2006 GREAT SOUTHERN TREE CONFERENCE

RESEARCH REPORT

UF UNIVERSITY of FLORIDA IFAS

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November 30 – December 1, 2006

UNIVERSITY OF FLORIDA
Environmental Horticulture Department
GAINESVILLE, FLORIDA 32611

Great Southern Tree Conference results help growers and landscapers manage trees more efficiently

Dr. Ed Gilman, Professor
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2006: A YEAR OF GROWTH

More than 35 outdoor projects are under way or have already been completed at the Great Southern Tree Conference site at the University of Florida's Environmental Horticulture Department since the year 2000, when the Conference began. Some of these have helped develop and/or substantiated current techniques and practices. Others are designed to look for more efficient methods of performing common jobs such as nursery production pruning. Some recent work focuses on the effects of pruning types and planting techniques on tree behavior in hurricanes. All these and much more will be experienced November 30-December 1, 2006.

None of this can be accomplished without six years of generous support from our industry partners. These companies and organizations provide direct financial support as well as plant material, supplies and guidance. We hope this remains at the present level so we continue to make technical advancements and delivers products and services with increased efficiency. This unique partnership has few equals in the US.

Described in this report are a number of projects underway or recently completed that have direct application to many aspects of either nursery tree production or landscape management. Some are already published in scientific journals but have not reached the main stream of professionals. There are a lot of details included in this report. Some projects will have direct implications to your organization, and might help you save time and money. We encourage you to browse the table of contents to find projects relevant to your interests.

Much more work lies ahead. For example we are just beginning to discover the impact of root defects on landscape performance, especially in storms. We need better tools to prevent these problems. We must find more effective strategies for growing trees in urban spaces. Many spaces are getting smaller suggesting we need to find a greater variety of small maturing, urban-tough trees. However, small trees provide limited benefits to urban environments because they have a small canopy, and many are short lived. We need more technical information on production of some native and tropical trees. Canopy quality has been improving in the last few years but we have a long way to go with generating quality root systems.

We thank you for the opportunity to serve you and we appreciate your continued support. Our profession has made significant advances in the last ten years, and we hope this Conference will continue to make contributions to the further advancement. Enjoy the Conference and we hope to see you in the near future.

A special "Thank you" to our great tree team staff for their hard work - Chris Harchick, Alison Boydstun, Ryan Eckstein, Dustin Meador, Amanda Bisson, Patricia Gomez and Maria del Pilar Paz.

Special *"Thanks"* to our 2006 Great Southern Tree Conference Partners

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Great Southern Tree Conference Project Title: Staking technique influences caliper development on willow oak but not red maple.

Ed Gilman, Environmental Horticulture Department
University of Florida
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Gainesville, Florida

Objective: Determine if stake type influences tree growth in a field nursery.

What we did: In May 2003, thirty red maples and thirty willow oaks were planted from #1 containers. Ten of each were staked in the following three ways: 1) short (2 ft long) 3/16" steel rod, 2) 8 ft long ¾ inch diameter very stiff thick-walled metal conduit, 3) 8 ft long 5/16 inch diameter solid galvanized steel rod. All short steel rods were removed in June 2004; they were used only long enough to keep trees from falling over. All 30 trees were pruned, splinted, and tied as needed to develop a straight trunk beginning July 2004. In August 2004, the 8 ft conduit and the 8ft steel rods were lifted, loosened and placed back into the ground. In February 2006, the 8 ft conduit and the 8 ft steel rods were removed. Caliper and height were measured in October 2005 and September 2006.

What we found as of Dec 2006: No caliper or height differences were detected at the end of 2006 among the different staking systems; although there were differences in caliper while the trees were staked (2005 caliper data, Table 1). Trees that were staked for 30 months apparently grew faster once stakes were removed than they did while staked. Staking was not species specific, as no growth differences were perceived among the staking systems at the end of the study in either maples or willow oaks (Table 1).

Table 1. Trunk caliper and height of maples and willows staked by three different methods.

Staking method	2005 Caliper (in)	2005 Height (ft)	2006 Caliper (in)	2006 Height (ft)
Maple				
2ft steel rod, then no stake	2.17	14.05	2.49	15.68
8ft conduit	2.06	14.89	2.46	15.99
8ft steel rod	2.06	13.86	2.40	14.69
Willow Oak				
2ft steel rod, then no stake	1.73a[1]	9.81	2.13	11.66
8ft conduit	1.24b	9.58	1.61	10.16
8ft steel rod	1.25b	7.89	1.56	8.92

[1]Means in column with a different letter are statistically different from each other at $P<0.05$; no letter means no difference.

Conclusion: Stakes driven into the ground should be removed from the trunk as soon as the trunk develops enough caliper to hold it erect. Combined with retaining low branches, this will reduce the likelihood of stakes limiting caliper development.

¾” electrical conduit	5/16” steel rod	Short stake, then no stake

Figure 1. Staking trees with galvanized electrical conduit (left) and galvanized solid wire (center) resulted in smaller caliper on willow oaks but not red maple compared to trees not staked (right) only while they were staked. Differences disappeared one year after stakes were removed.

Great Southern Tree Conference Project Title: Effect of planting depth on Cathedral Oak® growth and quality in containers.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30- December 1, 2006
Gainesville, Florida

Objective: Demonstrate how planting depth can influence root and top growth, and tree quality during production.

What we did: 310 Cathedral Oak® rooted cuttings from 2.25 inch diameter containers were planted into #3 ACCELERATORS early May 2003. The point where the top-most root emerged from the trunk was placed at 5 different depths as follows: 1) 0.5 to 0.75 inch below the media surface, 2) 1.5" below, 3) 2.5" below, 4) 3.5" below, or 5) 4.5" below the media surface. Each depth treatment contained 44 trees, with the exception of the 0.5-0.75" treatment that had 90 trees and the 2.5" treatment that had 88 trees. Canopies were pruned in July 2003 and September 2003. All trees were sprayed for powdery mildew once in October 2003. In early May 2004, all trees were potted into #15 ACCELERATORS. The top of the media in the #3 containers was placed even with the media surface in the #15 containers for all trees of each planting depth with the exception of half of the trees planted 2.5" deep. The remaining half of the trees planted 2.5" deep were planted another 2.5" deep when potted into #15s, for a total of 5" deep. Canopies were pruned in May 2004 and September 2004. In March 2005, all trees were potted into #45 ACCELERATORS whereby the top of the media in the #15 containers was positioned even with the media surface in the #45 containers. The trees planted 2.5" deep in both #3s and #15s were planted another 2.5" deep for a total of 7.5" deep. All trees were pruned in May 2005 and in February and June 2006. Trees were irrigated and fertilized throughout the study.

Caliper and height were taken in 2005 and 2006, with spread also being measured in 2006. In addition, all trees were graded in 2006. In September 2006, the roots of 5 trees of each treatment were excavated; all roots at least 10mm in diameter and within 3"of the trunk down to a depth of 3" were counted and their diameters measured. The presence of a root flare and the number of surface roots was also determined for all 30 trees.

What we found as of Dec 2006: Caliper in the first 30 months following planting (2005 data) was larger in trees planted 1.5" deep, than in trees planted at a depth of 0.5-0.75", and 2.5" in #3s followed by 5" in #15s and 7.5" in #45s (Table 1). Trees planted 1.5" deep were also taller than trees of all other depths except those planted 0.5-0.7" deep. Furthermore, trees planted 0.5-0.75" deep were taller than trees planted 2.5" deep and 2.5" deep in #3s followed by 5" in #15s and 7.5"in #45s. After 40 months (2006 data), trees planted 1.5" and 3.5" deep had a larger caliper than trees planted at 0.5-0.75" below grade. In turn, trees in the 0.5-0.75" depth treatment were taller than all other trees except for those in the 1.5" depth treatment. With respect to spread, trees planted at 1.5", 3.5" and 0.5-0.75" deep were wider than trees planted 2.5" deep in #3s followed by 5" in #15s and 7.5" in #45s. Moreover, trees planted at a depth of 1.5" and 3.5" were wider than trees planted 2.5" and 4.5" deep. Overall, caliper of trees planted with the first root right within 0.75" of the surface grew slowest in the first couple years but caught up in the last 12 months. Slower growth early of very shallow planted trees may have been due to the roots becoming too dry for a short time after potting into the #3 containers. With respect to height, shallow planted trees were tallest.

Trees planted 2.5" deep in #3s followed by 5" in #15s and 7.5" in #45s had fewer, smaller, and deeper roots than trees planted at all other depths (Tables 2 and 3). The presence of a root flare decreased with increasing planting depth. Conversely, the percentage of roots that originated above the top root increased with increasing depth. In addition, planting depth was found to be independent of the number of roots of different diameter sizes (data not shown). Cathedral Oak® may be among the small number of trees capable of adjusting to deep planting by generating new roots at the media surface, but only on very young trees.

As a final point, trees planted at a depth of 1.5" below grade demonstrated the highest likelihood of grading as either a Florida Fancy or Florida #1 (Table 4). Trees planted 2.5", 3.5" and 4.5" deep exhibited the highest variability in grade.

Table 1. Effect of liner planting depth on growth of live oak the first 15 months after potting into #45 containers.

Planting depth of top root (in)	2005 caliper (in)	2005 height (ft)	2006 caliper (in)	2006 height (ft)	2006 spread (ft)
0.5-0.75	2.06b[1]	11.47ab	2.45b	12.9a	5.65ab
1.5	2.19a	11.69a	2.57a	12.5ab	5.74a
2.5	2.15ab	10.9c	2.50ab	12.4b	5.42bc
3.5	2.09ab	11.14bc	2.56a	12.2b	5.77a
4.5	2.12ab	11.0bc	2.51ab	12.1b	5.41bc
2.5 (#3), 5 (#15), 7.5 (#45)	2.07b	10.85c	2.51ab	12.2b	5.21c

[1]Means in a column followed by different letters are statistically different at $P<0.05$.

Table 2. Effect of liner planting depth of live oak root growth the first 15 months after potting into #45 containers.

Planting depth of top root (in)	Average number of roots per tree	Average root diameter (mm)	Total cross-sectional root area per tree (mm^2)	Average surface to root distance (in)
0.5-0.75	6.0a[1]	23.4	2944.4a	1.58
1.5	5.6a	22.2	2486.1a	1.60
2.5	8.0a	22.0	3591.5a	1.81
3.5	7.6a	18.9	2426.9a	1.89
4.5	7.4a	20.3	2760.3a	1.93
2.5 (#3), 5 (#15), 7.5 (#45)	1.4b	16.3	320.2b	2.49

[1]Means in a column followed by different letters are statistically different at $P<0.05$. Data based on 5 trees per depth treatment. Only roots in the top 3" were measured.

Table 3. Effect of liner planting depth on shallow root growth of live oak the first 15 months after potting into #45 containers.

Planting depth of top root (in)	% trees with root flare	Average number of surface roots per tree[1]	% roots originating above top root[2]
0.5-0.75	100%	2.0	3.3
1.5	100%	2.0	35.7
2.5	80%	0.8	56.4
3.5	20%	0.2	94.7
4.5	40%	0.8	100.0
2.5 (#3), 5 (#15), 7.5 (#45)	0%	0.0	100.0

Data based on 5 trees per depth treatment.
[1]Surface roots means roots visible on the surface of the media.
[2]Top root means the root that was the top-most root when the rooted cutting was planted into the #3 container.

Table 4. Percentage of trees by grade of live oak planted at 6 depths (excludes step 10 - root grading).

Planting depth of top root (in)	Florida Fancy	Florida #1	Florida #2	Cull
0.5-0.75	11%	81%	6%	2%
1.5	7%	91%	2%	0%
2.5	16%	72%	12%	0%
3.5	16%	77%	7%	0%
4.5	24%	65%	9%	2%
2.5 (#3), 5 (#15), 7.5 (#45)	5%	90%	5%	0%

Based on 44 trees per treatment.

Conclusion: Increasing planting depth in the container reduced height. Trees planted 0.5" deep had the least caliper; we do not suggest planting liners this shallow into #3 containers. Cathedral Oak® has the ability to generate new roots on the buried portion of the stem when trees are 1/4 inch diameter in the #3 container but losses that capacity on older trees. Planting liners so the top-most root from a rooted cutting is 1.5 inches below the media surface appears to be the best management practice to achieve quality trees in containers.

Roots circling the outside of the finished #3 containers.

Roots were visible at the surface on trees planted 1/2 and 1.5" deep into #3 containers.

Main roots were present close to the surface even on trees planted 4.5" deep into #3 containers.

No roots were at the surface and there was no root flare on trees planted 2.5" deep each time the tree was repotted to a larger container.

Great Southern Tree Conference Project Title: Effects of planting depth and mycorrhizae on MISS CHLOE® magnolia, 'Florida Flame' maple, Highrise® live oak, and Allée® elm in container nursery production

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30 - December 1, 2006
Gainesville, Florida

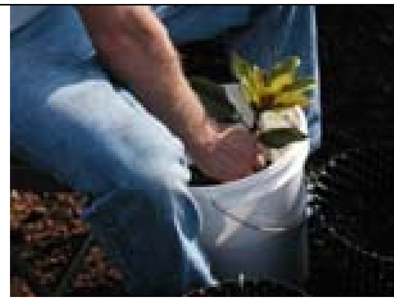
Objective: Determine impacts of planting depths and mycorrhizae application on root and top growth in the nursery of four commonly planted tree cultivars.

