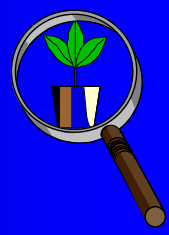
In Support of Plants Grown in BIG CONTAINER?



Ted Bilderback
Nursery Extension Specialist
Department of Horticulture Science
North Carolina State University
Ted_Bilderback@ncsu.edu
http://www.ces.ncsu.edu/depts/hort/nursery/

This presentation discusses methods and practices for staking and support of trees grown in large containers.

Spacing can have considerable effect on canopy development of container grown trees. The following five slides discuss results of a container spacing study conducted at the University of Florida, Great Southern Tree Conference research station. In this slide live oaks in the second year of production are being grown in 15 gallon Accelerator pots. These plants are spaced at 6 foot and irrigated by 1 spray stake in each pot.

Jammed 3's Shifted to 15's at 6 foot spacing

Live oaks in this slide were grown in 3 gallon containers for 1 year at pot to pot (jammed) spacing, then transplanted to 15 gallon Accelerator pots spaced at 6 foot (on center) for growth in year 2. Growth measurements will be presented in slide 5. My observation was that the jammed 3 gallons, developed minimal lower branch development, but

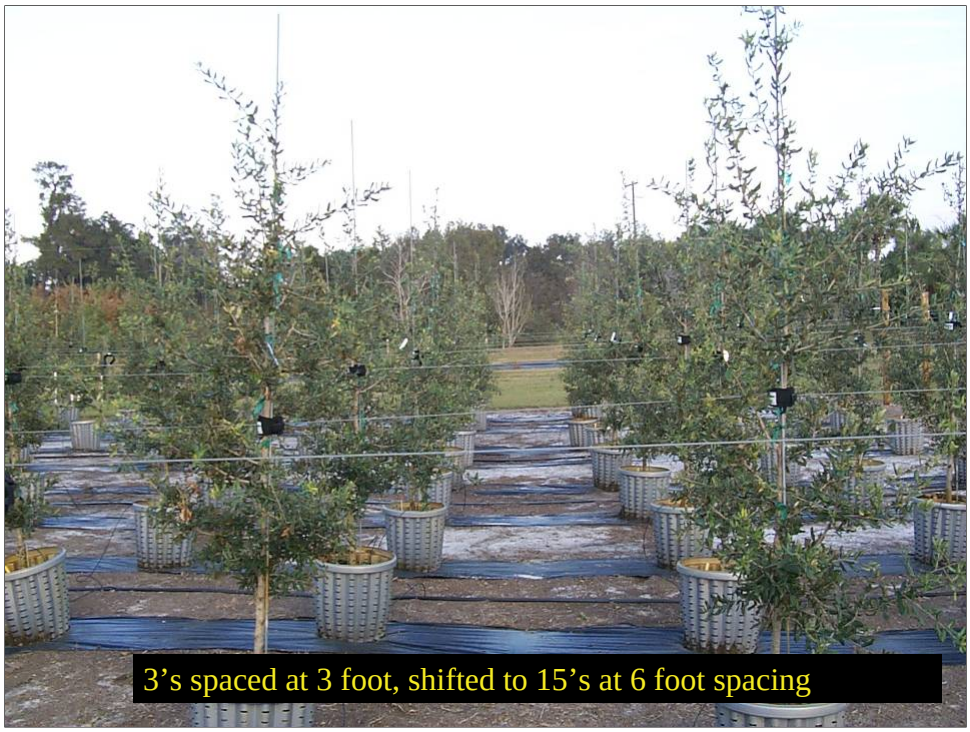
6 foot spacing in 15's developed wider scaffold (permanent branches) during year 2.

Jammed 3's Shifted to 15's at 3 foot spacing

Live oaks in these 15 gallon Accelerator pots were grown at 3 foot spacing as 3r's during the first year and as 15 gallon containers spaced at 3 foot during year 2. My observations were that low branch growth was minimal due to shading and upper scaffold branches (permanent branches) were present but not as well developed as 6 foot spaced 15 gallons. This group of plants would develop good branch arrangement and width in year 3.

