08) containers.

Container Size (beginning caliper)	Caliper (in)	% caliper increase	Height (ft)	% height increase
#3 (.5")	1.98 a[1]	83 a	10.2	45 a
#10 (1")	1.92 ab	84 a	10.3	26 b
#15 (1.3")	1.89 b	80 b	10.2	24 b

[1]Means in a column with a different letter are statistically different at P<0.05. Based on 40 trees per container size averaged across root pruning treatments.

Some leaf drop occurred after planting into the field nursery when trees were root pruned just prior to planting. However, this did not impact growth.

Great Southern Tree Conference: Impact of live oak root ball slicing at planting on landscape stability.

Ed Gilman, Maria Paz, Chris Harchick and Alison Boydstun, Environmental Horticulture,
University of Florida
December 4 – December 5, 2008
Gainesville, FL

Objective: Determine if severing circling roots at planting impacts survival, growth and landscape tree stability.

What we did: Sixty Cathedral Oak® live oaks were transplanted from #45 containers (~2.5" caliper) into the field on March 2005. Half of the trees were root pruned at planting (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), whereas the other half was planted without root slicing. Trees were fertilized with 100g of 16-4-8 per tree, applied to a 36" area around the stem in March, April and September 2005. In 2006, 400g of 16-4-8 were similarly applied to each tree in April, June and September. In April 2006, the trees were cleaned of small shoots from the ground up to the start of the canopy. Caliper, height and spread were measured in October 2007. Seven trees from each treatment were pulled over with a winch November 2007 and force required to pull the trunk to 5, 10, 15, 20 and 25 degrees recorded. Tree stress was calculated based on force required to pull each tree, height to pull point and tree diameter at pull point. Root balls were later dug from the ground and data collected included number of roots growing into landscape soil over 5 mm in diameter, root diameter, largest root diameter and root depth.

What we found out as of November 2008: Caliper and height in the first 30 months following planting were not affected by root slicing at planting (GSTC Report 2007). Slicing the root ball at planting had no impact on tree stability 2.5 years after planting. Slicing had no effect on root ball characteristics (Table 1).

Table 1. Maximum stress from pulls and root ball characteristics of 5.5" caliper live oak planted from #45 containers 2.5 years earlier with and without root slicing at planting.

Treatment	Max Stress (lbs/sq in)	Number of roots	Average root diameter (mm)	Largest root diameter (mm)	Root depth (in)
Root sliced	6434	55	6.7	14.6	5.8
Not root sliced	7238	55	6.7	14.2	6.2

Conclusion: Slicing container root ball sides at planting, deep enough to sever circling roots appears to have no positive or negative impact on the tree.


Roots were cut on outside of ball.


Root ball was cut top to bottom in 5 locations with hand pruning.


Trees were installed and growth measured.

Force to pull trees to a 25 degree angle was measured on trees after root balls were either sliced or not at planting. Trees were installed March 2005 and pulled over in November 2007.

Root ball sat tilted after pulling trunk to 25 degree angle. The leeward side of the root ball sank (see right side of trunk) at the point where the original #15 container was; the windward side broke from the ground at the outer edge of the #45 container (see left side of photo).

There were circling roots on the edge of the container when trees were planted March 2005.

The same tree November 2007. The original root ball is clearly visible 2.5 years after planting into the landscape from #45 containers. There were plenty of roots growing into the landscape soil, but circling roots that were present at planting are still clearly visible 2.5 years after planting. Slicing the root ball at planting had no impact on circling roots or tree stability.

Great Southern Tree Conference: Live oak tree size and root deformations impact tree stability in the landscape.

Ed Gilman, Maria Paz, Chris Harchick and Alison Boydstun and Environmental Horticulture,
University of Florida
December 4 – December 5, 2008
Gainesville, FL

Objectives: Determine impact of plant size and root form on tree stability.

What we did: Thirty Cathedral Oak® live oak from #45 containers, 30 from #15 containers, and 30 B&B were transplanted into the field at the end of March 2005. Following planting into the landscape, trees were fertilized with 100g of 16-4-8 per tree, applied to a 36" area around the stem in March, April and September 2005. In 2006, 400g of 16-4-8 were similarly applied to each tree in April, June and September. In April 2006, the #15 trees were limbed up 2 feet from the ground, whereas the #45 and B&B trees were cleaned of small shoots from the ground to the start of the canopy. Seven trees from each treatment were pulled over with a winch November 2007 and force required to tilt the trunk to 5, 10, 15, 20 and 25 degrees recorded. Stress placed on the tree was standardized based on force required to pull the tree to the set angles, height of pull point and tree diameter at pull point. Root balls were dug from the ground and data collected included number of roots over 5 mm in diameter, root diameter and root depth.

What we found as of November 2008: Trees grew at about the same rate whether planted from #15 or #45 containers or from a field-grown soil root ball (Figure 1). Stress (force) required to tilt #15 and #45 container trees was similar (Table 1). Trees planted from #15 containers were as well secured to the landscape soil as trees planted from #45 containers. This means that both were equally resistant against a wind event 2.5 years after planting. Stress (force) required to tilt trees to 10 degrees was greater for B&B trees than #15 or #45 container-grown trees (Table 1). This means that it would take a stronger wind event (by about 20%) to tilt the field-grown trees 2.5 years after planting than the container grown trees. Trees planted from a field nursery (B&B) had more than double the roots growing into the landscape than trees planted from either the #15 or #45 containers, and larger, shallower roots. In studies conducted by others (mostly in Europe) straight roots have been associated with greater stability in wind, and the field-grown trees used in this study had straighter roots (see photos next page). We will be learning much more about this in the next several years. We think we have developed a technique to develop straighter roots in containers by reducing root deflections, which will be discussed later in this report.

Table 1. Stress required to tilt trees to a 10 deg angle 2.5 years after planting, and root ball characteristics of live oak transplanted into the landscape from #15, #45 and field-grown (B&B) trees.

Size and caliper at planting	Stress to 10 deg (lbs/sq in)	Number of roots	Average root diameter (mm)	Root depth (in)
#15 (1")	5901 b[1]	36 c	7.3 b	6.7 a
#45 (2.7")	5617 b	55 b	6.7 b	6.2 ab
B&B (3")	6973 a	115 a	8.3 a	5.6 b

[1]Means in a column with a different letter are statistically different at $P<0.05$. Based on 7 trees per treatment.

Conclusions: Small live oak nursery stock appears to establish quicker and become self-sufficient sooner than larger nursery stock, but tree stability is higher for field grown trees.