What we did: In June 2005, 110 rooted cuttings each of *Magnolia grandiflora* MISS CHLOE® PP #11029, *Acer rubrum* 'Florida Flame', and *Ulmus parvifolia* Allée® Elm ('Emer II' P.P.# 7552) were planted in #3 airpots with the top-most root either 0.5 inches or 2.5 inches below grade. Another 110 rooted *Quercus virginiana* Highrise® ('QVTIA' P.P.# 11219) live oak cuttings were planted in #3 airpots with the same treatments in September 2005. In January 2006, all trees were potted into #15s, whereby half of the trees of each planting depth and species were planted with the top-most root even with the media surface and half 2.5 inches deeper. A total of four planting depths resulted from the 2 planting sessions: 0.5", 2.5", 3", and 5". In addition to planting depth, half of the trees of each species were dipped in a solution containing ectomycorrhizae spores (Plant Health Care, Inc.) when potting into #3 containers; the remaining half was not dipped. During repotting into #15s, endomycorrhizae was mixed into the soil of the mycorrhizae-treated trees of all species.

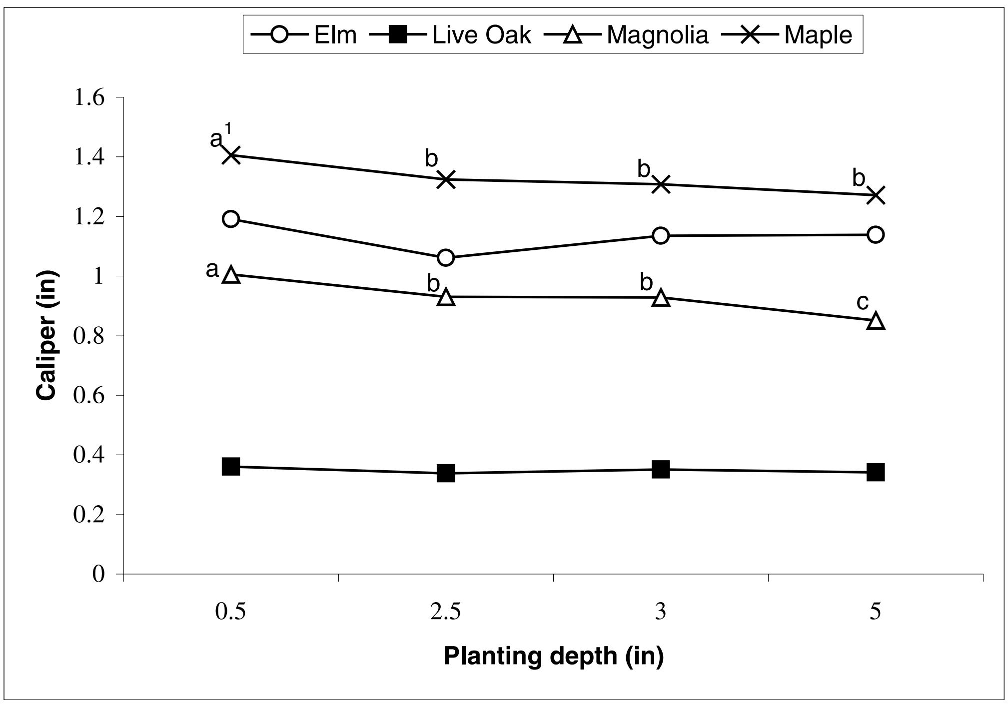
Irrigation began at planting with each pot receiving 1 gallon of water per day. Irrigation to maples and elms was reduced to 0.4 gallons every other day in September 2005. In 2006, trees were irrigated as needed in January, and then increased to 2.5 gallons/day in March, 3 gallons/day in May, and 5 gallons/day in August. Fertilizer was included in the potting soil (a mix of 50% bark, 40 % peat, and 10% sand) using 12.5 50-pound bags for each 35 yards of soil mixture. In August 2006, 1/2 a teaspoon of OH2® (oxyfluorfen, pendimethalin) was added to all oaks and magnolias. Elms and maples were pruned in May 2006 to develop a leader and to shorten lower branches. In April 2006, dieback on the elms was quantified. In September 2006, caliper and height were recorded for all trees.

What we found as of Dec 2006: Caliper was larger for both maples and magnolias planted at 0.5" below grade than those planted at all other depths (Figure 1). Furthermore, magnolia trees planted 2.5" and 3" deep had larger calipers than those planted 5" deep. In both maples and magnolias, trees planted 0.5" and 2.5" below grade were taller than trees planted at 5" below grade (Figure 2). No caliper or height differences among planting depths were detected for elm and live oak. No caliper or height differences were noted between trees treated and not treated with mycorrhizae (Table 1 and Table 2). Elm dieback was comparable among all planting depths, whereas twice as many elms not treated with mycorrhizae displayed no dieback symptoms (Table 3 and Table 4). Roots were not yet evaluated but they will be shown at conference.

Conclusion: Some tree species, especially magnolia and red maple, respond to deep planting by growing slowly. Therefore, plant liners with the top most root in the root ball about 1 to 1.5 inches below soil or media surface for best growth and highest quality trees.

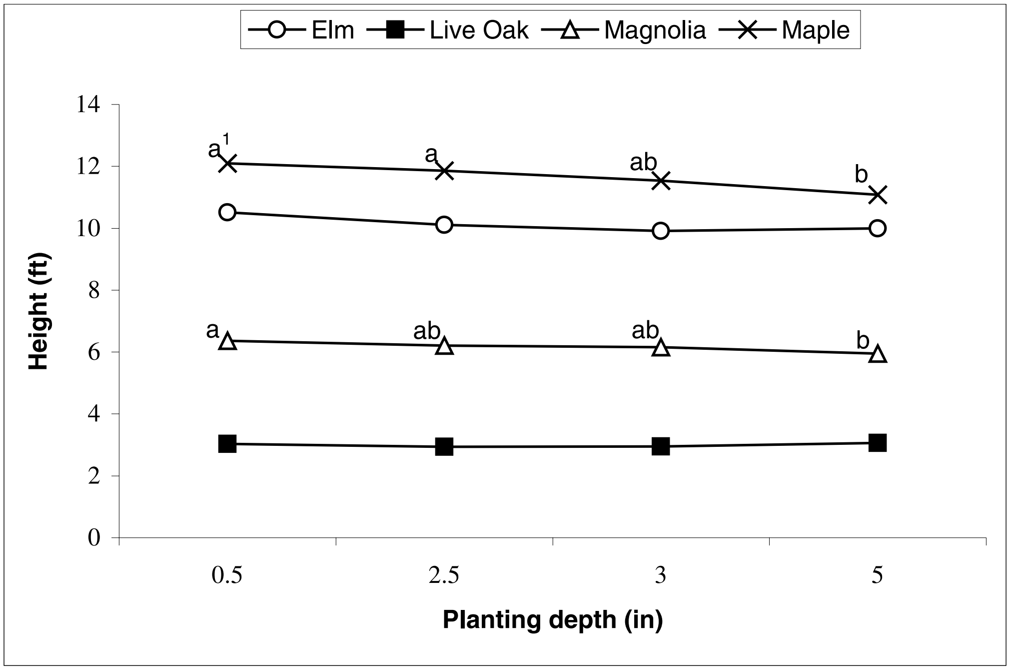


Planting at different depths (left), Dipping trees in mycorrhizae (above). Magnolias growing out in #3 containers (right).



[1]For each species, different letters indicate statistical differences at the $P<0.05$ level.

Figure 1. Caliper of #15 container trees of 4 species 12–14 months after being planted at 4 depths.



[1]For each species, different letters indicate statistical differences at the $P<0.05$ level.

Figure 2. 2006 height of #15 container trees of 4 species12–14 months after being planted at 4 depths.

Table 1. 2006 caliper of #15 container trees of 4 species12 to 14 months after being treated with mycorrhizae.

Mycorrhizae added	Elm	Live Oak	Magnolia	Maple
Yes	1.16	0.35	0.93	1.33
No	1.11	0.34	0.93	1.33

Table 2. 2006 height of #15 container trees of 4 species12 to 14 months after being treated with mycorrhizae.

Mycorrhizae added	Elm	Live Oak	Magnolia	Maple
Yes	10.2	2.97	6.16	11.7
No	10.1	3.01	6.18	11.6

Table 3. Number of elms in #15 containers in each dieback percentage range 8 to10 months after being planted at 4 depths. (Dieback may have been caused by cold temperatures around dormant season.)

Planting Depth	Dieback percentage					
(below grade)	0%	1-25%	26%-50%	51-75%	>75%	Dead
0.5”	7	12	2	1	2	4
2.5”	5	11	3	1	1	6
3”	8	13	0	1	3	3
6”	6	10	2	2	3	4

Table 4. Number of elms in #15 containers in each dieback percentage range 8-10 months after being treated with ecto-mycorrhizae. (Dieback may have been caused by cold temperatures around dormant season.)

	Dieback percentage					
Mycorrhizae	0%	1-25%	26%-50%	51-75%	>75%	Dead
Yes	9	22	6	4	5	8
No	17	24	1	1	4	9

Great Southern Tree Conference Project Title: Effect of container spacing on Cathedral Oak® growth and quality

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30 - December 1, 2006
Gainesville, Florida

Objective: Demonstrate how container spacing can affect tree height, caliper, pruning requirements, and quality.

What we did: 428 Cathedral Oak® rooted cuttings in 2.25 inch diameter containers were planted into #3 ACCELERATORS early May 2003; 214 were jammed pot-to-pot, 214 were spaced 3 feet apart. Trees were pruned in July 2003 and September 2003. All trees were sprayed for powdery mildew once in October 2003. In early May 2004, all trees were potted into #15 ACCELERATORS. Half of the jammed trees were placed on 3 feet spacing and half were spaced 6 feet in #15s. Similarly, half of the spaced trees continued to be spaced 3 feet, while the other half were spaced 6 feet apart in #15s. All trees were pruned in May 2004 and September 2004. In March 2005 all trees were potted into #45 ACCELERATORS whereby half of the trees in each of the 4 treatments were spaced 6 ft and the other half were spaced 8 ft. All trees were pruned in May 2005 and in February and June 2006. Trees were irrigated and fertilized throughout the study. The largest 1 or 2 branches on the lower 4.5ft of trunk were removed at each pruning; other long low branches were shortened as needed to keep them from growing into the canopy. Caliper and height were taken in 2003, 2004, 2005 and 2006; spread also was measured in 2006. The amount of time required to prune each tree was recorded for all years. Trees were graded according to Florida grades and standards in August 2006.

Summary of spacing treatments:

1. jammed in #3s then spaced 3' in #15s then spaced 6' in #45s
2. jammed in #3s then spaced 3' in #15s then spaced 8' in #45s
3. jammed in #3s then spaced 6' in #15s then spaced 6' in #45s
4. jammed in #3s then spaced 6' in #15s then spaced 8' in #45s
5. spaced 3' in #3s then spaced 3' in #15s then spaced 6' in #45s
6. spaced 3' in #3s then spaced 3' in #15s then spaced 8' in #45s
7. spaced 3' in #3s then spaced 6' in #15s then spaced 6' in #45s
8. spaced 3' in #3s then spaced 6' in #15s then spaced 8' in #45s

What we found as of Dec 2006:

First growing season (2003) - Caliper was not affected by container spacing the first growing season; however jammed trees were 6 inches taller than spaced trees (data not shown). This could have been due to increased temperature in the spaced plot slowing growth or a result of the more aggressive low branches on spaced trees. More time was required to prune the spaced trees because the lower branches were more aggressive than on trees jammed together (data can be found in 2004 GSTC report).

Second growing season (2004) - After potting up to #15 containers the caliper of trees at the end of the year in the jammed/6ft treatment was larger than trees spaced at 3ft in #15s, regardless of whether they had been previously jammed or spaced in the #3 containers (data not shown). Furthermore, the trees in the spaced/6ft treatment had a larger caliper than trees in spaced/3ft treatment. The jammed/3ft trees were taller than all other treatments, whereas the spaced/6ft trees were the shortest of all treatments. These results show that tree height increased as spacing between trees decreased. Pruning time was considerably higher for the spaced/6ft treatment than all other treatments. The pruning time for the jammed/6ft trees was significantly lower than that of the spaced/3ft trees (data can be found in 2005 GSTC report).

Third growing season (2005) – Following the potting up to #45 containers the caliper of trees in the spaced/6ft/8ft treatment was smaller than trees in both the jammed/3ft/8ft and spaced/3ft/8ft treatment (Table 1). Moreover, trees in the spaced/6ft/6ft treatment had a smaller caliper than all treatments except for the spaced/6ft/8ft treatment. Trees that were submitted to the jammed/3ft/8ft, spaced/3ft/6ft and spaced/3ft/8ft layouts were taller than all trees that were spaced at 6ft in #15s, regardless of their spacing in the #3s and #45s. In addition, trees in the jammed/3ft/6ft treatment were taller than the trees in the jammed/6ft/6ft, spaced/6ft/6ft, and spaced/6ft/8ft layouts. Trees in the jammed/6ft/6ft, jammed/6ft/8ft and spaced/6ft/6ft treatments took longer to prune than trees spaced at 3ft in #15s, regardless of their spacing in the #3s and #45s (Table 2). Furthermore, jammed/6ft/6ft and spaced/6ft/6ft trees had a higher pruning time than spaced/6ft/8ft trees. The 2005 results suggest that the spacing in the #15s, rather than spacing in the #3s and #45, affected tree growth. General trends included trees spaced 3ft in the #15s tending towards larger calipers and heights, and shorter pruning times. The following treatment appears most efficient: jammed in #3s for 12 months, 3ft spacing in #15s for 10 months, then 6ft spacing in #45s.