3's spaced at 3 foot, shifted to 15's at 3 foot spacing

Live oaks in this research block were grown in 3's at 3 foot spacing and shifted to 15's placed at 3 foot spacing. My observations were that low branches developed at 3 foot spacing during the 1st year. During the second year, upper scaffold branches developed resulting in more or less square canopies.



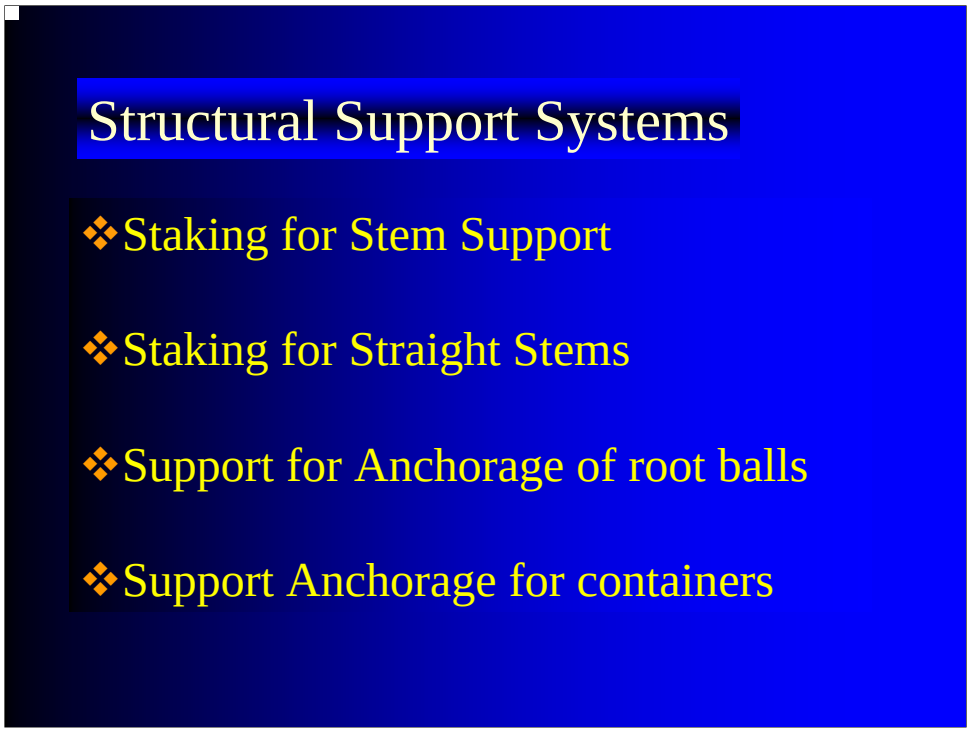
This block of live oaks were grown at 3 foot spacing as 3’s and 6 foot spacing as 15’s. My observations for this spacing treatment was that the 3 foot spacing during the 1st year induced lower branch growth which are not permanent branches and will need to be removed by year 3. If low branches develop caliper more than ¾ inches, more than one season may be required to close pruning wounds. However, lower branches do tend to increase lower canopy caliper. Wider spacings also increased growth of scaffold branches which should produce wider canopies during year 3.

Effect of Container Spacing

Spacing Treatment	Caliper (in)	height (feet)	Pruning Time (sec)
Jammed then 3 ft	1.04 bc	7.2 a	31 bc
Jammed then 6 ft	1.08a	6.5 b	28 c
Spaced 3 ft then 3 ft	1.02 c	6.6 b	33 b
Spaced 3 ft then 6 ft	1.07 ab	6.0c	38 a

Data recorded for this study showed jammed 3's then 15 gallons spaced at 6 foot produced the largest caliper. Greatest height occurred with trees grown at the tightest spacing (jammed then 15's spaced at 3 ft). Tightly spaced plants are expected to grow taller due to competition for light. The least height was recorded for trees grown at widest spacing. Pruning time was highest for the widest spaced treatment (3 foot spaced 3's and 6 foot spaced 15's). This was not unexpected from my observations. Lower branch development was increased by wider spacing of 3 gallons. Wide spaced 15 gallons created wide lateral branch growth that required pruning to balance the symmetry of the upper canopy. Most NC 15 gallon container production is spaced at 4 foot diagonal spacing. Based upon results in this study, 4 foot spacing might be a better spacing than 6 foot spacing.