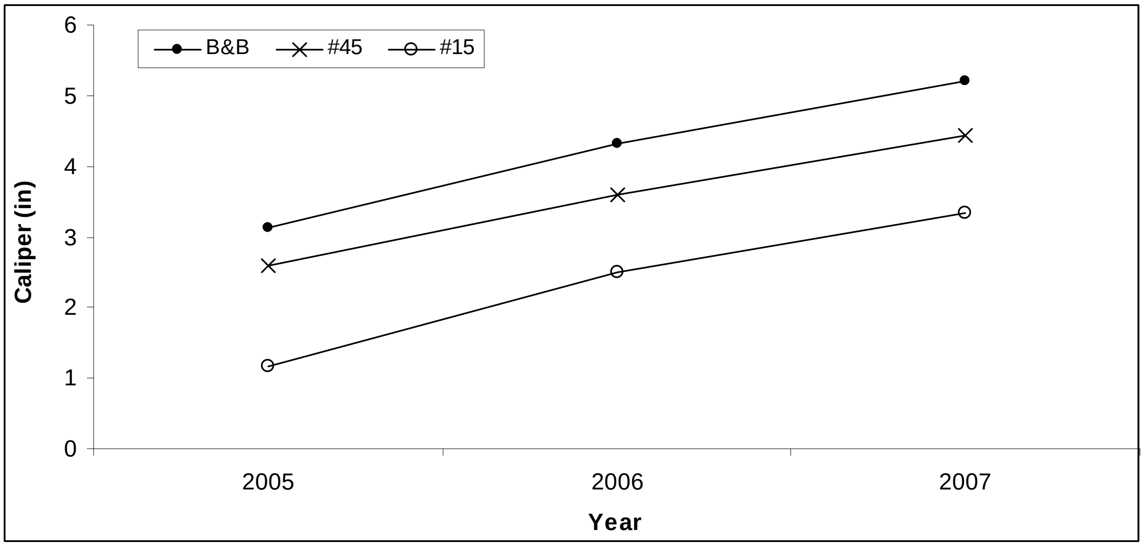


Figure 1. Caliper growth of live oak transplanted into the landscape from #15, #45 and field-grown (B&B).

Trees from #45 containers had large roots deflected down or around at the position of the #15 container. This deflection point appeared to weaken attachment to the landscape soil.

Trees from the field nursery had more straight roots. This appeared to be responsible for the increased stability in the years following planting to the landscape.

Great Southern Tree Conference: Planting depth did not affect live oak landscape stability

Chris Harchick, Maria Paz and Ed Gilman, Environmental Horticulture, University of Florida
December 4 – December 5, 2008
Gainesville, Florida

Objective: Determine the impact of planting depth in the landscape on tree stability.

What we did: In June 2003, twelve trees were planted into each of the following treatments: top most root in the root ball 2" above grade, 0 to 1"below grade, 4" below grade, or 7" below grade. Hardwood mulch chips 3" deep were added over the root ball and around the tree in an 8 ft x 10 ft rectangular area and kept weed free with periodic Round-up™ application. Trees were fertilized 3 times in 2004 with 272g of 16-4-8 and 3 times in 2005 with 544g of 16-4-8. In 2006, trees were fertilized with 544g of 16-4-8 in March and July, and then with 800g of 16-4-8 in October. In 2007, trees were fertilized with 544g of 16-4-8 in March and 814g of 16-4-8 in July and October, and at the same rate in April 2008. Twelve trees from each treatment were pulled over with a winch June 2008 and force required to pull the trunk to 5 degrees recorded. Stress on the trunk was calculated based on force required to pull the tree to set angles, height to the pull point, and tree diameter at the pull point.

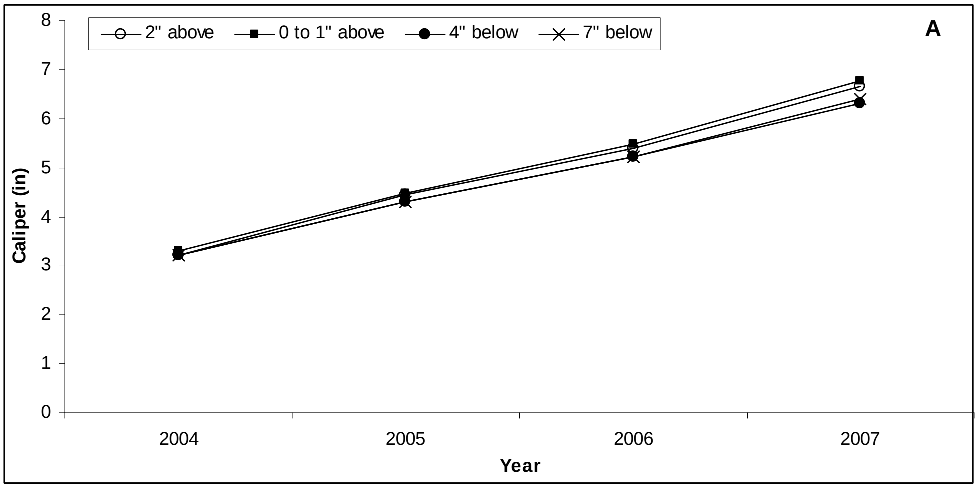
What we found as of November 2008: Although trees planted at or above grade were slightly larger in diameter than those planted more deeply, stress required to tilt the tree to several angles was similar for all planting depths (Table 1). The live oaks planted in this study were able to adapt their root systems enough to compensate for any ill effects of deep planting. Growth across planting depths has been very similar over time (Figure 1).

Table 1. Tree diameter at base and stress to pull live oak at four different planting depths.

Planting Depth	Tree diameter at base (cm)	Stress to 1 deg (lbs/sq in)	Stress to 2 deg (lbs/sq in)	Stress to 5 deg (lbs/sq in)
2" above	7.6 ab[1]	1642	2374	3267
0 to 1" below	7.8 a	1535	2404	3598
4" below	6.9 b	1554	2612	3970
7" below	6.9 b	1595	2580	3723

[1]Means in a column with a different letter are statistically different at P<0.05. Based on 12 trees per treatment.

Trees were pulled with an electric winch. A load cell recorded load required to tilt the trunk to a set angle.



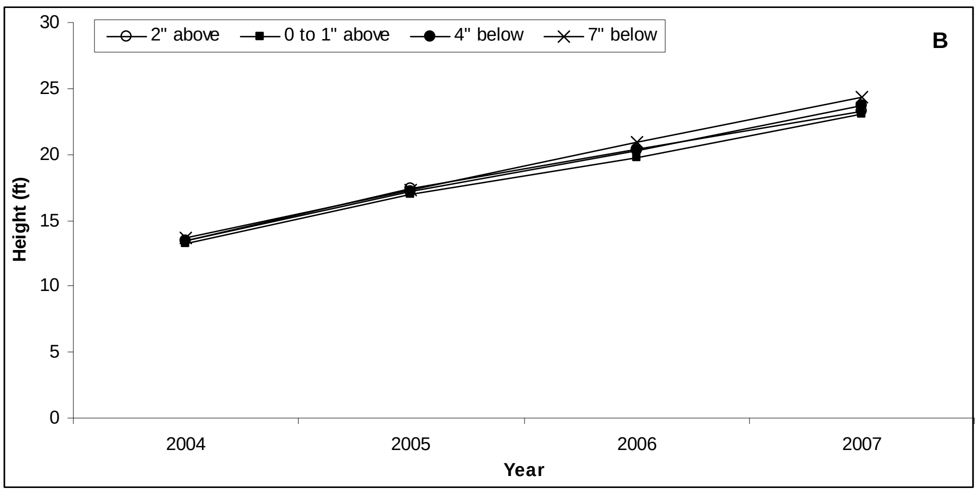


Figure 1. Caliper (A) and height (B) of live oak planted at four planting depths from 2004 to 2007.