Fourth growing season (2006) – A year after potting up to #45 containers, the caliper of trees in the spaced/6ft/6ft and spaced/6ft/8ft was smaller to trees of all other treatments except for those that were jammed/6ft/6ft. In turn, the jammed/6ft/6ft trees had a smaller caliper than the trees that were jammed/3ft/6ft, jammed/3ft/8ft, and jammed/6ft/8ft. Trees in the spaced/6ft/8ft treatment were shorter than trees of all other treatments except for its jammed counterpart. Trees that were submitted to the jammed/6ft/8ft layout were shorter than those of the jammed/3ft/6ft, jammed/6ft/6ft, spaced/3ft/6ft and spaced/3ft/8ft layouts. In addition, trees arranged in the spaced/3ft/6ft set-up were taller than trees from the jammed/3ft/8ft and spaced/6ft/6ft set-up. Jammed/3ft/8ft and spaced/3ft/8ft trees were wider than trees of all other treatments. Trees of the jammed/3ft/6ft had larger spreads than trees submitted to the spaced/3ft/6ft and spaced/6ft//6ft layout. Furthermore, jammed/6ft/8ft trees were wider than the spaced/6ft/6ft trees. Trees in the jammed/3ft/8ft and jammed/6ft/8ft treatments took longer to prune than all other trees except for those in the spaced/3ft/8ft treatment. In turn, spaced/3ft/8ft trees had a higher pruning time than jammed/3ft/6ft, jammed/6ft/6ft, spaced/3ft/6ft and spaced/6ft/6ft trees. Moreover, spaced/6ft/8ft trees took longer to prune than trees that were jammed/3ft/6ft and jammed/6ft/6ft. Lastly, the jammed/3ft/8ft and spaced/3ft/8ft treatments yielded the highest percentage of Florida Fancy trees (Table 3). The 2006 results continue to suggest that trees spaced 3ft in the #15s tend towards larger calipers, heights, and spreads, and shorter pruning times; these trees also tend to result in a superior grading. In addition, spacing at 8ft in #45s appears to encourage wider and shorter canopies than 6ft spacing with no impact on caliper. This is the only spacing that resulted in 100% of trees grading Florida #1 or better.

Total pruning time between 2003 and 2006: Trees in the jammed/3ft/8ft treatment took longer to prune than trees in all other treatments except for those in the spaced/6ft/6ft and jammed/6ft/8ft treatments, but resulted in the nicest trees. In turn, spaced/6ft/6ft and jammed/6ft/8ft trees took longer to prune than jammed/6ft/6ft, spaced/3ft/6ft and jammed/3ft/6ft trees. Finally, spaced/6ft/8ft and spaced/3ft/8ft trees had a higher pruning time than trees in the jammed/3ft/6ft treatment.

Conclusion: Jammed in #3s, 3ft spacing in #15s and 8ft spacing in #45s appears to produce Cathedral Oak® trees with the highest quality and largest size.

Table 1. Effect of container spacing on growth of Cathedral Oak® 40 months from rooted cuttings.

Spacing Treatment	2005 caliper (in)	2006 caliper (in)	2005 height (ft)	2006 height (ft)	2006 spread (ft)
#3 #15s #45s					
Jammed then 3ft then 6ft	2.10ab[1]	2.57a	11.3ab	12.5ab	5.59b
Jammed then 3ft then 8ft	2.15a	2.58a	11.5a	12.3bc	6.04a
Jammed then 6ft then 6ft	2.11ab	2.45bc	10.9bc	12.6ab	5.33bcd
Jammed then 6ft then 8ft	2.11ab	2.54a	10.9bc	12.0cd	5.52bc
Spaced 3' then 3ft then 6ft	2.11ab	2.52ab	11.5a	12.8a	5.32cd
Spaced 3' then 3ft then 8ft	2.14a	2.53ab	11.7a	12.5ab	6.04a
Spaced 3' then 6ft then 6ft	2.00c	2.40c	10.6c	12.3bc	5.24d
Spaced 3' then 6ft then 8ft	2.02bc	2.40c	10.7c	11.9d	5.41bcd

[1] Means in a column followed by the same letter are not statistically different from each other at the P<0.05 level.

Table 2. Pruning time for 2005, 2006, and the duration of the study (2003 to 2006) of Cathedral Oak® 40 months from rooted cuttings.

	Pruning Time (seconds)*		
Spacing Treatment	2005	2006	2003 to 2006
#3 #15s #45s			
Jammed then 3ft then 6ft	53c[1]	153d	274d
Jammed then 3ft then 8ft	56c	190a	328a
Jammed then 6ft then 6ft	71a	151d	286cd
Jammed then 6ft then 8ft	66ab	185a	309ab
Spaced 3' then 3ft then 6ft	56c	161cd	284cd
Spaced 3' then 3ft then 8ft	51c	177ab	300bc
Spaced 3' then 6ft then 6ft	71a	161cd	310ab
Spaced 3' then 6ft then 8ft	58bc	168bc	303bc

[1] Means in a column followed by the same letter are not statistically different from each other at the P<0.05 level.

*Pruning time indicates the average number of seconds required to prune a tree in that treatment.

Table 3. Percentage of trees by Grade of Cathedral Oak® submitted to 8 spacing treatments.

Spacing Treatment	Florida Fancy	Florida #1	Florida #2	Cull
#3 #15s #45s				
Jammed then 3ft then 6ft	14%	82%	2%	2%
Jammed then 3ft then 8ft	28%	72%	0%	0%
Jammed then 6ft then 6ft	10%	87%	3%	0%
Jammed then 6ft then 8ft	9%	82%	9%	0%
Spaced 3' then 3ft then 6ft	6%	84%	8%	2%
Spaced 3' then 3ft then 8ft	25%	73%	2%	0%
Spaced 3' then 6ft then 6ft	3%	77%	20%	0%
Spaced 3' then 6ft then 8ft	2%	88%	10%	0%

Great Southern Tree Conference Project Title: Effect of root defect removal timing on tree growth and quality in the nursery

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30 - December 1, 2006
Gainesville, Florida

Objective: Demonstrate when to remove root defects in containers for maximum efficiency.

What we did: 88 cutting propagated Cathedral Oak® rooted cuttings in 2.25 inch diameter ACCELERATOR pots were planted into #3 ACCELERATORS early May 2003. The top of the liner media was placed within 0.5" of the #3 container media surface. Root defects (circling or kinked roots) were cut on 44 liners as they were potted into the #3s; defects were not cut on another set of 44 liners. Canopies were pruned in July 2003 and September 2003. In early May 2004, all the trees were potted into #15 ACCELERATORS. Root defects on top of the root ball close to the trunk were again cut if needed on the 44 trees that previously had root defects removed; few of them actually needed this because they were previously root pruned. An additional 25 trees, from the group whose root defects were not cut when transferred into #3s had root defects removed when potted into #15s. Root defects were not removed on the remaining 19 trees. In addition to the defects removed from the top of the root balls close to the trunk, the top edge of the root ball of all root-pruned trees was clipped in 6 equidistant places prior to potting into each container size. For all trees at each repotting, media was removed to the first root and then planted even with the top of the media. Canopies were pruned in May 2004 and September 2004. In March 2005 all trees were potted into #45 ACCELERATORS. The trees that were previously root pruned had the top edge of the root ball clipped in 6 places prior to planting. All trees were canopy pruned in May 2005 and in February and June 2006. Trees were irrigated and fertilized throughout the study. Caliper and height were taken in 2004, 2005, and 2006.

What we found as of Dec 2006: Growth following planting into #3s was not reduced in response to pruning away root defects. Similarly, growth was not affected if we waited to remove the defect when trees were potted from #3s into #15s (Table 1). All trees produced in these containers without root pruning produced circling roots making them culls according to Florida grades and standards for nursery stock. Fewer culls were produced by pruning roots each time trees were potted into larger containers. Removing root defects by pruning roots when trees are potted to the next larger size reduced culls from 100% to 40% of the crop and is recommended for quality tree production.

Table 1. Effect of root defect removal on growth of live oak in containers. Trees are now finished in #45 containers.

	Caliper (in)			Height (ft)			
Root defects removed	2004	2005	2006	2004	2005	2006	%culls[1]
not in #3, not in #15, not in #45	0.99	2.00	2.45	6.60	11.14	12.27	100
not in #3, yes in #15, not in #45	1.05	2.07	2.49	6.37	10.68	12.08	40
yes in #3, yes in #15, not in #45	1.01	2.05	2.48	6.37	10.76	12.12	40

[1] Culls due to root circling according to Florida grades and standards for nursery stock.

Conclusion: Root defects can be removed either when liners are potted into #3s or when #3s are potted into #15s without reducing growth rate. Root pruning when trees are potted into larger containers dramatically reduces number of culls.

Great Southern Tree Conference Project Title: Live oak cultivar evaluation

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30- December 1, 2006
Gainesville, Florida

Objective: To demonstrate growth habits of three cutting propagated live oak cultivars

What we did: Ten each of Highrise® (#3s), Millennium™ (#3s), and Cathedral Oak® (#1s) were planted in August 2001 on 8 ft centers in rows 12 ft apart in a container nursery (#15 then into #45 containers). An additional 10 Highrise® (#3s),10 Millennium™ (#3s) and Cathedral Oak® (#1s) were also planted into the field on 8 ft centers in rows 12 ft apart in August 2001. All container trees were fertilized with Nutricote 17-7-8; once in 2002 (211g), twice in 2003 (211g, 203g), and 3 times in 2004 (203g each time). Field trees were fertilized 4 times in 2002 with 65g, 210g, 300g, and 400g respectively of 16-4-8. In 2003 and 2004, field trees were fertilized 3 times with 400g of 16-4-8. In April 2005, all trees in the container nursery were planted into the field. The 30 container-to-field trees were fertilized 3 times with 400g of 16-4-8 in 2006, whereas the 20 field trees were fertilized 3 times with 800g of 16-4-8 in both 2005 and 2006. All trees were irrigated throughout the study.

Also, in 2000, one 2.5-inch caliper tree of each of the 3 cultivars was planted in the open to evaluate growth form. The trees were irrigated and mulched for the first year only. The trees were fertilized 3 times in both 2005 and 2006 with 3.1lbs of 16-4-8. All 3 trees were structurally pruned and canopy lifted in July 2006. Caliper, height and spread were recorded in September 2006 for all trees in each of the 2 study groups.

What we found as of Dec 2006: The three live oak cultivars have different growth rates and canopy forms (Table 1 and Table 2). It is important to note that the growth rates shown below may not be duplicated in your nursery due to irrigation, fertilizer, media, and soil differences.

Table 1. Growth habits of three live oak cultivars during the first 5 years of production from #1 or #3 containers.

Cultivar and original liner size	Nursery location	Caliper (in)	Height (ft)	Width (ft)
#3 Highrise®	Container	3.78	19.3	8.57
	Field	4.40	22.6	9.35
#3 Millennium™	Container	4.31	15.9	9.53
	Field	5.78	22.6	12.2
#1 Cathedral Oak®	Container	3.66	14.9	8.58
	Field	5.0	19.6	10.4

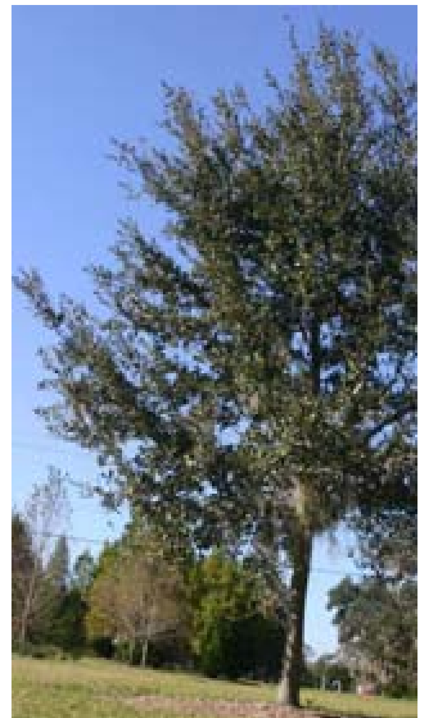
Highrise ® and Millennium™ were planted as #3 liners 4 to 5 feet tall; Cathedral Oak® were planted as #1 liners about 2 feet tall.

Table 2. Growth of three live oak cultivars 6 years after planting as 2.5" caliper trees.

Cultivar	Caliper (in)	Height (ft)	Spread (ft)
Highrise®	7.83	26.0	17.2
Millennium™	9.17	27.6	20.6
Cathedral Oak®	8.07	23.4	18.5

Highrise®

Cathedral Oak®



Millenium™

Above photos: Before pruning Cathedral Oak® , Highrise® and Millenium™ live oaks five years after planting from 2.5 inch caliper. **Below photos:** After pruning the same trees.