My observations based upon results of this study are that jammed 3 gallons and then a spacing wider than 3 foot for 15 gallons might be the best spacing for limiting lower branch development, yet in the second year, wider spacing increases scaffold branch development.



Structural support systems are required when large canopy trees are grown in containers for stem support, vertical growth of leaders, anchorage of root balls after transplanting, and anchorage to prevent wind throw (turning the container and tree over).

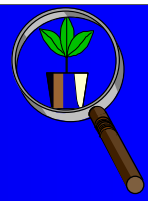
Close spaced trees require staking to stand upright and develop straight leaders. Stakes should be removed after 1 season.but best removed when the leader out grows the height of the stake to prevent bending of the leader.

Staking is a necessary evil in tree production. Closely spaced field grown trees will not have the strength to stand straight with out staking. The evil is that unless stakes and stake attachments are inspected, tight attachments removed or locations where trees are rubbing stakes; the tree will be damaged and quality reduced. Additionally, when the terminal of the tree over grows the stake, the terminal will bend (this is an auxin response where cells on the sunny side of the stem do not elongate as rapidly as cells on the shaded side of the stem, just like pot plants in windows bend toward the light). Stakes must be removed when the terminal reaches the height of the stake. Staking is a labor intensive, expensive essential practice.

As in field growth trees, container grown trees also require staking to stand straight and maintain straight stems. Even conifer like leyland cypress must be staked to maintain straight stems.

As discussed in the previous slide, the terminal of actively growing stems bend away from the stake when the leader out grows the stake. Lignified stems (older stems) do not bend but the top may become heavy and with out support or balanced pruning, the terminal may still bend due to weight of the top. In some cases, heavy tops actually snap at the highest attachment.

Staking/Support



Extend stake to height specification of container size or caliper

Use short stakes tied to woody portion of stem

Stakes must be removed or some nurseries extend the stake height. Another choice to prevent bending of active growing shoots is to cut the stake to provide support lower on the stem. Weight may however, still cause terminals to bend when short stakes are used.

TYPE ONE MATRIX — SPREADING & ROUNDED SHAPES								
CALIPER	MINIMUM TREE HEIGHT	MAXIMUM TREE HEIGHT	MINIMUM CROWN SPREAD DIAMETER			MINIMUM B&B ROOT-BALL DIAMETER	MINIMUM GROW BAG ROOT-BALL DIAMETER	MINIMUM CONTAINER VOLUME
			FL. FAN.	#1	#2			
1/4"	18"	30"	10"	8"	6"	6"	—	4" Sleeve
1/2"	24"	6'	14"	12"	8"	8"	—	1 Gal.
3/4"	4'	8'	30"	24"	18"	14"	—	3 Gal.
1"	5'	10'	36"	30"	24"	16"	12"	5 Gal.
1 1/4"	6'	11'	42"	36"	30"	18"	14"	7 Gal.
1 1/2"	7'	12'	48"	42"	34"	20"	16"	15 Gal.
2"	8'	15'	54"	48"	42"	24"	18"	15 Gal.
2 1/2"	9'	16'	60"	54"	48"	28"	18"	25 Gal.
3"	10'	18'	66"	60"	54"	32"	20"	45 Gal.
3 1/2"	11'	18'	6'	5 1/2'	5'	36"	24"	65 Gal.
4"	12'	22'	7'	6 1/2'	6'	40"	30"	95 Gal.
4 1/2"	14'	24'	8'	7 1/2'	7'	44"	36"	95 Gal.
5"	16'	26'	10'	9'	8'	48"	36"	95 Gal.
5 1/2"	17'	28'	11'	10'	9'	50"	—	200 Gal.

This slide is a table extracted from the Florida Grades and Standards bulletin. [http://www.doacs.state.fl.us/pi/pubs.html]. Standards (specifications) for caliper minimum height and maximum height for various production methods are shown in this table. This table can be used as a guide for production and staking. For example, a 15 gallon container tree fitting this matrix (such as red maple) should not exceed 2 inch caliper and be no more than 15 feet tall. Therefore, 15 feet is the maximum height for a 15 gallon tree. Therefore, no more than a 15 foot stake should be used for 15 gallon trees. When the tree reaches this height, the terminal should not be allowed to over grow the stake. The tree can be headed back at 15 feet and a lateral shoot or bud selected to become the terminal. If the tree meets two of the three specification (height, caliper or width) it is ready for sale or for shifting.