Conclusion: Planting depth had no impact on tree stability five years after planting. Trees planted deeply grew slightly slower than those planted correctly. We did not yet evaluate root defects resulting from deep planting.

Trees planted even with or slightly higher that the surrounding landscape soil had a distinctive flare at the base of the trunk.

Trees planted deeply had no flare at the base of the trunk. You will see the roots at the outdoor demonstration site.

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, Chris Harchick and Alison Boydstun, Environmental Horticulture, University of Florida
December 4 – December 5, 2008
Gainesville, Florida

Objective: Determine how planting depth in the root ball and planting depth in the landscape influence trees following landscape planting. This will be a 5 to 10 year demonstration to track long term effects.

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 2-3" 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 340g of 12-2-14 and with 400g of 16-4-8 in July 2008. Caliper and height were measured in July 2008.

What we found as of November 2008: Trunk caliper and tree height two years after landscape planting were not affected by planting depth in the nursery, landscape planting depth, or root pruning at planting (Tables 1, 2 and 3). Tree height appeared to be affected by landscape planting depth only (Table 2); trees planted deeper remained shorter but this difference was less than a foot. .

Table 1. Caliper and height of live oak produced at different nursery planting depths.

Nursery planting depth	Caliper (in)	Height (ft)
Level in #3, #15, #45	3.52	13.72
2.5" below in #3 and #15, level in #45	3.55	13.35
4.5" below in #3 and #15, level in #45	3.50	13.18
2.5" below in #3, #15, #45	3.48	13.22

Table 2. Caliper and height of live oak at three different landscape planting depths.

Landscape planting depth	Caliper (in)	Height (ft)
Level	3.55	13.83 a[1]
4” Below	3.48	13.28 b
8” Below	3.50	13.02 b

[1]Means in a column with a different letter are statistically different at P<0.05. Based on 40 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.

Root pruning	Caliper (in)	Height (ft)
Yes	3.51	13.32
No	3.51	13.42

What’s next: Caliper, heights and tree quality will continue to be collected to determine the effect of planting depth on landscape live oak growth. Roots will be excavated in several years and trees pulled over or blown with the wind machine to measure root structure, 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 two years after planting. Although slicing the root ball as shown above reduces the amount of circling roots, we can do better. See report on the following page.

Great Southern Tree Conference: Highrise® live oak root system quality and stability following root pruning

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 4 – December 5, 2008
Gainesville, Florida

Objective: Compare stability and root form on trees subject to various root pruning methods at planting.

What we did: In March 2008, 48 Highrise® live oaks were planted to the field from #15 containers. Trees were produced in containers from rooted cutting liners with the following planting depth treatments: (1) 0.5" below grade into #3, level into #15; (2) 0.5" below grade into #3, 2.5" below grade into #15; (3) 2.5" below grade into #3, level into #15; or, (4) 2.5" below grade into #3 and #15. Trees from each of these four depths in the containers were root pruned in three different ways before planting to the field for a total of twelve treatment combinations. The three root pruning treatments were: (1) no root pruning; (2) root ball shaved by removing 1.5" of the edge and bottom of the root ball (see photos); (3) root slicing by cutting 3-4" deep into the side of the root ball in 6 equidistant places from the top of the root ball to the bottom (see photos). Planted trees are irrigated three times a day. Each tree was fertilized with 200g of 16-4-8 on May 2008 and 400g on August and September 2008. Caliper and heights were collected on September 2008. Half of the trees on each treatment will be pulled in November 2008 and the other half in September 2009 to test tree stability.

What we found as of November 2008: Planting depth in the container had no impact on tree growth the first year following planting. Root pruning at planting had no effect on tree caliper or height the first year following planting (Table 1). Tree stability will be determined at the end of November 2008 and the root balls will be characterized at this time.

Table 1. Caliper and height of Highrise® live oak from four different planting depths in containers and three types of root pruning at planting into the landscape.

Container Depth	Root Pruning Type	Caliper (in)	Height (ft)
0.5" below in #3; level #15	No Pruning	1.84	9.0
	Sliced	1.90	8.4
	Root ball shaved	1.94	9.2
0.5" below in #3; 2.5" below in #15	No Pruning	1.87	8.8
	Sliced	1.90	9.2
	Root ball shaved	1.91	8.4
2.5" below in #3; level #15	No Pruning	1.99	9.1
	Sliced	1.96	8.7
	Root ball shaved	1.77	8.7
2.5" below in #3 and #15	No Pruning	1.99	9.4
	Sliced	1.98	9.1
	Root ball shaved	1.92	9.1

Root balls were full of circling roots and roots that grew down after deflection by the container wall.

Trees showed few large roots at the outside surface of the root ball.

Slicing made six radial cuts about 3 to 4 inches deep inside the root ball from top to bottom of the root ball.

Root ball shaving removed the entire outside inch of the root ball after planting by inserting the shovel blade tangent to the trunk as shown.

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
December 4 – December 5, 2008
Gainesville, Florida

Objective: Determine impact of amount of foliage removed from a codominant pruned stem on subsequent growth rate.

What we did: In May 2005, 48 5-inch caliper, 23 feet tall Highrise® live oaks were pruned to reduce the biomass of one codominant stem by one of four targeted pruning doses: 0% (control), 25%, 50%, or 75% foliage removed. On each tree, two similarly sized codominant stems growing from the same union were located, and the diameter at the base of each stem was measured. One of the stems (termed the codominant stem) was pruned according to the prescribed dose; the other stem 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 of the pruned codominant stem just above the point where it joined the leader stem. One to four pruning cuts were made on each pruned stem 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 between 2003 and 2008. In May 2006, June 2007 and May 2008, the pruned and un-pruned stems of each tree were measured to determine stem diameter growth.