Great Southern Tree Conference Project Title: Growth effects of 3 large caliper Highrise® production strategies.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30 - December 1, 2006
Gainesville, Florida

Objective: Determine the most efficient pruning method for producing 8" caliper trees.

What we did: In August 2001, 30 Highrise® live oak from #3 containers were planted 16 ft apart in the field, in rows spaced 12 ft apart. Ten trees were submitted to each of 3 production strategies: 1) Grow trees with the intention of producing an 8" caliper tree; 2) Grow finished trees for 6" market then convert them to large caliper trees; 3) Grow finished trees for 4" market then convert them to large caliper trees. The pruning needs for each treatment was as follows: 1) Shorten low branches twice a year with canopy beginning at 8ft; 2) Shorten low branches twice a year with canopy beginning at 6ft, and then remove the lowest 2ft of branches to convert to a large tree caliper; 3) Shorten low branches twice a year with canopy beginning at 4.5ft, and then remove the lowest 3.5ft of branches to convert to a large tree caliper.

Trees were structurally pruned once in 2002, twice in 2003 and 2004, once in 2005 and 2006. In October 2004, the trees grown for a 4" market had the lower 4.5ft of branches removed. In February 2006, half of the trees (5) grown for both the 4" and 6" market were lifted to 7-8ft by removing all low branches. The other half of the trees grown for the 4" and 6" market and all of the trees grown for the 8" market had about half of their lower foliage removed by pruning the largest diameter branches and topping upright branches growing into the canopy.

The trees were root pruned 4 times in 2003, twice 14 inches from the trunk and twice 16 inches from the trunk. Irrigation started at 2L every other day as of December 2001, and successively increased to 6 gallons every day by the end of May 2002. Irrigation was decreased to 2 gallons every day in November 2002, and then decreased to 1.5 gallons every other day at the end of December 2002. In 2003, irrigation was increased to 3 gallons every day in March, and then to 6 gallons every day in July. This was followed by a decrease to 1 gallon every other day in December 2003 through March 2004. Irrigation increased to 6 gallons daily in April, and no irrigation December through March 2005. Irrigation resumed to 6 gallons every day in April 2005, and then decreased to 2 gallons every day in November 2005. Irrigation for 2006 has consisted of 2 gallons daily in January and February, and 6 gallons per day as of March. In 2002, trees were fertilized 4 times with 16-4-8: 65g, 210g, 300g and 400g respectively. All trees were fertilized 3 times in 2003 and 2004 with 400g of 16-4-8, and in 2005 and 2006 with 800g of 16-4-8.

What we found as of Dec 2006: No growth differences were detected among the trees of the 3 production strategies (Table 1). Trees grown for the 4" market had larger lower branches, which resulted in larger pruning cuts than the trees grown for the 6" and 8" market. This project has several more years to complete.

Conclusion: Trees have grown at the same rate regardless of prunng strategy.

Table 1. 2006 average caliper, height, spread and pruning cut caliper of Highrise® live oak submitted to 3 production strategies 5 years after planting into the field from #3.

Production Strategy	Caliper (in)	Height (ft)	Spread (ft)	Pruning Cut Caliper (mm)
Grown for 4” market	4.74	21.6	7.60	33.1a[1]
Grown for 6” market	4.69	21.4	6.89	29.3b
Grown for 8” market	4.24	21.4	7.13	29.7b

[1] Means followed by the same letter are not statistically different from each other at the P<0.05 level.

Great Southern Tree Conference Project Title: Root pruning during field production effects on nursery growth and transplantability.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30- December 1, 2006
Gainesville, Florida

Objective: Demonstrate root-pruning techniques during field production that result in superior root systems and transplantability.

What we did: Thirty #1 liner (24"tall) Cathedral Oak® live oaks were planted in August 2001, on 8 ft centers in three rows 12 ft apart. Ten trees were not root pruned; ten trees were root pruned only four times in 2004; ten trees were root pruned four times in both 2003 and 2004. Root pruning consisted of 1.3 shovel width to depth of balling spade (12") on two opposite sides of the tree. Trees were staked and shoots pruned in May 2002. Trees were pruned in April and October 2004. All low branches were removed in October 2004, some with diameter of ¾ to one inch in size. All trees were fertilized 3 times in 2004 with 400g of 16-4-8. All trees were dug in November 2004 with a 36 inch spade (trees 2.5" caliper) and moved about 50ft. Roots from 24 trees were excavated in January 2005; the remaining 6 trees continue to grow in the field in which they were last transplanted. The transplanted trees were irrigated for 8 weeks after transplanting to the landscape, and then irrigation was shut off. The transplanted trees were fertilized once in 2005 with 362g of 16-4-8. In September 2006, caliper, height and spread were recorded for the 6 remaining trees.

What we found out as of Dec 2006: Trees that were root pruned both in 2003 and 2004 grew at a slower rate than trees that were not root pruned and trees that were only root pruned in 2004 (data shown in J Arboriculture 2006). Root pruning Cathedral Oak® only in the last year of production appeared to be the most efficient, resulting in the largest trees with only moderate stress after digging and excellent survival. However, these trees were challenging to root prune with a balling shovel because roots were thick. A tree spade would make quick work of this.

Following transplanting in Nov 2004, trees that were not root pruned in the nursery lost considerable foliage nearly one year later in the dry weather experienced in late summer and early fall 2005. Trees root pruned only in the last year of production lost some foliage; trees with roots pruned the last two years of production lost very little foliage and looked fuller one year after pruning. This indicates that purchasing field-grown live oak from nurseries located on sandy well-drained soil, that are root pruned, will appear fuller and healthier in the first year after planting than trees that are not regularly root pruned. As of 2 years after transplanting (2006), all transplanted trees were comparable in size (Table 1) and their canopy's appeared uniformly dense.

Conclusion: Purchase root pruned nursery stock when selecting live oak from a field nursery located in the sandy soil typical of the central Florida ridge. More frequent root pruning creates better root systems that translate into healthier trees one and two years after transplanting. Trees grown on different soil types might respond differently.

Table 1. Current size (Sept 06) of transplanted Cathedral Oak® grown with and without root pruning during field production.

Treatment	Caliper (in)	Height (ft)	Width (ft)
Not root pruned	4.01	16.5	8.80
Root pruned only in 04	4.11	16.4	8.75
Root pruned in 03 and 04	3.63	16.6	8.28

6 trees are in this demonstration project. Trees transplanted Nov 04.

Cathedral Oak® not root pruned

Cathedral Oak® root pruned last year of production.

Cathedral Oak® root pruned last two years of production

Cathedral Oak® not root pruned, root pruned last year, root pruned last two years of production (left to right).

Great Southern Tree Conference Project Title: Impact of red maple root ball slicing at planting on growth in the landscape.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30 - December 1, 2006
Gainesville, Florida

Objective: Determine the impact of slicing the root ball at planting on root defects, top growth, and root generation following planting.

What we did: In December 2003, fifteen #25 red maple trees were planted into the landscape. Seven 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. Eight trees were not root pruned. Trees were fertilized twice in 2004 with 362g of 16-4-8, and twice in 2005 and 2006 with 724g of 16-4-8. Caliper and height were measured in October 2005 and September 2006.

What we found as of 2006: Root pruning at planting appeared to reduce circling roots (data not shown). There were no caliper or height differences two years after pruning between trees with pruned roots and those not root pruned at planting (Table 1). These results suggest that root slicing the outside surface of the root ball at planting for the purpose of eliminating circling roots does not affect growth in maples after planting.

Table 1. 2005 and 2006 trunk caliper and trunk height of #25 maples planted into the landscape with and without root slicing at planting.

Treatment	2005 caliper (in)	2005 height (ft)	2006 caliper (in)	2006 height (ft)
Root sliced	4.42	21.77	5.21	24.7
Not root sliced	4.52	21.85	5.26	25.04

What's next: We will excavate all the trees this winter to evaluate the impact of root pruning at planting on root growth into landscape soil. We are particularly interested to see if pruning roots at planting will reduce the circling root defects. We also plan to measure the force required to pull trees over to evaluate stability in the soil.

Conclusion: Root pruning the outside surface of the root ball at planting for the purpose of reducing root circling defects does not stress maple trees nor reduce growth in the first two years after planting. Slicing root balls at planting is recommended to reduce likelihood of circling roots becoming a problem latter.

Not root pruned at planting

Root pruned at planting

Great Southern Tree Conference Project Title: Impact of live oak root ball slicing at planting on post-planting establishment and growth.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30- December 1, 2006

Objective: To determine if severing circling roots at planting impacts post-transplant stress and growth in live oak.

What we did: Sixty Cathedral Oak® were transplanted from #45 containers (2.5" caliper) into the field at the end of 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. We stressed trees considerably in the first 4 months after planting by withholding water for a period required to bring trees to a near death experience (this means foliage began to drop). Then we irrigated daily beginning July 2005 through mid-September 2005. With the exception of two days in May, when trees appeared stressed due to drought, no irrigation was applied in 2006. In April 2006, the trees were cleaned of small shoots from the ground up to the start of the canopy. Caliper and height were measured in September 2006.

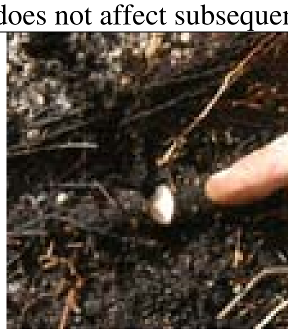
What we found out as of Dec 2006: Growth in the first 18 months following planting #45 container trees into the field was not affected by root slicing at planting. Trees with a 2.5"caliper trees can become drought stressed and die even 14 months after planting.

Table 1. 2006 trunk caliper, tree height and tree spread 18 months after planting live oak from #45 containers with and without root slicing at planting.

Treatment	Caliper (in) 2006	Height (ft) 2006	Spread (ft) 2006
Root sliced	3.72	14.8	8.21
Not root sliced	3.60	14.8	8.13

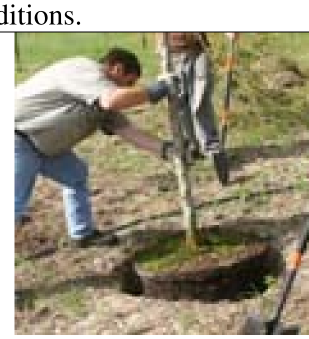
What's next: Trees will be left in the ground for another year. We will pull trees over with a winch in 2007 to evaluated trees ability to stand up in windstorms. We want to determine if root slicing enhances root growth so trees are more stable in the ground.

Conclusion: Slicing container root ball sides at planting, deep enough to sever circling roots, is recommended. This probably reduces likelihood of circling roots becoming a problem later, and does not affect subsequent growth on the tree even under drought conditions.



Roots were cut on outside of ball.

Root ball was sliced top to bottom in 5 locations.



Trees were installed and growth measured.

Great Southern Tree Conference Project Title: Effects of root pruning on planted live oak.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30 - December 1, 2006
Gainesville, Florida

Objective: Determine if slicing the outside surface of the root ball at planting enhances root and top growth on establishing trees.

What we did: In March 2006, 14 live oak were planted into the field from #45 containers; the trees averaged 2.93" in caliper, 12.8 ft in height, and 6.11 ft in spread. The caliper was just within the upper range of size for #45s according to Florida Grades and Standards. During planting, the root balls of half of the trees were sliced top to bottom in 5 places to an approximate depth of 2 inches with hand clippers. All trees were irrigated daily with 7.5 gallons of water since planting. An additional 120 gallons were applied in May and 10 gallons in June 2006. The trees have not been fertilized since planting. Caliper, height and spread were recorded in September 2006.

What we found as of Dec 2006: The first observation was that 3" trees are too large for #45s. The root ball appeared to be nearly solid roots. Trees should be potted to a larger sized container well before this time. No growth differences were detected between trees that were and were not root pruned 6 months after planting into the landscape (Table 1).

Table 1. Caliper, height and spread of live oak 6 months after planting into the field from #45 containers.

Root Pruned	Caliper (in)	Height (ft)	Spread (ft)
Yes	3.22	13.2	8.52
No	3.11	13.3	8.35

Means calculated on 7 trees per treatment

Conclusion: Growth was not slowed by slicing root balls at planting. Slicing container grown root balls at planting is recommended to sever circling roots. Slices should be as deep as is practical.

Seven trees over-grown in #45 containers were root pruned at planting and 7 were not root pruned.

Great Southern Tree Conference Project Title: Live oak tree size impacts establishment rate after landscape planting.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30- December 1, 2006

Objectives: Determine if smaller nursery stock becomes established faster than larger nursery stock; determine if larger trees secure themselves in the ground at the same rate as smaller trees.

What we did: Thirty Cathedral Oak® from #45 containers, 30 from #15 containers, and 30 B&B were transplanted into the field at the end of March 2005. 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. We stressed trees considerably in the first 4 months after planting by withholding water for a period required to bring trees to a near death experience (this means foliage began to drop). Then we irrigated daily beginning July 2005 through to mid-September 2005. With the exception of two summer days, when the trees appeared stressed, no irrigation was applied in 2006. In April 2006, the #15 trees were limbed up 2 feet from the ground, whereas the #45s and B&B trees were cleaned of small shoots from the ground up to the start of the canopy. Caliper, height and spread were measured in May 2005 and in September 2006. Settlement was also measured in September 2006. Root extension data was collected in April 2006.