TYPE TWO MATRIX — PYRAMIDAL SHAPES

CALIPER	MINIMUM TREE HEIGHT	MAXIMUM TREE HEIGHT	MAXIMUM CROWN SPREAD DIAMETER			MINIMUM B&B ROOT-BALL DIAMETER	MINIMUM GROW BAG ROOT-BALL DIAMETER	MINIMUM CONTAINER VOLUME
			FL. FAN.	#1	#2			
1/4"	18"	36"	10"	8"	6"	6"	—	4" Sleeve
1/2"	18"	4'	14"	10"	8"	8"	—	1 Gal.
3/4"	3'	5'	15"	12"	10"	14"	—	3 Gal.
1"	4'	7'	20"	16"	12"	16"	12"	5 Gal.
1 1/4"	5'	9'	24"	20"	16"	18"	14"	7 Gal.
1 1/2"	6'	11'	30"	24"	20"	20"	16"	15 Gal.
2"	6'	14'	42"	36"	30"	24"	18"	15 Gal.
2 1/2"	8'	16'	48"	42"	36"	28"	18"	25 Gal.
3"	9'	18'	58"	48"	40"	32"	20"	45 Gal.
3 1/2"	10'	18'	65"	54"	44"	36"	24"	65 Gal.
4"	10'	22'	6'	5'	4'	40"	30"	95 Gal.
4 1/2"	12'	24'	7'	6'	5'	44"	36"	95 Gal.
5"	14'	26'	8'	7'	6'	48"	36"	95 Gal.
5 1/2"	15'	28'	9'	8'	7'	50"	—	200 Gal.

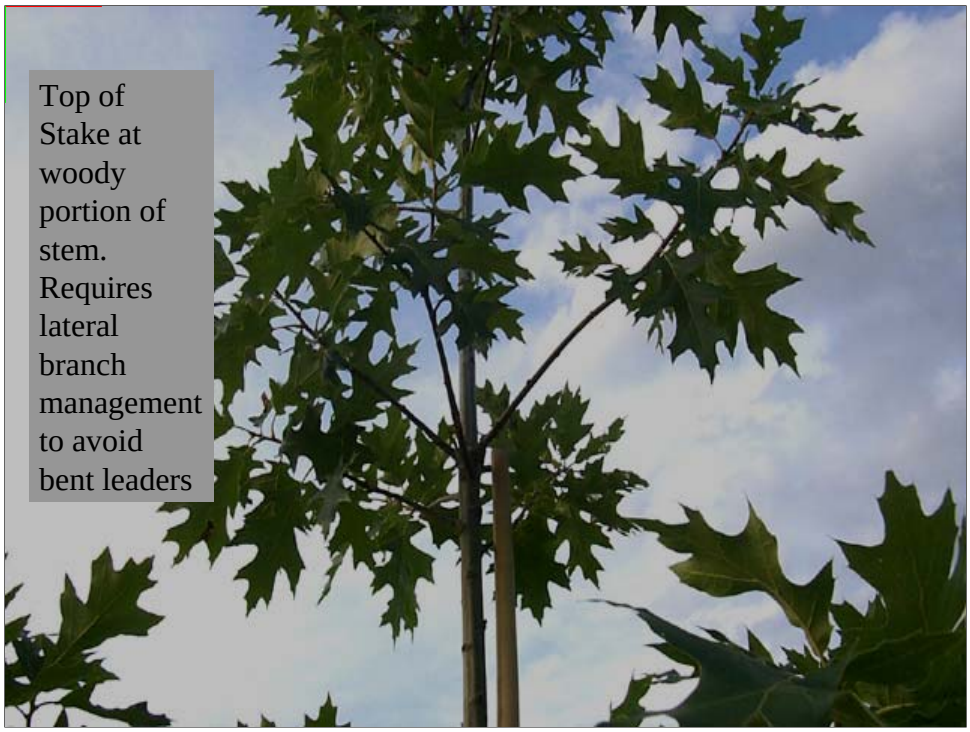
Notes:

The Florida Grades and Standards has a matrix for all forms of plants in production. The specifications may change related to the form of any particular nursery crop.