What we found as of November 2008: Pruned stems grew slower than stems that were not pruned in the first 3 years after administering the pruning dose (Figure 1). Increasing the pruning dose by removing more foliage and branches reduced growth in a more-or-less linear fashion. This trend has become more pronounced with time (data not shown). Pruned stems grew slower than stems that were not pruned (Figure 2). Increasing pruning dose reduced growth as targeted pruning dose increased from 25% through 75%. Furthermore, 3 years following pruning, the basal area of the non-pruned leader stem grew more for the target doses of 25% or 50% than trees pruned with the 75% dosage or non-pruned trees (Figure 2). Pruning at the 25% and 50% dose shifted (increased) growth to the leader compared to the leader on trees not pruned.

Conclusion: As much as 75% or more of a codominant stem or branch can be removed without killing the stem on these young trees. This supports the ANSI A300 pruning standard allowing more than 25% removal per stem. It also provides guidelines for growers producing leaders when structurally pruning. Increased pruning reduces growth in proportion to the amount of foliage removed on the pruned stem. Light pruning (25-50%) of a codominant stem enhanced growth in the unpruned leader, whereas heavy pruning (75%) had no effect on leader growth when compared to codominant stems that were not pruned.

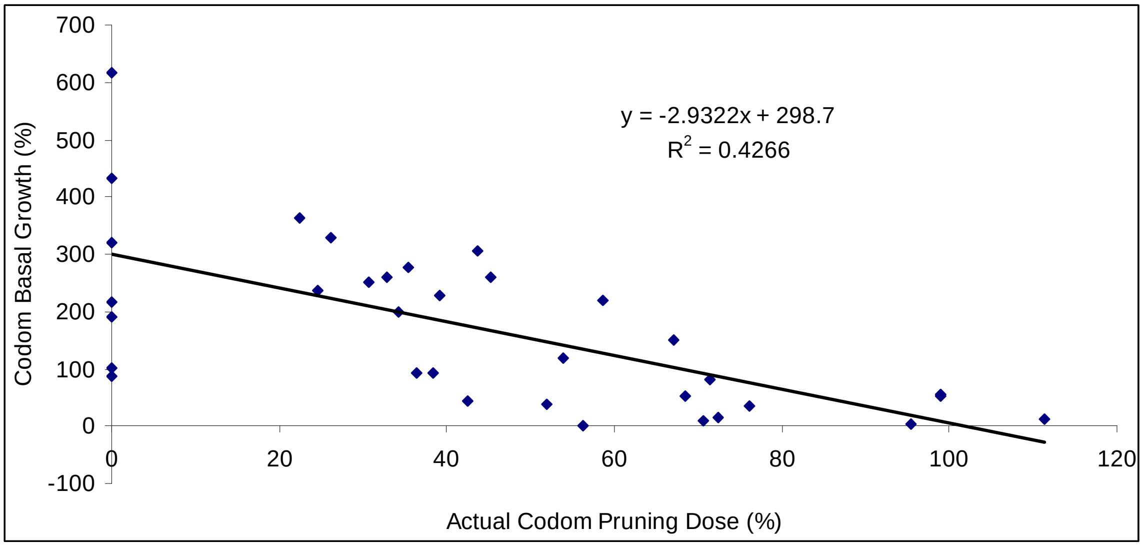
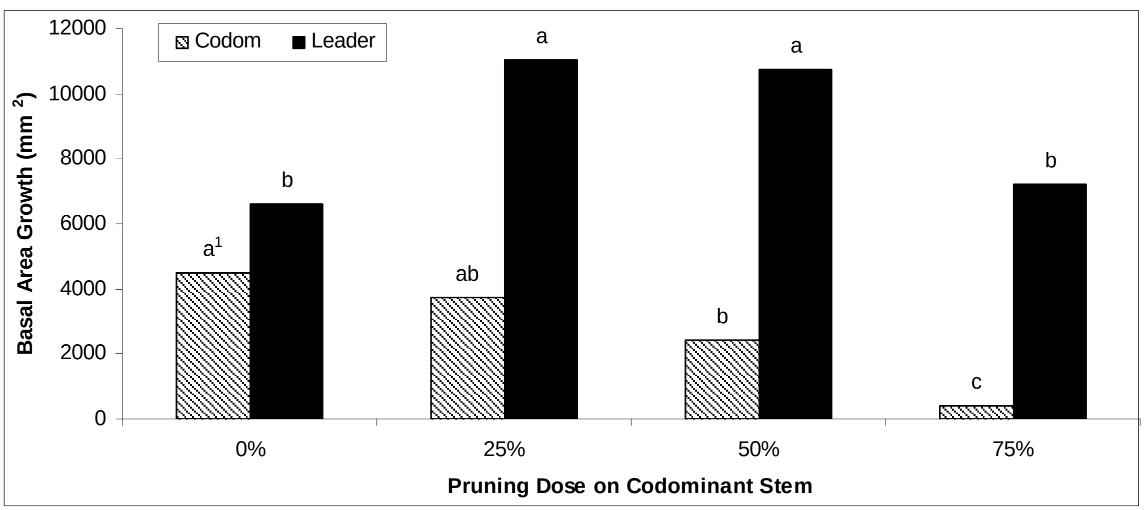


Figure 1. Pruned codominant stem basal area growth (%) between May 2005 and June 2008 following removal of increasing amounts of foliage in 2005. Pruning dose calculated as described above.



[1] Bars for leader or codominant stem with the same letter are not statistically different at P<0.05. Codominant and leader stem are not compared.

Figure 2. Basal area growth of pruned codominant stem and non-pruned leader stem following removal of target pruning dose.

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 4 – December 5, 2008
Gainesville, Florida

Objective: Determine impacts of container type and root pruning on root defects including kinks, formation of stem girdling roots and diving roots.

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, SmartPot, RootBuilder, RootMaker, Fanntum, Florida Cool Ring, Airpot or Jackpot, and were placed pot to pot. 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 in the growing season and were staked in May 2008. Calipers and heights were collected in September 2008. Root balls on 10 trees of each container were excavated November 2008.

In January 2009 the #3 container types will be shifted to the same type of #15 containers. Before shifting into #15 containers, the root systems will be 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. In summer 2010, four trees of each treatment combination will be destructively harvested to evaluate root defects. The rest of the trees (12 trees for each treatment combination) will be shifted into #45 containers of the same 8 container types. Roots will be pruned before shifting following the same protocol described above. In summer 2011, four trees of each treatment combination will be destructively harvested to evaluate root defects. The rest of the trees (8 trees for each treatment combination) will be planted into the landscape. In spring 2012, stress required to pull trees to a 10 degree angle will determine landscape tree stability. After 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 2008: Although the focus of this study is on root form, we have noted that caliper and height were impacted by #3 container types (Table 1). Airpot, Fanntum pot, RootMaker, RootBuilder and Smooth sided containers have the largest caliper sizes. Heights are very similar for most of the containers, except for Cool Ring and Jackpot which have the shortest trees. Please be advised that root balls from each container type vary and photos below only show one tree from each type; you will see all ten trees from each type when you visit the outdoor plots. This project is ongoing and more data will be collected in the next four years.