What we found as of Dec 2006: #15 sized container trees displayed a much greater caliper, height, and spread growth rate the first eighteen months following transplanting into the landscape than #45 containers and B&B trees (Table 1). The #15 trees were considerably smaller (1.15") at transplanting than the #45 (2.64") and B&B (3.15") trees, and this appears to have allowed them to become established much quicker. This means that roots came into balance with the trunk at a faster rate than the larger trees. Accordingly, the slightly smaller #45 trees exhibited a greater height and spread growth rate than B&B trees; caliper growth rate did not differ.

The greater root spread to canopy spread diameter ratio on the small trees allowed for the increased growth in smaller trees; #15 trees had roots extending to more than twice the diameter (2.20) of its canopy, followed by #45 (1.72) and B&B trees (1.69), which had root spreads less than twice the size of their canopy (Table 2). A proportionally greater root spread with respect to canopy enhanced the nutrient and water uptake by the tree, allowing for rapid growth in the landscape. Finally, trees planted from both container sizes settled after planting (indicated by a negative number in Table 2) whereas B&B trees lifted up slightly in the first 18 months after planting. Settling after planting container-grown trees has been noted before (2005 GSTC report).

Table 1. Percent caliper, height, and spread increase between May 2005 and September 2006, along with % of trees settled and their average distance settled as of September 2006 for live oak transplanted into the field from #15, #45 and B&B.

Size at planting	% caliper increase	% height increase	% spread increase	% of trees that settled	distance settled* (in)
#15	117.4a[1]	76.5a[1]	138.4a[1]	43.3	-0.17
#45	38.4b	22.1b	38.3b	30.0	-0.11
B&B	40.6b	11.9c	18.1c	18.5	+0.23

[1] Means in a column followed by the same letter are not statistically different from each other at the P<0.05 level.
*Distance settled: negative number indicates that trees settled deeper into soil in the first 18 months after planting; positive number indicates trees lifted up out of the soil in the first 18 months after planting.

Table 2. Average root spread diameter for May 2006 to average canopy spread for September 2006 ratio and proportion for live oak planted into the field from #15 and #45 containers and from B&B.

Size at planting	Root spread (ft) **:** Canopy spread (ft)*	Root spread to canopy diameter proportion
#15 containers	10.01 **:** 4.57	2.20a[1]
#45 containers	14.00 **:** 8.12	1.72b
B&B	14.94 **:** 8.85	1.69b

[1] Means in a column followed by the same letter are not statistically different from each other at the P<0.05 level.

*Root spread is average diameter of the root system; canopy spread is average diameter of the canopy

What's next: We intend to evaluate the ability of all trees to withstand tropical and hurricane force winds.

Conclusions: Small live oak nursery stock appears to establish quicker and become self-sufficient sooner than larger nursery stock.

Small trees grew faster than larger trees in the first 18 months after planting.

Great Southern Tree Conference Project Title: Effect of tree size on red maple stress following landscape planting.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30 - December 1, 2006
Gainesville, Florida

Objective: Determine if smaller nursery stock becomes established faster than larger nursery stock.

What we did: In February and March 2006, 16 red maples were planted into the landscape from #3s, #25s, #65s and #300 containers, for a total of 64 trees. Trees were irrigated everyday from planting to the beginning of May (15 gallons irrigation the first 3 weeks followed by 7 gallons thereafter for #300s, 5 gallons for #65s and #25s, and 2.5 gallons for #3s). This was followed with approximately 2 weeks of no irrigation. Irrigation resumed to every other day at the end of May 2006 and continues to present, with #300s receiving 18 gallons, #65s receiving 9 gallons, #25s receiving 6 gallons and #3s receiving 3 gallons of water each irrigation day. An exception to this schedule was made during 3 weeks in June, when irrigation was administered every day. Trees have not been fertilized since planting. Water potential was recorded intermittently between May and October 2006 for a subset of the 64 trees. Caliper, height and settlement measurements were collected for all trees in September 2006.

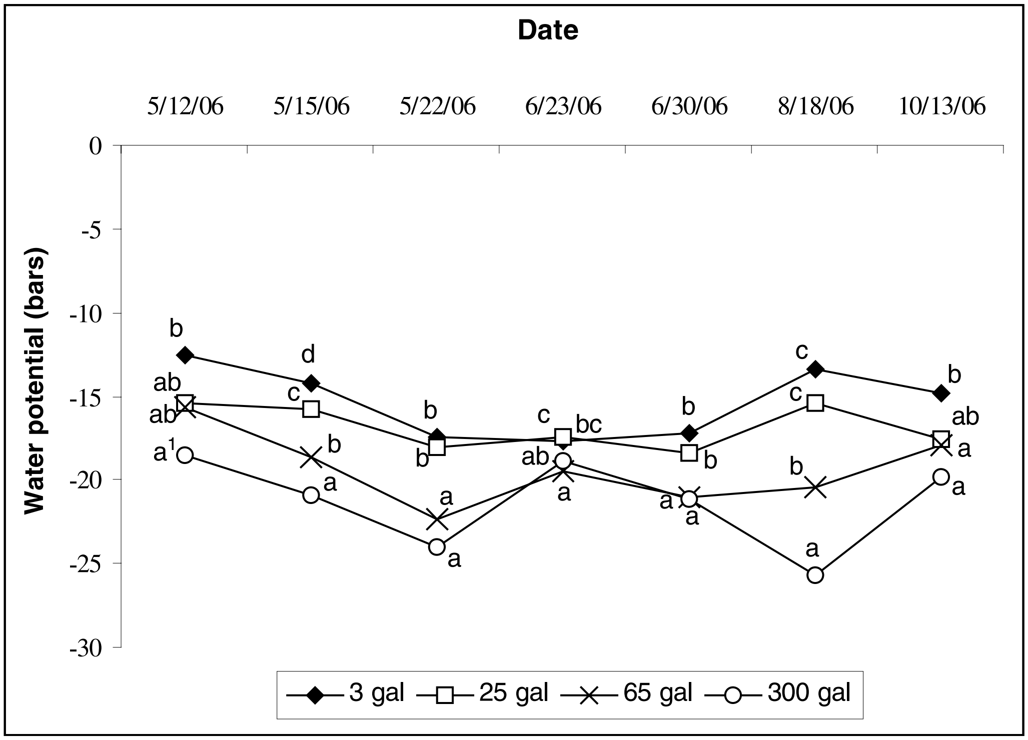
What we found as of Dec 2006: Trees planted from #3s were the least stressed after planting whereas #65 and #300 trees were the most stressed (Figure 1). Dieback resulting from water stress was noticeable on #300 and #65 trees. Dieback was rarely evident, if at all, on the #3 and #25 trees, which appeared to be growing during this period of water stress. Also, the larger trees settled 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.

Conclusion: Small nursery stock establishes quicker and is less stressed after planting than large nursery stock. Large nursery stock is more likely to dieback following planting than small nursery stock. Trees planted from larger containers settle more following planting than smaller trees.

Table 1. Average caliper, average height, % of trees settled and their average distance settled 6 months after planting red maple into the field from #3, #25, #65 and #300 containers.

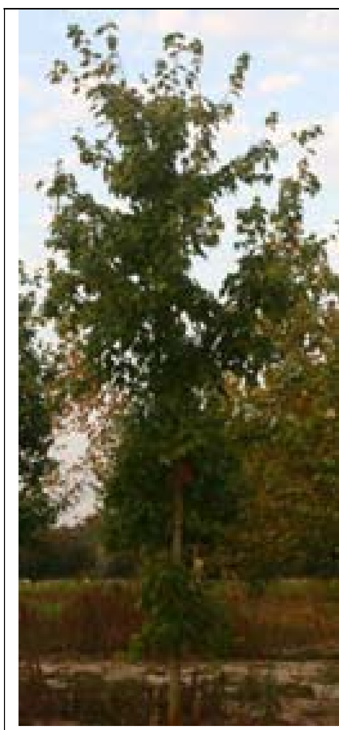
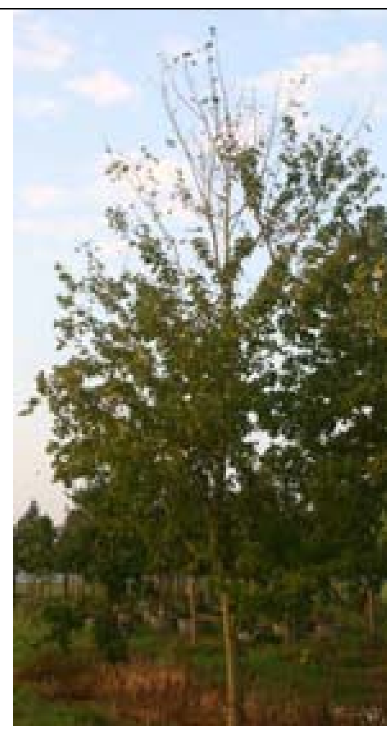
Container size at planting	Caliper (in)	Height (ft)	% of trees that settled	Distance settled (in)*
#3	1.00	8.0	6.3	+0.125
#25	2.67	15.1	6.3	+0.063
#65	3.66	16.8	25.0	-0.250
#300	6.20	24.9	100.0	-0.467

Caliper and height averages based on 16 trees.
*Distance settled: negative number indicates that trees settled deeper into soil in the first 6 months after planting; positive number indicates trees lifted up out of the soil in the first 6 months after planting.



[1] Means for each date followed by a different letter are statistically different from each other at the P<0.05 level.

Figure 1. Water potential (stress) of red maple in the first 7 months after planting into the landscape. Trees with water potential closer to zero are less stressed.

		
From #25 container	From #65 container	From #300 container

Great Southern Tree Conference Project Title: Growth of live oaks following planting.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30- December 1, 2006
Gainesville, Florida

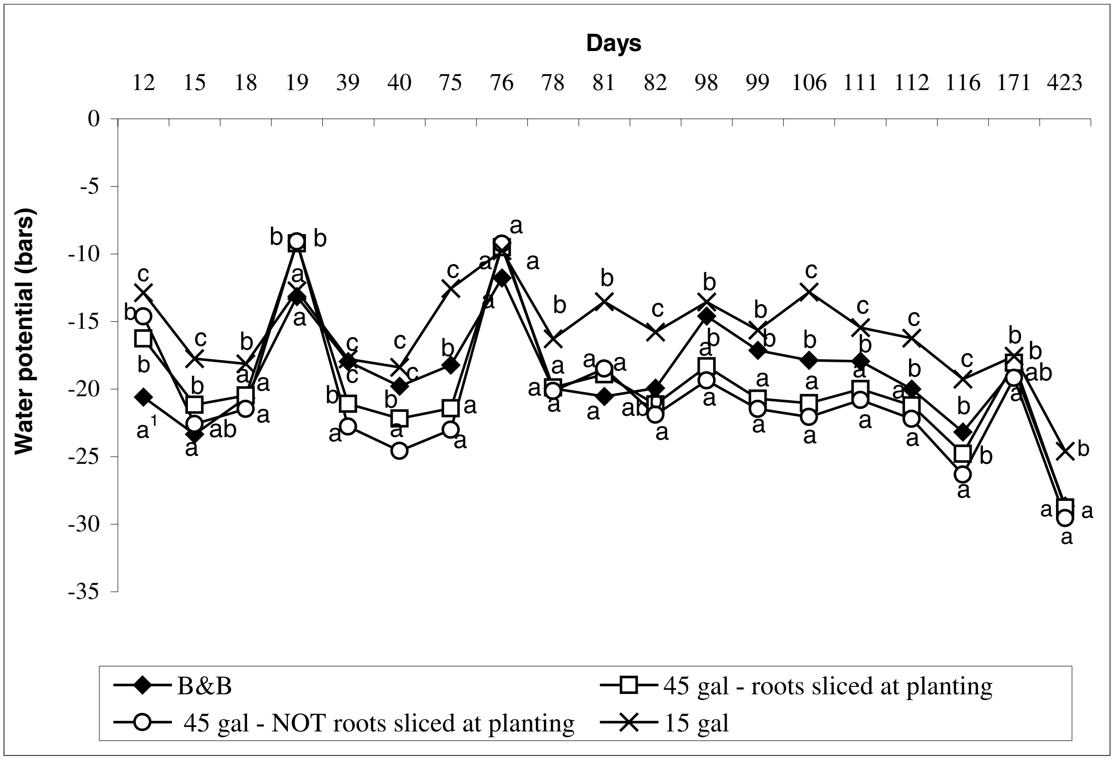
Objective: Measure establishment rate of live oak; determine influence of adding mycorrhizae on transplant success.