Using these standards, growers can ‘grow crops to order’, taking guess work out of how tall, what caliper or width a tree should be to meet specifications for sale.

In this slide, a stake extender is constructed using a PVC splint to connect two ¾ inch bamboo stakes.

The final height of the stake is the maximum height for the crop being produced in a specific container size

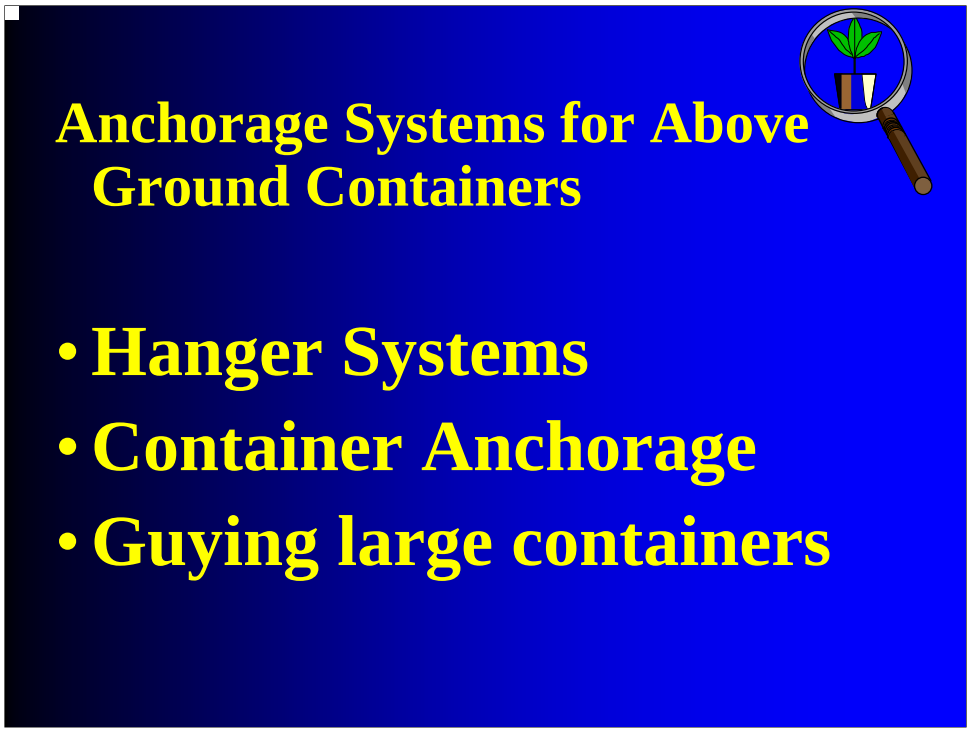


The stake in this slide did not cause the terminal to bend because, the stem is lignified (woody) and the terminal shoot was not actively growing at the height of the stake.

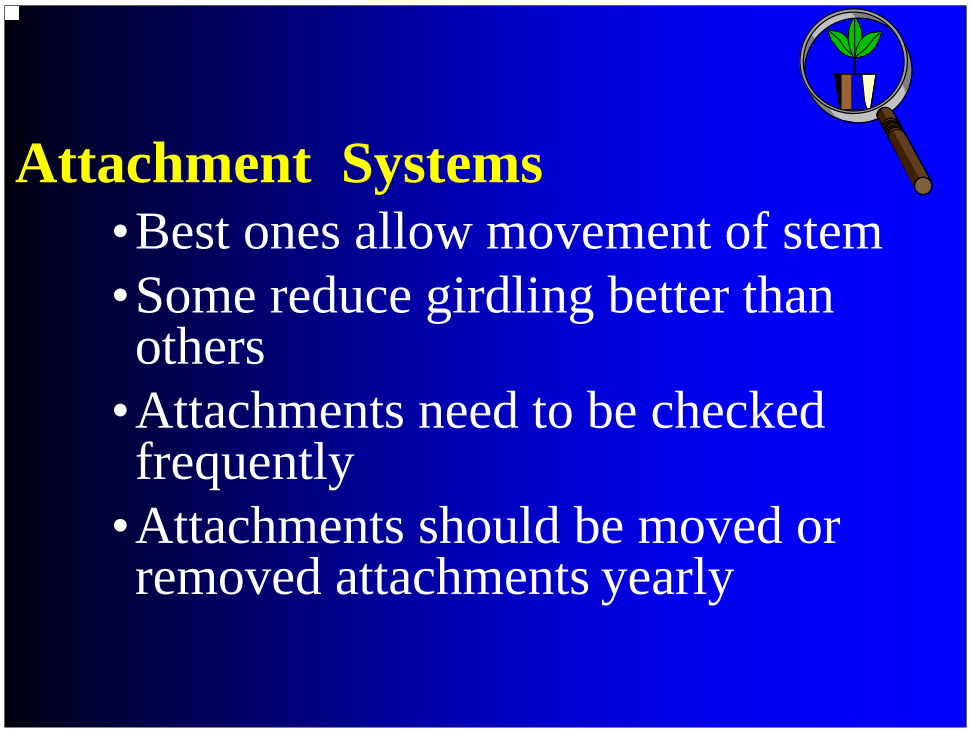
Various types of attachments are used to connect the stake to the tree. Plastic tape stretches and has a moderately wide area of contact with tree stems, thus reducing injury. Plastic tape can be installed using a Max-Tapener which applies the tape and staples the tape in place. Even though plastic tape has become popular since it reduces the time required to install attachments, reduces injury, the tape does not deteriorate and will restrict stem caliper therefore causing damage. Attachments still must be check and removed when stem restriction becomes imminent.