Table 1. Caliper and height of 'Florida Flame' maples growing in eight different #3 container types

Container type	Caliper (mm)	Height (ft)
Airpot	16.7 abc[1]	7.1 a
Cool Ring	15.8 c	6.4 b
Fanntum	17.4 ab	7.0 a
Jackpot	14.6 d	6.5 b
RootMaker	17.7 a	7.1 a
RootBuilder	17.7 a	7.2 a
Smart Pot	16.6 bc	6.9 a
Smooth sided	17.4 ab	7.1 a

[1]Means in a column with a different letter are statistically different at $P<0.05$. Based on 48 trees per treatment.


Smooth sided


Florida Cool Ring

Fanntum



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 4 – December 5, 2008
Gainesville, Florida

Objective: Track growth, root characteristics, and stability of trees 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 (15 gallons irrigation the first 3 weeks followed by 7 gallons thereafter for #300, 5 gallons for #65 and #25, and 2.5 gallons for #3). 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. Also in May 2007, half of the irrigated trees and half of the non-irrigated trees for each size were mulched with a 3" layer of shredded hardwood, while the other half was kept bare with Roundup. Trees have not been fertilized since planting. Caliper, height and settlement measurements were collected for all trees in October 2008.

What we found as of November 2008: Trees appeared to grow in trunk caliper at the same rate regardless of initial tree size (Figure 1A). Height on the largest trees (planted from #300 containers) did not increase much the first two years after planting (Figure 1B). This allowed the smaller trees to somewhat catch up to these larger trees. The smaller trees grew more than the larger trees relative to where they began (Table 2). The larger trees settled the first two years after planting more than the smaller trees (Table 1). It appears that heavy root balls are not only more likely to settle into the soil, but do so to a greater depth. All 16 trees planted from #300 containers settled.

Irrigated trees grew more than non-irrigated trees (Table 2). Irrigation interacted with tree size to affect height and caliper increase (Table 2). Irrigated trees from #3 containers had greater caliper and height increase than those not irrigated from the same size. Irrigated trees from all the other sizes had similar height and caliper increases when compared to non-irrigated trees. Mulch had no effect on caliper or height (data not shown). We found in another study at this site that addition of mulch has not had an impact on live oak caliper growth either (published 2006 *J. Arboriculture*).

Table 1. Settlement of trees as of October 2008 after planting red maple into the field from #3, #25, #65 and #300 containers.

Size at planting	Settlement* (in)
#3	+0.005 (-0.19 to +0.62) a
#25	-0.20 (-0.63 to 0) ab
#65	-0.33 (-0.69 to 0) b
#300	-0.65 (-1.5 to -0.31) c

[1]Means in a column with a different letter are statistically different at $P<0.05$. Based on 16 trees per size.
*Settlement: negative number indicates that trees sunk deeper into soil; positive number indicates trees lifted up out of the soil. Numbers in parenthesis is the range in settlement among the 16 trees in each size.

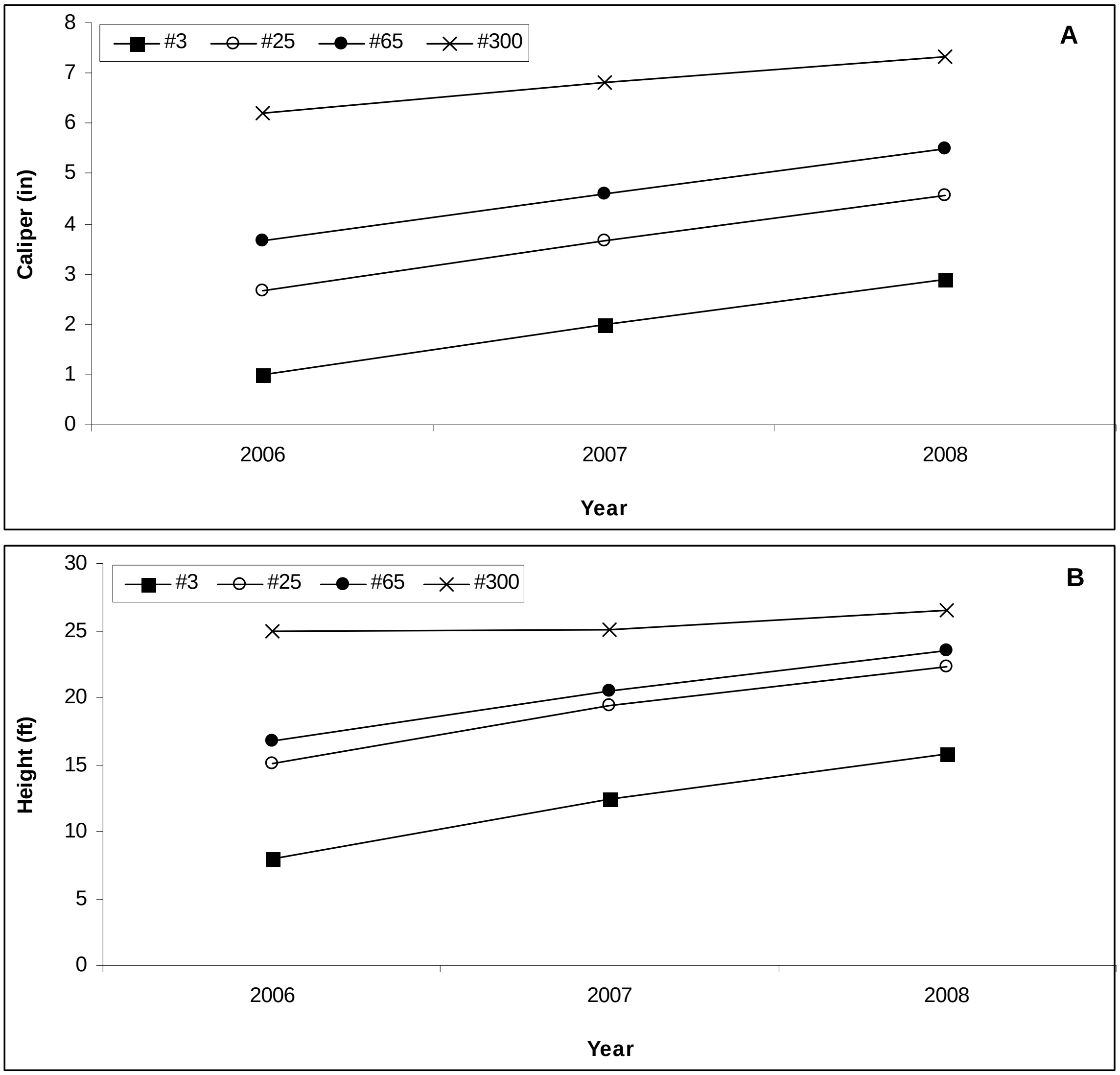


Figure 1. Caliper (A) and height (B) of 'Florida Flame' maples from September 2006 to October 2008 planted from #3, #25, #65 and #300 containers.