What we did: 120 Cathedral Oak® were transplanted from containers and B&B (half the root system was pruned Nov 2004 in the nursery and hardened-off several weeks following digging) into landscape soil at the end of March 2005. Specifically, 60 trees were planted from #45 containers, 30 B&B trees, and 30 #15 container trees. Half of the container 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 were not root pruned.. In May 2005, mycorrhizae spores were applied to half of the trees of each size using MycorTree™ Ecto Injectable. All B&B trees were staked at transplanting since they were loose in the root ball. 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. We stressed trees considerably in the first 4 months after planting by withholding water for a period required to bring trees to a near death experience (this means foliage began to drop). Then we irrigated daily beginning July 2005 through to mid-September 2005. With the exception of two days in May 2006, when trees exhibited symptoms of stress (yellow leaves, defoliation), no irrigation was applied in 2006. 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 up to the start of the canopy. Water potential (stress) was measured periodically between April and September 2005. In 2006, water potential, along with level of defoliation, was recorded once in May during a period of severe water stress.

What we found as of Dec 2006: Trees planted from #15s were the least stressed after transplanting whereas #45 trees were typically the most stressed, especially one month after transplanting (Figure 1). #15 container trees continue to be the least stressed 14 months after transplanting, as evidenced by both water potential and appearance (Table 1). It is important to note that #15 trees were and continue to be the smallest in caliper, height and spread. #45 trees and the B&B trees are the largest (data not shown). Furthermore, root slicing at planting does not appear to affect stress as root sliced trees responded similar to tress that were not root sliced. (Figure 1) However, it is important to note that of the #45 trees that were not root sliced at planting, all displayed some level of defoliation, whereas 28.6% of trees that were root sliced at planting did not defoliate (Table 1). So in addition to potentially reducing formation of stem girdling roots, slicing appears to somewhat reduce stress during drought. Perhaps these trees are producing a better distributed root system.

It appears that mycorrhizae did not affect tree caliper, height and spread in the first eighteen months following transplanting into the landscape (Table 2). With the exception of one day, mycorrhizae did not significantly reducen water stress in the transplanted live oak (data not shown). However, mycorrhizae–treated trees exhibited the highest level of defoliation, albeit a small percentage, whereas trees not treated with mycorrhizae were not severely defoliated (Table 3).

Conclusion: Smaller nursery stock appears to establish quickly. Hardened-off B&B nursery stock was less stressed and lost less foliage in drought following transplanting to the landscape than comparable-sized container grown trees. Adding mycorrhizae near recently planted trees did nothing for the trees



[1] Means for each day followed by a different letter are statistically different from each other at the P<0.05 level.

Figure 1. Water potential (stress) of live oak up to 423 days after transplanting into the landscape from #15s, # 45s and B&B.

Table 1. Percentage of tree exhibiting different levels of defoliation in May 2006 (423 days after transplanting) of live oak transplanting into the field from #15s, #45s and B&B. Trees evaluated during a severe dry period.

	Level of Defoliation			
Treatment	None	Some	Medium	Heavy
#15	92.9%	7.1%	0.0%	0.0%
#45 – not root sliced	0.0%	64.3%	21.4%	14.3%
#45 – root sliced	28.6%	42.9%	21.4%	7.1%
B&B	42.9%	35.7%	21.4%	0.0%

Based on a sample of 15 trees of each type.

Table 2. % caliper, height and spread increase between May 2005 and September 2006 for live oak transplanted into the field from #15s, # 45s and B&B.

Mycorrhizae	% caliper increase	% height increase	% spread increase
Yes	57.0	32.3	53.6
No	63.6	35.8	66.1

Table 3. Percentage of trees exhibiting different levels of defoliation in May 2006 (423 days after transplanting) of live oak transplanting into the field from #15s, # 45s and B&B. Trees evaluated during a severe dry period.

	----------------------Level of Defoliation-----------------------			
Mycorrhizae	None	Some	Medium	Heavy
Yes	47.2%	30.6%	13.9%	8.3%
No	30.0%	50.0%	20.0%	0.0%

Based on a sample of 56 trees

Hardened-off B&B (above) and #45 containers (right) being transplanted.

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Great Southern Tree Conference Project Title: Planting depth affects live oak establishment in the landscape.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30 - December 1, 2006
Gainesville, Florida

Objective: Determine the impact of planting depth in the landscape on stress, survival and growth.

What we did: In June 2003, twelve trees were planted 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 a 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. Caliper, height and spread were measured in September 2006.

What we found as of 2006: There were no differences in caliper, height and spread among the four planting depths in 2006 (Table 1). These results suggest that planting depth does not affect growth in live oaks installed in well-drained sandy soil in the first 3 years after planting. However, soil over the root ball resulting from deep planting intercepted water, resulting in more tree stress and greater likelihood of tree death in the first four weeks after planting these trees (Gilman, J. Arboriculture, 2004). However, trees planted deeply were less stressed three months after planting. This may indicate that roots are growing up into the soil placed over the root ball on deep-planted trees. This has been associated with long-term tree problems with red maples and southern magnolia as some of these roots begin to grow against the trunk and strangle the tree.

Table 1. 2006 caliper, height and spread of live oak in plots with four different planting depth treatments.

Planting Depth	2006 caliper (in)	2006 height (ft)	2006 spread (ft)
2” above	5.47	19.8	12.9
0 to 1” below	5.37	20.4	12.5
4” below	5.23	20.3	12.4
7” below	5.23	20.9	12.6

What’s next: Trees will be left in the ground for another year or two, then trees will be pulled over to measure tree stability and excavated to determine if deep-planted trees develop stem girdling roots as roots grow in the loose soil placed over the root ball.

Conclusion: Trees should be planted in the landscape with the top-most root close to the soil surface, not buried under several inches of soil and mulch.

Great Southern Tree Conference Project Title: Effect of planting depth in containers and in the landscape on stress, growth and health after planting

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30- December 1, 2006
Gainesville, Florida

Objective: Determine how planting depth influences tree stress, root development, and growth in the landscape. This will be a 5 to 10 year demonstration to track long term effects.

What we did: In July 2006, 144 Cathedral Oak® were planted to a bahia grass field in Citra, FL 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; others drained better. Trees were produced in containers by planting liners into #3s either with 1) the top-most root close to the surface, 2) 2.5" below the surface, 3) 4.5" below the surface or 4) 2.5" below the surface in #3s, 5" in #15s and 7.5" in #45s. 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 even with landscape soil; 2) 4" below soil surface; 3) 8" below soil surface. Following transplanting, all trees were irrigated with 33.75 gallons/day for approximately 2 ½ weeks. At the end of July, irrigation was reduced to 7.5 gallons/day for two weeks. In mid-August, 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. In late September the irrigation was turned off and trees were watered with varying amounts following water potential (stress) measurements. Water potential was recorded for 5 days in October 2006.

What we found as of December 2006: No difference in stress was detected among the 3 landscape planting depths (Figure 1). Furthermore, there was no difference in stress among the 4 container planting depths that preceded the landscape transplanting (Figure 2). One tree from the 8" planting depth lost all foliage in August presumably from a dry root ball; it leafed back out in September. These results so far do not directly duplicate what we found 4 years ago in our Gainesville plots. Unlike the soil in Citra, the Gainesville study was conducted on a soil that was well drained. The lack of stress difference among planting depths in Citra may have been due to the wetter soil keeping the deep planted trees moist. We showed in the Gainesville study 4 years ago that deep planting can cause greater water stress resulting in dry root balls and dead plants. This appears to be due to the soil over the root ball intercepting water that should have flowed into the root system.

Conclusion: This study just began in July 2006 so its too soon for conclusion.

Planting depth correct.

Planting depth too deep.

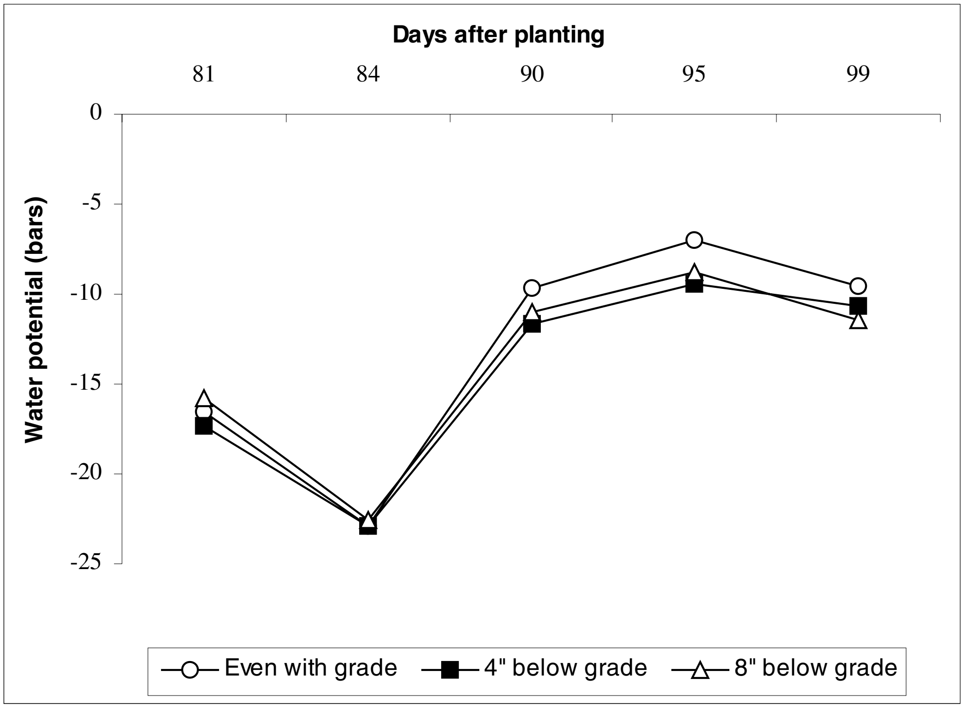


Figure 1. Water potential (stress) of live oak planted into the landscape at 3 different depths up to 99 days after installation.

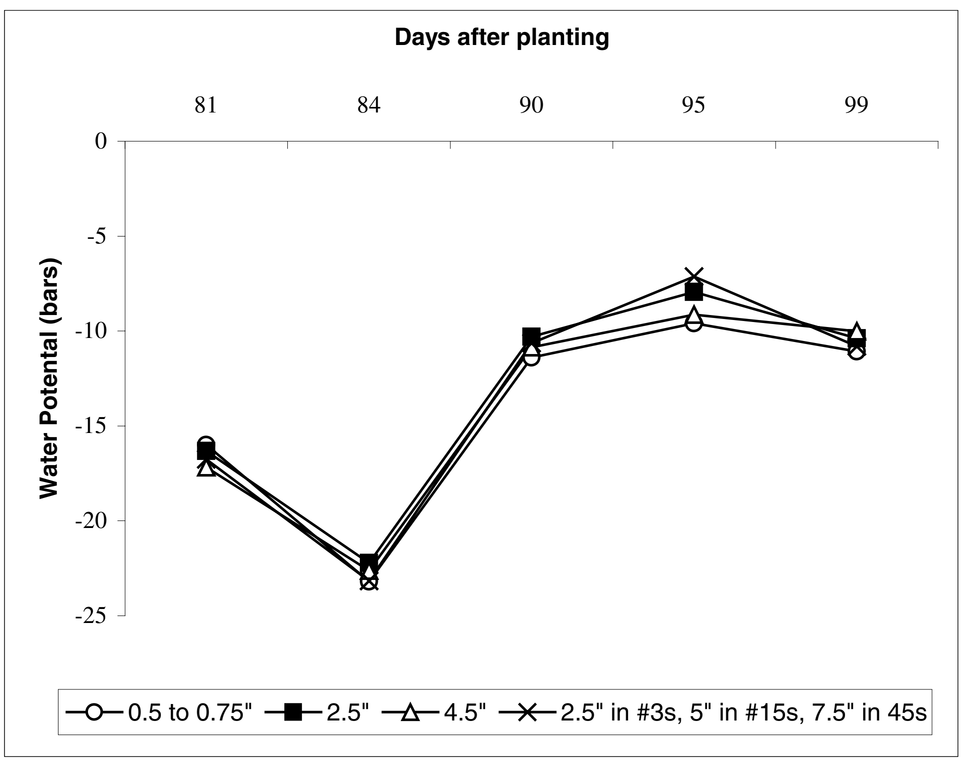


Figure 2. Water potential (stress) of live oak up to 99 days after landscape installation.. Prior to landscape installation, trees were originally planted into nursery containers at the indicated depths.

Great Southern Tree Conference Project Title: Mulch management affects live oak establishment.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30- December 1, 2006
Gainesville, Florida

Objective: Determine if mulch depth, type, and placement influence landscape tree establishment.

What we did: The 16 ft x 8 ft rectangular soil area around the root ball of 49 three-inch caliper Highrise® live oak planted October 2002 was managed in one of the following seven different ways: 1) bare soil, 2) 3" deep chipped mulch, 3) 6" deep chipped mulch, 4) 3" deep shredded mulch, 5) 6" deep shredded mulch, 6) 3" deep shredded mulch but no mulch on the root ball (the top of the root ball was not covered with mulch as it was in the other four mulch treatments), 7) bahia grass turf up to the edge of the root ball. One tree died in the turf plot. 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 2006. Mulch was added in 2004 and 2005 to maintain treatments at the proper depths. Caliper and height were measured yearly from 2002 to 2005. In 2006, only the caliper was recorded.