Shade trees require at least two to four pruning cycles each year to maintain leaders. Lateral shoots located at the same node as the leader or nodes below the leader must be cut back or removed to eliminate competitive growth. No more than two lateral shoots should be allowed to develop at any node. Pruning may be required two to three times during the growing season and once during the dormant season.

Several nursery crops are produced using multiple plants per containers. Many nursery stake each plant in the container to direct orientation of each stem, producing wider canopies and better stem configuration.



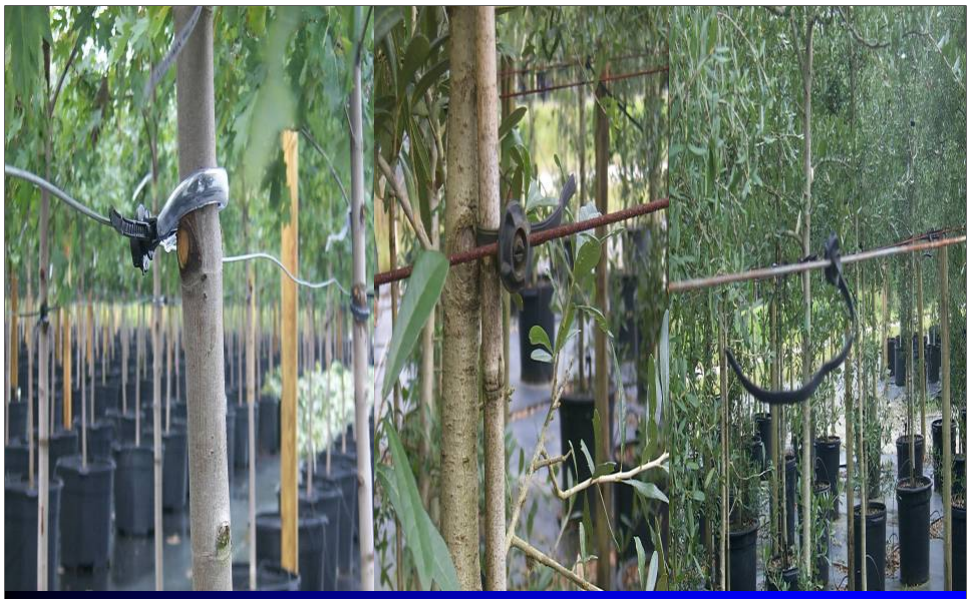
Pot in Pot production of plants in large containers, inherently provided anchorage and eliminated turn over of pots. However, Pot in Pot production areas are expensive, costing as much as $25 per socket to install, considering installation of drainage systems and burying irrigation distribution lines. Therefore, as more nurseries wanted to grow trees in large containers, they chose to construct above ground large container production areas. Above ground container production areas must also develop anchorage systems to eliminate blow over.