Table 2. Percent caliper and height increase between September 2006 and October 2008 after planting 'Florida Flame' maple into the field from #3, #25, #65 and #300 containers that were irrigated or not irrigated in the landscape.

Size at planting	Irrigation	% caliper increase	% height increase
#3	Yes	218.9 a[1]	110.5 a
	No	166.5 b	87.9 b
#25	Yes	77.4 c	47.3 c
	No	62.9 c	47.7 c
#65	Yes	50.3 cd	44.5 c
	No	50.1 cd	36.5 c
#300	Yes	16.4 d	8.3 d
	No	20.0 d	4.7 d

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

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

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 4 – December 5, 2008
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.

What we did: In April 2008, 40 #3 container-grown 'Florida Flame' maples and 40 Cathedral® 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 #15s 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 collected included: root ball quality ratings (where 1=poor root ball quality and 5=excellent root ball quality), main root diameter, number of roots growing into the #15 substrate greater than 2 mm diameter, and whether the tree was considered a cull based on Florida Grades and Standards for Nursery Stock. Caliper and heights of all trees were also collected in September 2008. Twenty trees of each species (10 per treatment) will be planted in the field in December 2008 to test tree stability in the landscape resulting from root pruning treatment.

What we found as of November 2008: Tree caliper and heights were not affected by root pruning for either species (Table 1). For maples, shaving root balls reduced culls from 100% for non-root pruned trees to 40% for trees with shaved root balls. Shaving maples before shifting into #15 containers also produced higher quality root balls (this was a subjective visual rating given to each root system) and a greater number of roots above 2 mm diameter (Table 2). These roots grew more-or-less straight out or at a slight angle away from the trunk. This sure appeared to be much better than the circling and diving orientation of trees not root pruned (see photos).

The larger roots on non-pruned trees kinked, descended down the container wall, or circled the #3, which led to poorer quality. Shaving is recommended to improve root ball quality by reducing root ball defects, and did not affect tree caliper or height. In the upcoming months we will determine if root ball shaving had the same effect on live oak root balls. We will also determine if shaving improves tree stability following planting into the landscape.

Table 1. Caliper and height of 'Florida Flame' maples and Cathedral® live oaks root pruned by shaving the outer inch of the root ball or not root pruned before shifting from #3 containers into #15 containers.

Species	Root Pruning	Caliper[1] (mm)	Height[1] (ft)
Maples	No pruning	37.7	11.5
	Root ball shaving	36.6	11.1
Live Oaks	No pruning	27.9	8.0
	Root ball shaving	26.5	7.8

[1] Based on 20 trees per treatment combination.

Table 2. Root ball characteristics of maples root pruned by shaving the outer inch of the root ball or not root pruned before shifting from #3 containers into #15 containers.

Root Pruning	% Culls[1]	Root rating[2]	Main root diameter (mm)	Number of roots >2 mm[4]
No pruning	100	2.0 b[3]	15.3 a	26 b
Shaving	40	4.3 a	11.5 b	47 a

[1] Based on Florida Grades and Standards for Nursery Stock.
[2] 1=poor quality root ball 5=excellent quality root ball.
[3] Means in a column with a different letter are statistically different at P<0.05. Based on 10 trees per treatment.
[4] Number of roots growing out into the substrate in the #15 container.

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).

Root balls that were shaved when #3s were shifted into #15 containers had roots growing mostly radially away from the trunk.

Root balls that were not shaved when shifting into #15 containers had circling and diving roots at the edge position of the #3 container.

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 4 – December 5, 2008
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, 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. 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 irrigated twice weekly. All trees were staked with the Terra Toggle system. Caliper and heights were collected on October 2008.

What we found as of November 2008: 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). Deeply planted trees had a lot more root defects, which included circling roots and roots deflected by container walls. Defects were especially apparent at the #3 container size (about 4 inches from the edge of the trunk). Defects were more prevalent in maples than elms as indicated by about twice the time required to remove defects (Table 1).

There was no difference in tree caliper or heights between the 8 treatments eight months after planting (Table 2). The average caliper for elms was 2.8 in and the average height was 16.1 ft. The average caliper for maples was 3.28 in and the average height was 17.9 ft. Some trees under went severe root removal, but it appears that it has not affected tree caliper or heights in the landscape. This project is still ongoing and more time will be needed to determine the long term impact of the treatments.

Table 1. Time it took to remove root defects of even or deep planted in #45 on maples and elms.

Species	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.

Table 2. Caliper and height of trees eight months after planting that were root pruned or not root pruned before planting from #45 containers.

Species	Root pruning at planting	Caliper (in)	Height (ft)
Elms	Yes	2.81	16.0
	No	2.82	16.2
Maples	Yes	3.28	17.7
	No	3.28	18.1

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).

Trees were staked and either mulched up to the root ball with no mulch on top of the root ball…….

….. or trees were staked and mulch was placed on top of the root ball up to the trunk as most landscapes are currently managed.

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 4 – December 5, 2008
Gainesville, Florida

Objective: Demonstrate the impact of the time liners are left in #3 containers and in #15 containers in the nursery on subsequent root quality on finished trees in #45 containers.

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; (2) potted Sept 2007 into #15 after 7 months in #3, and then potted July 2008 into #45 after 10 months in #15; (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 will be finished in #45 containers in October 2009. Root balls are not pruned when shifted to a larger container and are planted even with the substrate in the larger container. All trees are getting irrigated three times a day. Maples and elms were staked in October 2007, and pruned to establish a leader in July 2008. Calipers and heights were collected on October 2007 and 2008. Growth and tree quality will be monitored through out the project.

What we found as of November 2008: Only half of the trees have been potted in #45 containers, the other half were still in #15 containers when data was collected for this report. For elms, caliper and height, but not caliper and height increase, was affected by time in different container sizes (Table 1). Overall, trees that have been less time in #3 and #15 had larger caliper and were taller. For magnolias, caliper, as well as caliper and height increase, but not height, were affected by time in different container sizes (Table 1). Trees that spent 12 months in #3 and are still in #15 are growing the slowest when compared to the rest of the treatments. For maples, caliper, as well as caliper and height increase, but not height, were affected by time in different container sizes (Table 1). Trees that spent 4 months in #3 and 8 months in #15 have had the smallest caliper and height increase, although they have the largest caliper trees. These results are not conclusive since the project is still ongoing and half of the trees have not been potted into #45. The real objective of this project is to study influence of time in each container size has on root deformations; this evaluation will take place in late 2009.

Table 1. Caliper, height, %caliper increase, and %height increase from October 2007 to 2008 of elm, magnolia and maple grown for different times in #3, #15, and #45.