What we found as of Dec 2006: Tree caliper growth on trees with turf up to the edge of the root ball was smaller than on trees of all other treatments (Table 1). Tree height increased at similar rates. Addition of mulch around recently planted live oak did not result in better growth compared to trees with bare ground around the tree. Therefore, it appears to be lack of turf, not presence of mulch that enhances the health and growth of recently planted trees. Earlier results of this project (published in 2004 in J. Arboriculture) showed that placing mulch over the root ball at planting can reduce the amount of water reaching the roots, resulting in stressed and dead trees, but only when rainfall or irrigation fall in light amounts. Therefore, only apply a thin 1-2 inch mulch layer over the root ball at planting; mulch can be deeper outside the root ball.

Table 1. Increase in trunk caliper between 2002 and 2006, and increase in height between 2002 and 2005 of live oak in plots with seven different surface treatments.

Surface treatment	Caliper Increase (in)	Height Increase (ft)
Shredded mulch (3 in)	2.69a[1]	7.79
Shredded mulch (6 in)	2.56a	7.36
Chipped mulch (3 in)	2.47a	8.07
Chipped mulch (6 in)	2.56a	8.36
Bare ground/no mulch	2.67a	7.49
Shredded mulch (3 in) but no mulch on root ball	2.47a	7.71
Turf / no mulch	1.96b	6.65

[1]Means (calculated on 7 trees per treatment) followed by the same letter are not significantly different from each other at the $P<0.05$ level.

Conclusion: It appears to be lack of turf, not presences of mulch, which enhances survival of trees after planting compared to trees with turf up to the root ball. Only a thin layer of mulch should be applied over the root ball since a 3 inch or more layer can intercept water resulting in tree stress or death.

Great Southern Tree Conference Project Title: Effects of soil amendments at transplanting on stress and growth of B&B live oak.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30 - December 1, 2006
Gainesville, Florida

Objective: Determine if soil amendments at transplanting influence live oak growth.

What we did: In October 2002, twenty-one 2.5" caliper Cathedral Oak® were planted approximately even with grade in three blocks of seven trees (21 trees total). The trees received one of the following treatments at transplanting: 1) Terrasorb polymer; 2 packs (3 oz each) mixed in backfill 2) Compost; 1/3 mixed into backfill, 3) Root ball planted in wide hole; 7' wide, 4) Mycorrhizae / Biopak; 3 packs (3 oz each) Tree Saver, 6 Biotabs per tree, 5) Fertilizer; Nutricote 17-7-8 over ball just under mulch, 6) Cambistat™ (a growth regulator); 25 ml in 250 ml of water applied at base of trunk around root collar 7) no soil amendment. Each block contains one tree of each treatment. Caliper, height and spread were measured in 2006.

What we found as of Dec 2006: In 2006, trees treated with Cambistat™ displayed smaller calipers and spreads than all other treatments (Table 1). With respect to height, Cambistat™ treated trees were shorter than trees treated with compost, fertilizer, mycorrhizae, and Terrasorb polymer. There appears to be as much benefit from digging a wider planting hole as adding amendments.

Table 1. 2006 trunk caliper, height, and spread of Cathedral Oak® live oak in plots with seven different soil amendments.

Soil Amendments	2006 Caliper (in)	2006 Height (ft)	2006 Spread (ft)
Wide Hole / No Amendment	6.00a[1]	22.4ab	15.6a
Compost	6.32a	24.2a	15.7a
Fertilizer	6.60a	24.1a	16.3a
Mycorrhizae	6.48a	24.4a	15.7a
No Amendment	5.88a	22.4ab	15.4a
Terrasorb Polymer	6.05a	23.5a	14.9a
Cambistat	4.64b	20.2b	11.9b

[1] Means followed by a different letter are statistically different from each other at the $P<0.05$ level.
Means calculated on 3 trees per treatment

Conclusion: Soil amendments appear not to be of much benefit for live oak, at least when planting in good soil.

Great Southern Tree Conference Project Title: Effects of covering crape myrtle trunks on sprout development.

Ed Gilman and Chris Harchick, Environmental Horticulture Department,
University of Florida
November 30- December 1, 2006
Gainesville, Florida

Objective: Determine if covering trunks impedes the development of sprouts.

What we did: In June 2005, 20 crape myrtle trees in 2 neighboring rows located 16 ft apart were pruned to a 5' single leader and had all young sucker sprouts removed by hand. One tree (3-4" caliper) of each across-row pair was randomly fitted with a trunk shelter consisting of a black corrugated plastic drainpipe, 6 inches in diameter. The shelter was placed on the lower trunk up to the first branch. In 2006, trees were irrigated daily with 1 gallon of water between January and February. No fertilization was administered to these trees. In February 2006, shelters were removed and the number of sucker shoots were counted and removed by hand.

What we found as of Dec 2006: There was no difference in the number of sucker shoots between trees with and without a shelter (Table 1). It was noted that the plastic shelters encouraged both the formation of fire ant piles, and scarring of the trunk.

Table 1. The average number of sprouts per tree, and the range of sprout number per tree 9 months after covering the lower trunk of crape myrtle.

Treatment	Number of sprouts	Range in sprout number
No shelter	7	0 - 21
Shelter	4.9	0 - 15

Plastic covering reduced but did not eliminate sprout number on some trees.

More sprouts appeared without covering

Great Southern Tree Conference Project Title: Growth effects of flush cuts and collar cuts on 'Florida Flame' red maple.

Ed Gilman and Chris Harchick, Environmental Horticulture Department,
University of Florida
November 30 - December 1, 2006
Gainesville, Florida

Objective: Evaluate impacts on growth and trunk decay from removing branches with collar and flush cuts.

What we did: In July and August 2001, 13 'Florida Flame' maples were planted from 3 gal liners into the field. Beginning in February 2003, low branches on 5 trees were removed with flush cuts, 5 trees were submitted to collar cuts, and 3 trees were not pruned. Trees were fertilized and irrigated regularly through 2006. In September 2006, trunk caliper was recorded for all trees; in October 2006 one tree receiving flush cuts and one receiving collar cuts was split open to evaluate decay from pruning cuts.

What we found as of Dec 2006: No statistical difference was found among trunk caliper probably due to the low sample size. It appears that trees that were not pruned had a slightly larger caliper than trees pruned with collar or flush cuts (Table 1). Flush cuts made on 'Florida Flame' maple for the first three years resulted in about the same decay as collar cuts; flush cuts made in 2006 resulted in more decay than collar cuts. Apparently flush cuts on large branches result in more decay than collar cuts on large branches.

Table 1. 2006 average trunk caliper of red maple 31 months after administering different pruning cuts

Pruning Cuts	Caliper (in)
None	6.86
Collar	5.97
Flush	5.48

Flush cuts removed the collar (left). Decay behind flush cuts (above left) was greater than behind collar cuts (right).

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

Tim Broschat, Ft. Lauderdale Research and Education Center (REC)
Ed Gilman, Environmental Horticulture Department
University of Florida,
November 30 - December 1, 2006

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

What we did: Ten sabal palms 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. Half of the palms in each fertilizer treatment had only dead leaves removed once per year, while the other half had all but 4 of the youngest leaves removed once per year. The trees were first fertilized and trimmed in March 2006. Total number of leaves, number of green leaves, and number and severity of potassium (K)-deficient leaves were recorded in September 2006. A similar experiment was initiated at the Ft. Lauderdale REC on January 2006 with data collected on October 2006.

What we found as of Dec 2006: Nine months after the study began Gainesville trees that were severely trimmed had fewer K-deficient and total leaves and higher deficiency rating scores than trees that had only dead leaves removed (Table 1). There were fewer K deficient leaves because the K deficient leaves had been removed with pruning. There were no differences between pruning treatments with respect to number of green leaves in the canopies. Fertilization treatments had no effect on palm visual quality at this time. The number of green leaves, symptomatic leaves, and total leaves was low for the severely-trimmed palms receiving the 8-2-12-4Mg fertilizer due to an inadvertent delay of 6 months in the trimming of these palms.

In Ft. Lauderdale only total number of leaves differed between treatments, with those severely trimmed generally having fewer leaves than those having only dead leaves removed (Table 2). Since changes in palm nutritional status and canopy size occur slowly, it is expected that treatment differences will be more pronounced in future years.

Conclusions: Since this is a long term experiment, it is too early to draw any conclusions from preliminary data.

Table 1. Numbers of green, K-deficient, and total leaves and K deficiency score for sabal palms in Gainesville.

Fertilizer	Pruning	Green leaves	Symptomatic leaves	Total leaves	K deficiency score*
None	Dead only	13.8	7.6 a[1]	21.4 a	4.32 b
None	Severe	11.8	1.6 b	13.4 b	4.86 a
16-4-8	Dead only	10.8	8.8 a	19.6 a	4.24 b
16-4-8	Severe	10.6	1.8 b	12.4 b	4.81 a
8-2-12-4Mg	Dead only	10.4	9.2 a	19. a	4.38 b
8-2-12-4Mg	Severe	10.4	0.2 b	10.6 b	4.98 a

[1]Means within a column followed by different letters are significantly different at P<0.05 level
*0=dead, 1=severe K deficiency, 3=moderate K deficiency, 5=no deficiency symptoms

Table 2. Numbers of green, K-deficient, and total leaves and K deficiency score for sabal palms in Ft. Lauderdale.

Fertilizer	Pruning	Green leaves	Symptomatic leaves	Total leaves	K deficiency score*
None	Dead only	11.4	4.2	15.6 a[1]	4.73
None	Severe	7.3	2.5	9.8 c	4.74
16-4-8	Dead only	9.2	4.0	13.2 ab	4.71
16-4-8	Severe	11.4	2.8	14.2 ab	4.80
8-2-12-4Mg	Dead only	12.4	3.4	15.8 a	4.77
8-2-12-4Mg	Severe	10.8	1.0	11.8 bc	4.92

[1]Means within a column followed by different letters are significantly different at $P<0.05$ level

*0=dead, 1=severe K deficiency, 3=moderate K deficiency, 5=no deficiency symptoms

Pruning treatments were severe (left) and removing only dead leaves (above).

Two plots were established, one in Ft. Lauderdale and one in Gainesville.

Great Southern Tree Conference Project Title: Evaluation of landscape tree stabilization systems.

Ryan Eckstein, Environmental Horticulture Graduate Student
Ed Gilman, Environmental Horticulture Department
University of Florida,
November 30 - December 1, 2006

Objective: Determine effectiveness of landscape tree stabilization systems when subjected to loading.

What we did: In the fall of 2006 we tested nine different tree stabilization systems (Table 1) through pull tests. Ten repetitions of each system were tested plus the control for a total of 100 trees. Cathedral Oak® between 2.75-3.00" in caliper and 18-22' tall grown in #45 containers were used. All trees were planted following the same protocol and were pulled within a few days to minimize the effect of rooting-in on the experiment. Soil within an 8ft x 8ft block around the tree was brought to field capacity with sprinklers to create the same soil conditions for each repetition. The trees were pulled with a winch and pulley system anchored to a concrete pillar. Data was collected through a computerized data acquisition system and the trees were instrumented with two inclinometers which measure angle and a load cell which measures force. One inclinometer was mounted to the root ball and the other was mounted on the trunk above the tie-in point on the aboveground systems. The load cell was in-line with the rope to monitor the force exerted on the tree. The trees were pulled until the inclinometer in the root ball measured 20°. Five trees were pulled for each staking system from two different directions of orientation for a total of ten trees for each staking system.

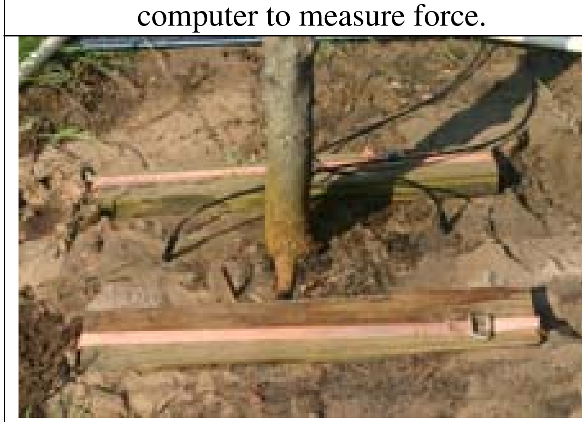
What we found as of Dec 2006: The direction in which each system was pulled had a major impact on force required to pull the tree to a 20° angle. The Brook's Tree Brace the 2"x 2"s on the root ball, and the Terra Toggle required the most force to pull trees over to a 20° angle (Table 1).

Table 1. Force to failure for landscape tree stabilization systems.

Stabilization system	Average Max. force (lbs) required to pull tree to 20° angle		
	Direction 1*	Direction 2	Average
Root ball Anchoring			
2"x 2" on root ball	477.79	339.66	408.27 a[1]
Dowels in root ball	135.12	109.14	122.13 c
Terra Toggle	514.21	512.12	513.16 a
Tree Staple	100.62	155.28	127.95 c
Above-ground Systems			
Arborbrace	205.98	115.33	160.65 b
Brook's Tree Brace	369.61	640.18	504.89 a
Duckbill	155.81	328.44	242.13 b
Rebar and Arbor Tie	180.41	407.66	294.04 b
T-stakes with Wellington tape	120.37	102.79	111.58 c
Control	56.18 d		

[1]Means followed by the same letter are not significantly different at the P<0.05 level. Means based on five trees for each staking system and direction combination.
*Direction 1: stake or guy oriented directly toward pulling force. Direction 2: Oriented 90°or 180° from Direction 1, depending on staking system.