Above ground large container production has been the most rapid type of expansion in the nursery industry since 2000. Growers have developed a multitude of methods to stake and anchor large containers. Additionally, many new commercial staking and anchorage systems have been introduced. Several systems will be discussed in the following slides.

A true clothes line system is seen in this slide. Trees are attached using plastic ties attached to wires suspended between the clothes line posts. Pipe insulation tubes are used at this nursery to reduce injury. The plastic ties are looped around the wire and stem with the pipe insulation placed around the stem at the point of attachment to reduce injury to the stem. This nursery is also interspacing low growing shrubs in containers, to make use of the area more efficient and to reduce sun exposure on lower stems of trees.

In this above ground container production area, trees are attached using a commercial plastic strap attachment covered by a tygon tubing. The plastic strap has notches that provided loop width adjustment. Irrigation is provided by a single lateral irrigation line with spray stakes being placed in containers on each side of the distribution line. Although this method conserves on cost of irrigation, rabbits may use the irrigation aisle as a travel lane and frequently clip spaghetti tubes when this irrigation system is installed.



Two attachment methods are seen in picture 1 and 2. The first directly to the tree, the second to the stake which is attached to the tree.

As described in the previous slide, this commercial attachment system attaches to the wire hanger system using a unique clap. The loop width can be adjusted by loosening the loop and widening the attachment as tree stems expand.

Another commercial attachment system has a U clamp which attaches to the wire hanger and a wide cloth strap with velcro and a buckle to secure the strap to the tree. This system seems to last 3 to 5 years before the velcro no longer secures the strap in place.

Tree Systems tree straps were developed by a Florida nursery and are now marketed to the nursery industry.

The tree attachment system seen in this slide was developed at a South Carolina nursery. Stiff wire is attached on two sides of the wire hanger using U clamps. Rubber hose threaded around the stiff wire on all three sides to protect the tree stem. Since considerable hardware and home manufacturing is required, this system is relatively expensive to install, but should last several years.

This attachment system is similar to the previous slide. As seen in this picture, lateral branches can create problems if hangers height is not compatible to tree canopy development. Such problems can be alleviated if the market size of the container plant is identified. The canopy height of the tree at market time may not require permanent branches at the same height of the wire hanger. Most shade trees with caliper of 2 inches or greater, may have canopy heights of 6 feet (72 inches). High clearance is required for landscape sized trees used in commercial landscapes. Therefore, no branches would be located at hanger height. Smaller feather type shoots can be left low on the stem to assist in tree caliper, however they should be removed the season before sales.

Over time, hanger wires may sag due to wind movement. Placing a mechanical rachet at the end of each line allow the grower to easily tighten hangers.

The T Mate attachment system is being used to maintain trees erectly in this Pot in Pot system since tree foliage is heavy and trees may bend under the weight. Since trees are also staked, there may be more support than necessary in this case. The T Mate system is designed to fit on steel fence posts.

The T Mate system uses rubber bands as attachments to the tree. A pipe insulation foam piece is used in this slide to reduce wear on the stem from the rubber bands. Some flexing is allowed by the rubber bands.

The Tree Mate loop comes apart to allow placement of the loop around the tree stem.

This anchorage system was constructed using chain length fence posts and rails and galvanized rods as stakes. Attachments from the fence rails were made to the galvanized stake using clothes line rope. Tree attachments were made to the galvanized stake using plastic tape. Therefore attachments were not made directly from the rail to the tree, thus reducing injury to tree stems. Although this system was a very innovative method for support of trees, lightening may be a concerns.

In this slide, irrigation tubing is threaded over the wire hanger and a second wire covered with irrigation tube is attached to the hanger using stiff wire. A stake is between the hanger and the tree stem, however, wind displaces the stake and therefore the irrigation tube can wear on both sides of the tree stem.

This attachment system using irrigation tube allows contact with the stem and irrigation tube, but the nylon strap is used to secure the stem to the hanger.

During 3 hurricanes in 2004, the nylon strap caused abrasion on the back side of tree stems.

Damage after hurricanes resulted in wounds on the front side of the hanger caused by wear from the irrigation tube threaded over the hanger cable.

The new attachment method is to use a stake for attachment to the hanger with no direct contact to the stem from the hanger to the tree. It is hoped that this arrangement will reduce wind damage to tree stems. The tree is attached to the stake using plastic tape.