Treatment	Caliper (in)	% caliper increase	Height (ft)	% height increase
	Elm			
4 mo #3; 8 mo #15; 20 mo #45	2.00 a[1]	138	11.5 a	86
7 mo #3; 10 mo #15; 15 mo #45	1.76 b	138	10.9 ab	87
9 mo #3; 12 mo #15; 11 mo #45	1.62 c	120	10.8 ab	93
12 mo #3; 14 mo #15; 6 mo #45	1.56 c	128	10.4 b	86
	Magnolia			
4 mo #3; 8 mo #15; 20 mo #45	1.70 a	121 a	7.1	91 b
7 mo #3; 10 mo #15; 15 mo #45	1.50 b	124 a	6.8	129 a
9 mo #3; 12 mo #15; 11 mo #45	1.35 c	106 ab	6.8	134 a
12 mo #3; 14 mo #15; 6 mo #45	1.31 c	94 b	6.4	108 d
	Maple			
4 mo #3; 8 mo #15; 20 mo #45	1.94 a	129 b	11.0	117 b
7 mo #3; 10 mo #15; 15 mo #45	1.73 b	158 a	11.6	176 a
9 mo #3; 12 mo #15; 11 mo #45	1.68 b	163 a	11.4	182 a
12 mo #3; 14 mo #15; 6 mo #45	1.70 b	156 a	11.4	163 a

[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.

Great Southern Tree Conference: Tropical tree production.

Ed Gilman, Maria Paz and Chris Harchick, Environmental Horticulture, University of Florida
December 4 – December 5, 2008
Gainesville, Florida

Objective: Determine if root pruning affects tropical tree production.

What we did: In May 2008, five species (Mahogany, Gumbo Limbo, Royal Poinciana, Lysiloma and pink Tabebuia) were shifted into #3, into #15 or into #45 containers. Thirty trees of each species from liners were shifted into #3. Before shifting, substrate of fifteen of these trees was massaged from the root system to expose the main roots so we could remove kinked, circling, ascending, and descending roots. If a defective root was very large then we did not remove that root. The other fifteen trees were potted with the liner root ball untouched. Ten trees of each species from smooth-sided #3 containers were shifted into #15. Before potting into #15, five trees were root pruned by shaving off the outer peripheral inch of the root ball with a sharp blade. The other five trees were potted with the root ball untouched. Six trees of each species from smooth-sided #25 containers were shifted into #45. Before shifting, three trees were root pruned by shaving as described above. The other three trees were shifted with the root ball untouched. Tabebuia was not root sliced when it was potted into #45.

All trees are getting watered three times a day. Trees were pruned and staked in June 2008. Trees were fertilized with Graco slow release 19-5-11 with 40g for the #3, 200 g for the #15, and 620 g for the #45. The last week of October the trees had to be placed indoors to protect them from frost. The root balls were harvested in November 2008 to characterize the root system. The data will not be included in this report because it is still being collected. Calipers and height were collected in October 2008.

What we found as of November 2008: Root pruning when shifting into #3, into #15 or into #45 had no effect on tree caliper (Table 1, 2, and 3). Root pruning when shifting into #3 only had an effect on Mahogany height, trees that were not root pruned were a little taller that trees that were pruned (Table 1). Root pruning when shifting into #15 had no effect on tree height (Table 2). Root pruning when shifting into #45 only had an effect on Gumbo Limbo height; trees that were not root pruned were taller that trees that were pruned (Table 3). Root balls from trees that were root pruned for each container size have a better root system than trees that were not root pruned (Table 1 and 2). It appears that root pruning before potting up tropical trees is a good practice, and does not slow growth in any of the trees tested.

Table 1. Caliper, height, root quality of tropical trees root pruned or not when shifted into #3s.

Species	Root Pruned	Caliper (mm)	Height (ft)	% Root culls
Gumbo Limbo	Yes	21.6	5.2	30
	No	20.8	5.1	60
Lysiloma	Yes	13.3	3.7	30
	No	12.0	3.6	60
Mahogany	Yes	7.5	2.3 b[1]	12
	No	9.1	3.0 a	88
Royal Poinciana	Yes	20.0	5.0	10
	No	18.6	5.1	50
Pink Tabebuia	Yes	11.8	3.1	67
	No	10.8	3.0	90

[1]Means in a column within species with a different letter are statistically different at $P<0.05$. Based on 15 trees per treatment.

Table 2. Caliper, height, and root quality of tropical trees root pruned or not when shifting into #15 containers.

Species	Root Pruned	Caliper (mm)	Height (ft)	% Root culls
Gumbo Limbo	Yes	48.1	8.2	0
	No	44.8	7.1	0
Lysiloma	Yes	23.1	7.1	0
	No	28.2	7.4	100
Mahogany	Yes	30.0	7.9	0
	No	32.9	8.5	67
Royal Poinciana	Yes	32.6	6.5	0
	No	37.2	6.7	100
Pink Tabebuia	Yes	28.2	6.5	0
	No	32.4	6.5	100

Table 3. Caliper and height of tropical trees root pruned or not when shifting into #45 containers.

Species	Root Pruned	Caliper (in)	Height (ft)
Gumbo Limbo	Yes	4.05	13.5 b[1]
	No	4.00	15.4 a
Lysiloma	Yes	2.31	10.2
	No	2.63	10.9
Mahogany	Yes	2.55	11.7
	No	2.64	11.9
Royal Poinciana	Yes	2.79	12.8
	No	2.75	11.6
Pink Tabebuia	No	3.03	10.2

[1]Means in a column within species with a different letter are statistically different at P<0.05. Based on 6 trees per treatment.

Tabebuia in a #15 not root pruned when shifted from a #3 showing several large diving and circling roots.

Tabebuia in a #15 shaved when shifted from a #3 showing many straight roots and virtually no defects. Small roots circling the #15 container are easily removed when shifted to larger size.

Mahogany in #15 not root pruned when shifted from the #3. The roots that circled the #3 pot are clearly visible.

Mahogany in #15 shaved when shifted from a #3 showing many straight roots and virtually no defects. Root ball shaving works

Lysiloma in #3 not root pruned when shifted from the liner tray. The roots that circled the liner are clearly visible close to the trunk.

Lysiloma in #3 shaved when shifted from a liner tray showing many straight roots and no defects. Root ball teasing and shaving works.

Royal Poinciana in #3 not root pruned when shifted from the liner tray. The roots that circled the liner are clearly visible close to the trunk and all roots grow down.

Royal Poinciana in #3 shaved when shifted from a liner tray showing many straight roots and no defects. Root ball teasing and shaving works.