Conclusion: The systems that withstood the most amount of force were the 2"x 2"s on the root ball, the Terra Toggle, and Brook's Tree Brace. The least effective systems tested were the Tree Staple, the wood dowels, and the T-stakes with Wellington tape.

<table>
<tr><td>
A home-made root ball anchoring system that worked well.</td><td>
Trees were pulled over until they tilted 20 degrees.</td></tr>
<tr><td>
Pulley system with load cell and cable to computer to measure force.</td><td>
Inclinometer (with cable) measured angle of root ball as tree was pulled over.</td></tr>
<tr><td>
The root ball anchoring system Terra Toggle worked well.</td><td>
Brooks Tree Brace worked well to stabilize trees.</td></tr>
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Great Southern Tree Conference Project Title: Impact of pruning dose on codominant stem growth.

Ed Gilman, Environmental Horticulture Department,
University of Florida
November 30- December 1, 2006
Gainesville, Florida

Objective: Determine impact of amount of foliage removed from a 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%, 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 2006. In October 2005 and September 2006, the pruned and un-pruned stems of each tree were measured to determine stem diameter growth.

What we found as of December 2006: Pruned stems grew slower than stems that were not pruned in first the 16 months after administering the pruning dose (Figure 1). Increasing the pruning dose by removing more foliage 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). Furthermore, as of 16 months following pruning, the basal area of leader stems has grown at a constant rate across all pruning doses (Figure 2). Increasing pruning dose reduced growth as targeted pruning dose increased from 25% through 75% (Figure 2).

Conclusion: As much as 75% or more of a codominant stem or branch can be removed without killing the stem. This suggests we might consider adjusting the ANSI A300 pruning standard to allow for more than the current 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 of a codominant stem enhanced growth in the unpruned leader whereas heavy pruning had no effect on leader growth.

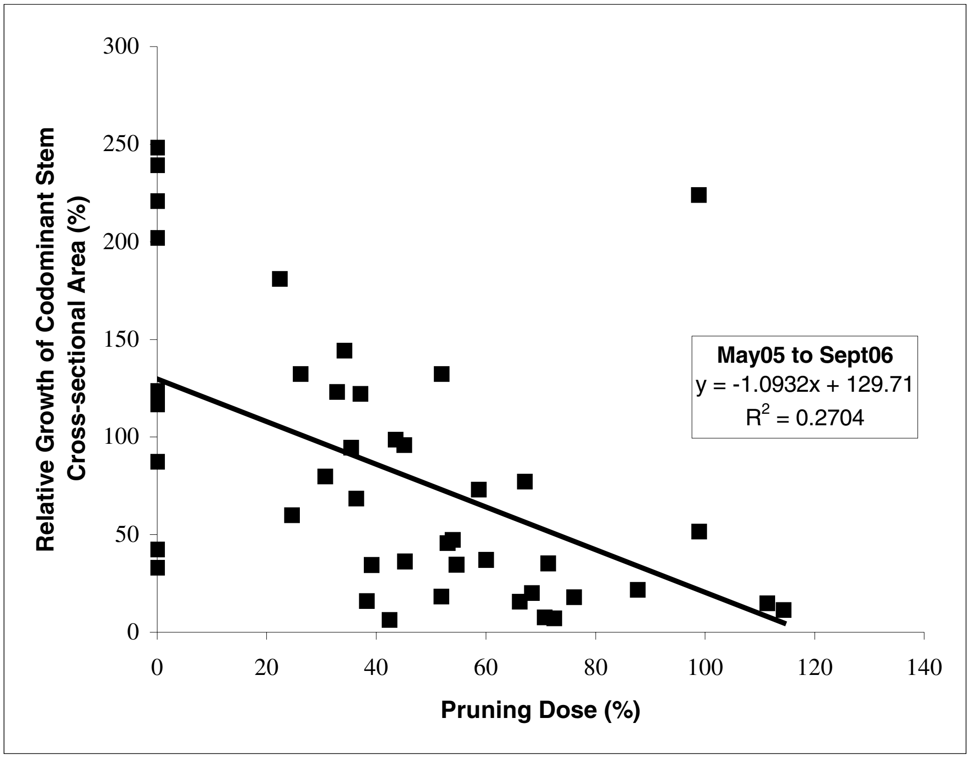
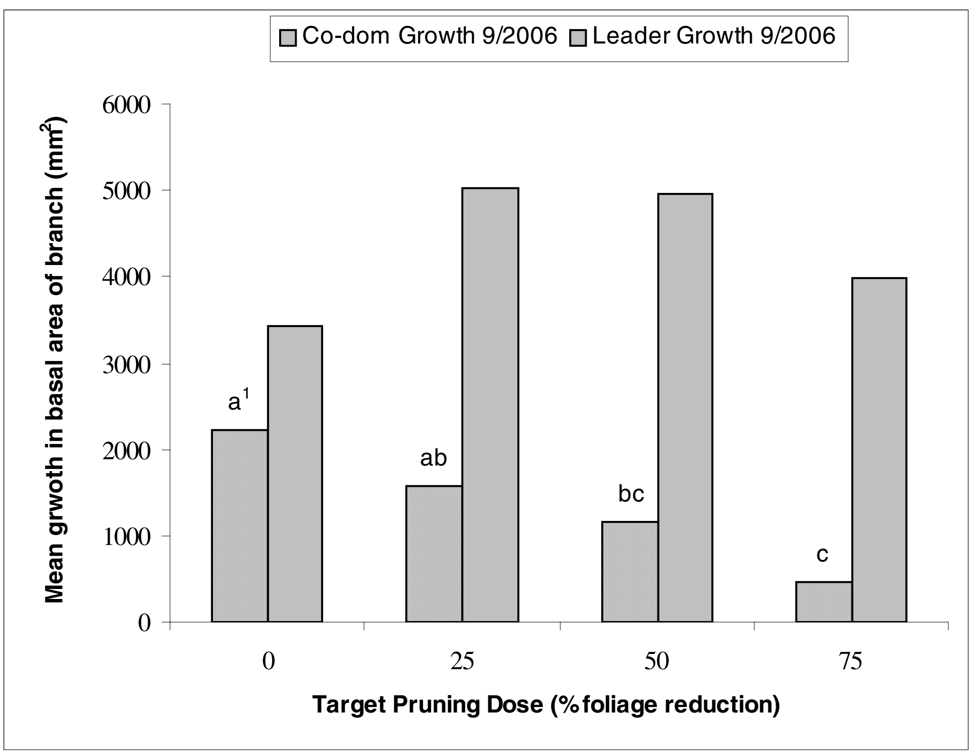


Figure 1. Relative growth of codominant stem basal area between May 2005 and September 2006 following removal of increasing amounts of foliage. Dose calculated as described above.



[1] For codominant stem growth bars with the same letter are not statistically different from each other at the P<0.05 level.

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

Great Southern Tree Conference Project Title: Effects of pruning dose and type on tree response in tropical storm winds

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University of Florida
Jason Grabosky, Rutgers University
November 30- December 1, 2006
Gainesville, Florida

Objective: Demonstrate effect of pruning dose and type on tree movement in wind

What we did: We built a machine capable of generating 75 mph winds to determine the influence of pruning amount (dose) and ANSI A300 pruning type on trunk movement of *Quercus virginiana* 'QVTIA' PP #11219, Highrise® at various wind speeds. Trunk movement was regressed against wind speeds and pruning doses for each tree tested.

What we found as of Dec 2006: Increasing wind speed increased trunk movement but the magnitude of the increase depended on pruning dose and pruning type. Increasing pruning dose reduced trunk movement but the magnitude of the reduction was greater at higher wind speeds. The trunk movement of thinned trees was statistically greater than movement of structurally pruned, raised, and lion's tailed trees at wind speeds of 45 mph and greater. There was no difference in movement among reduced, raised, structurally pruned, and lion's tailed trees, and there were no statistical differences in trunk movement among pruning types at the lower wind speeds. Thinning by removing ¼ to ¾" diameter branches from the edge of the canopy appeared to be the least effective pruning type for reducing trunk movement and presumably the resulting wind load. Thinning in this manner did not reduce the surface area of the canopy exposed to the wind. This may explain why thinned trees moved more than other pruning types because all other pruning types reduced the canopy surface area exposed to the wind.

Conclusion: Pruning reduced trunk movement in the wind, and the effects of pruning increased with increasing wind speed. Thinning by removing ¼ to ¾"diameter branches from the outer portion of the canopy does not appear to reduce trunk movement as well as the other pruning types at tropical storm force velocity (45 to 70 mph). Raising, reduction, and structural pruning all reduced trunk movement equally well at all wind speeds.

Airboat generated up to 70 mph winds blowing against the canopy of Highrise® live oaks

Great Southern Tree Conference Project Title: Effects of pruning type on tree response in hurricane force winds.

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University of Florida
Jason Grabosky, Rutgers University
November 30- December 1, 2006
Gainesville, Florida

Objective: Determine effect of pruning type on tree movement in hurricane force wind.

What we did: The experiment was conducted at the Environmental Horticulture Teaching Lab at the University of Florida in May of 2006. The trees that were tested were *Quercus virginiana* Cathedral Oak® cultivar and were 5 years old with 5” caliper. This species was selected because it is a commonly used tree in urban landscapes and because the trees were clones that were propagated from cuttings. The dose of each pruning treatment applied to each tree, i.e. the amount of foliage removed, was 33% of the total canopy. The three pruning treatments and the control are as follows:

- **Thinning**: Branches were removed back to the trunk throughout the canopy.
- **Reducing**: One cut was made on the trunk to a point where 1/3 of the foliage was removed.
- **Raising**: Branches were removed from the bottom of the canopy
- **Control**: No pruning.

Orientation sensors (inclinometers) were used to measure trunk deflection. The three orientation sensors were mounted at the same three fixed points along the trunk in the canopy of every tree. The highest mounting position was at 104 in. from ground level. The second highest mounting position was at 72 in. at the average center of mass, which was calculated by using the data collected from the three dissections. The lowest was at 42 in. above ground level. The data collected from these three points enabled a curve to be constructed, simulating the bend in the trunk of the tree, when subjected to high wind speeds.

The wind generator was designed and manufactured by Diamondback Airboats, Inc. It is comprised of a four-fan array mounted to a trailer for mobility. Driving each fan is a Chevrolet ZZ402 big block engine housed in an outer steel frame. Wind is generated by means of two 80 inch counter-rotating airboat propellers mounted to each engine.

Each tree was subjected to the same wind loading sequence of a constantly increasing wind speed until the target top wind speed of 120 mph was reached. The sequence was applied to each tree by computer software that monitored and controlled wind speed by controlling the throttles on the wind machine remotely. This allowed each tree to be subjected to the exact same test procedure in order to isolate the effect the pruning technique had on trunk movement

What we found: At 110 mph, the average angle of deflection for the topmost inclinometer on the unpruned trees was 45.8°.(Table 1) Of all the twenty trees tested, the one that had the most trunk deflection was a control tree that bent over 64.2° from its original position.

The trees that were raised showed the second most trunk deflection with the average maximum reading from the top inclinometer of 30.8°, but raised trees were not statistically different from unpruned trees. The thinned trees showed the third most deflection having an average maximum angle of 23.1°. Lastly, the reduced trees showed the least amount of deflection with an average maximum angle of 16.9°.

Table 1. Deflection from vertical of Cathedral Oak® pruned in various manners.

Pruning Treatment	Angle of Deflection (°) at topmost inclinometer*
Unpruned/Control	45.8a[1]
Raised	30.8ab
Thinned	23.1bc
Reduced	16.9c

[1]Means followed by different letters are significantly different at P<0.05 level.
*Topmost inclinometer was set 104" from ground level.

The raising and reducing techniques are similar in that they concentrate the remaining foliage of the canopy into a smaller area than before the tree was pruned. However, the data shows that trees pruned in these two ways will react to wind loading much differently. The raised trees had their canopies concentrated at the top of the trunk, giving them a longer moment arm (force at the base of the trunk). This is why the tree bent more. The reduced trees' canopies were concentrated at the lower region of the trunk, giving them a shorter moment arm so less force was translated into the lower trunk. This key difference is why the raised trees bent over, on average, almost twice as much as the reduced trees.

The thinned trees bent over almost half as much as the control trees. Thinning a tree reduces the frontal area of a canopy by increasing its porosity. We think that thinning trees in this manner (i.e. removing branches back to the trunk or back to large branches using 1-2 inch pruning cuts) was effective at reducing movement because it created holes in the canopy for air to pass. Holes were not created in the canopy using the thinning technique in the above study (Effects of pruning dose and type on tree response in tropical storm winds) because pruning cuts were too small. This did not allow the tree to reconfigure nor allow for air to pass through the canopy. The difference in trunk deflection between the thinned and reduced trees was not statistically significant.

Conclusion: Pruning trees minimizes canopy movement. We think this reduces the risk of tree failure during high wind speeds. Trunk movement was minimized with the thinning and reducing treatments. More research is warranted in this area including the testing of different species, different pruning doses, and testing the effect of wind speeds for different durations.

Reduced tree withstanding 120 mph winds.

Unpruned trees bending 64°.