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

Tim Broschat, Fort Lauderdale Research and Education Center (REC)
Ed Gilman, Environmental Horticulture, University of Florida
December 4 – December 5, 2008, 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. 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 and 2008. Total number of leaves, number of green leaves, and severity of potassium (K)-deficient leaves were recorded in March 2007 and 2008. A similar experiment was initiated at the Fort Lauderdale REC on January 2006 with data collected in October 2007 and 2008.

What we found as of November 2008: For both locations, fertilizer type has had no effect on total number of leaves, number of green leaves or potassium deficiency symptoms (Table 1 and 2). For both locations, severe pruning resulted in fewer living leaves (Table 3 and 4). Since there are fewer leaves in the severely pruned palms when compared to the palms which had dead leaves removed only, the proportion of green leaves is much greater for the severely pruned ones. Also, the deficiency scores are higher for severely pruned palms than dead-only pruned leaf palms for the same reason and very similar for both sites (Table 3 and 4).

Conclusions: We think that potassium limits the number of leaves a palm can support. Severe pruning reduced the number of leaves in the canopy to less than this number so that the potassium reserves were distributed among fewer leaves. This resulted in a smaller canopy and less visible potassium deficiency symptoms. This experiment is ongoing and more data will be needed to see if this holds true over time and see if fertilizer will have an effect on appearance of sabal palms.

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 March 2008.

Fertilizer	Total living leaves	Green leaves	% Green leaves	K deficiency score*
None	25	12	49.3	4.08
16-4-8	24	11	51.1	4.06
8-2-12+4	24	10	43.1	3.98

[1]Means in a column with a different letter are statistically different at P<0.05. Based on 10 trees per treatment.
*0=dead, 1=severe K deficiency, 3=moderate K deficiency, 5=no deficiency symptoms.

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 2008.

Pruning	Total living leaves	Green leaves	% Green leaves	K deficiency score*
None	16	5	35.4	4.2
16-4-8	18	7	44.8	4.5
8-2-12+4	18	8	50.8	4.5

[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 March 2008.

Pruning	Total living leaves	Green leaves	% Green leaves	K deficiency score*
Dead only	32 a[1]	11	36.1 b	3.52 b
Severe	17 b	10	59.5 a	4.56 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 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 2008.

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.

March 2007 after removing all but 4 leaves.

Same palm November 2007.

Sabal March 2007 after removing only dead leaves.

Same palm November 2007.

Potassium deficiency symptoms.

Great Southern Tree Conference: Life cycle and management of a bullet gall wasp: *Disholcaspis quercusvirens*.

Jessica Platt and Dr. Eileen Buss, Entomology and Nematology, University of Florida
December 4 – December 5, 2008
Gainesville, Florida

Introduction: Gall wasps (Hymenoptera: Cynipidae) are one of the most complex families of gall inducing insects. Cynipid galls can form on nearly any plant part; however branches, stems, buds and leaves are the most common sites. Gall-makers usually develop in rapidly growing tissue, and redirect plant nutrients into the gall tissue. Many insects live in galls besides the gall-maker because of this nutrient-rich gall tissue. Identifying the gall-maker can be confusing because of these other insects, and also because many cynipids have two alternating generations where the asexual and sexual adults not only look different, but also have dissimilar galls on different plant parts. This has often resulted in the different generations being described as different species, or only one of the generations is known.

Disholcaspis spp. (Hymenoptera: Cynipidae) are prevalent throughout North and Central America. *Disholcaspis quercusvirens* forms woody bullet galls on *Quercus virginiana.* The life cycle of *D. quercusvirens* has not been studied and only the asexual generation has been described. We suspect the females may emerge from late November through February and lay eggs into dormant buds. Trees that are heavily infested with stem galls tend to also produce blister or pucker leaf galls after bud break (E. Buss, personal observations). Light gall infestations are usually harmless to the trees, but heavily infested trees are physically and aesthetically damaging, especially in nurseries. The bullet galls also exude a sticky substance (Figure 1) that attracts stinging insects and ants (Figure 2), which can be hazardous for nursery workers.


Figure 1. Bullet galls with sticky exudate.


Figure 2. Bullet galls with sooty mold

Proper management of gall makers is dependent on knowing the gall maker's life cycle (Eliason and Potter, 2000). Galls can be pruned and burned (chipping leaves large woody pieces in which wasps may still survive), but pruning is very labor intensive. Treatments could be timed to kill wasps as they emerge from galls and before they lay eggs, or after the sexual generation begins development (once that generation has been correctly identified).

Objective I: Determine the life cycle of *D. quercusvirens* including the natural enemy complex, male and female morphology of the sexual generation and the complete development time. A block of 94 Cathedral Oak® live oak trees located at Shadowlawn Nursery in Penny Farms, Florida (Clay County) were reserved for research use beginning February 2007. Stem gall and gall maker development of the asexual generation will be monitored and described over time to determine how long one generation lasts. Potential stem galls or swellings (Figure 3) were located on branches starting mid-May 2007 and caged with white chiffon mesh. Fifty compound galls have been caged, and will remain until all inhabitants emerge (Figure 4).

Twenty additional compound galls will be cut every 1-3 weeks (10 will be frozen and dissected, and insects will be reared from the remaining 10). The length of compound gall, number of individual galls, each individual gall's diameter and height, diameter of stem apical to the compound gall, presence of exit holes, and presence of arthropod inhabitants will be recorded.

Figure 3. Stem galls starting to become visible.

Figure 4. Mature stem galls.

Once *D. quercusvirens* emerges, we will conduct experiments to confirm the sexual generation. The length of emergence period, number of eggs per female, location of oviposition, and how long a female can live will be determined. The location of the galls of the sexual generation will be described, and also the male and female morphology.

Objective II: Determine which varieties of live oak (Cathedral Oak®, Millennium®, Highrise®, and seedlings) are most susceptible to gall formation of *D. quercusvirens*. A variety trial will take place at the Great Southern Tree Conference site in Gainesville, Florida on 4 rows of 9 trees**,** with each row being composed of a different variety of live oak (Cathedral Oak®, Millennium®, Highrise®, and seedling). Differences in initial bud break, bud size and growth characteristics among the four varieties will be measured, and the gall forming ability will be assessed for each variety. Leaf nutrient content on galled versus ungalled leaves, and the differences in gall forming ability for galls of the sexual and asexual generations will be evaluated.

Objective III: Determine the best management plan for *D. quercusvirens.* After the life cycle of *D. quercusvirens* has been confirmed, we will conduct insecticide trials. Treatments will be timed to kill the wasps as they chew exit holes in the stem galls. This will take place at Shadowlawn nursery between late 2007 and early 2008. Insecticide trials will then be conducted for the sexual generation once it is confirmed.

References: Eliason, E.A. and D. A. Potter. 2000. Impact of whole-canopy and systemic insecticidal treatments on *Callirhytis cornigera* (Hymenoptera: Cynipidae) and associated parasitoids on pin oak. *Journal of Economic Entomology* 93 (1): 165-171.