Regardless of how attachments are made to hanger systems, the attachments to tree stems, must be checked, loosened or removed before disfigurement and damage to tree stems.

Larger trees such as these 400 gallon Cool Ring containers must be guyed to prevent wind blow.

Nylon straps are used as guys to keep trees upright. Auger anchors (mobile home anchors) are placed in the ground to provide anchorage. Nylon straps are looped around the tree and covered with hose to reduce wear on stems. The straps are secured using a knot that can be released quickly to loosen or tighten the strap. Straps must be placed at least ½ to 2/3 height to prevent wind throw.

Attachments should not remain on trees more than one season. If further production time and anchorage is required, straps should be moved up the stem. Any injury or damage attracts borers so prevention spray applications must be made.

Rebar used to stabilize pots

End 7 Irons to hold rebar

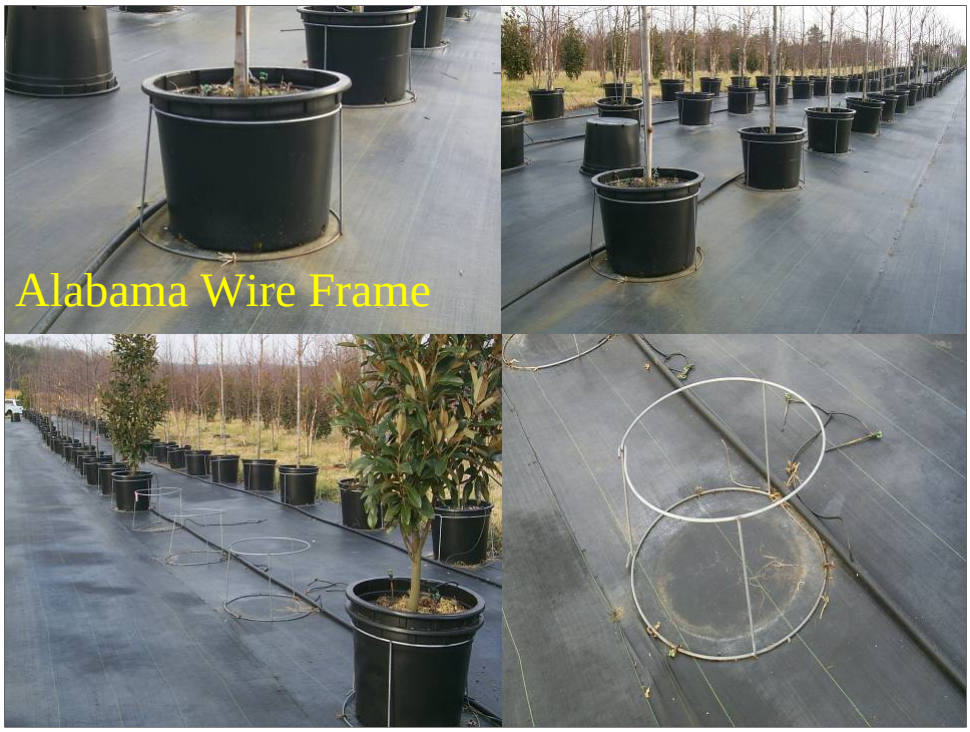
Some container anchorage systems have been developed by nurseries, entirely avoiding direct attachments to tree stems. In this slide, rebar is used to secure the top of containers. Welded rebar (7 iron) is used to hold the rebar tightly over the top of the container.

Second example of the rebar and 7 iron container anchorage system.

Some nurseries use welded rebar stakes to secure each container.

Poured concrete squares fit some sizes of containers and are used by nurseries to anchor container plants.

Seven gallon crape myrtles are placed in poured concrete squares to keep them upright.



Alabama Wire Inc sells a welded wire basket that is installed on nursery floors with long stakes with a U hook driven in the ground around the wire basket frame. Alabama Wire is an exhibitor at the NCAN Green and Growin Show in Greensboro held in January.

This anchorage system was developed by a North Carolina nursery to secure 75 gallon containers using two anchor cables running down each side of the container. Nylon straps were attached to the top of the containers which were attached to the ground cables.

This North Carolina nursery manufactured socket container pallets for production of above ground container trees.

Five socket containers are anchored to the nursery floor using the pallet system. High winds have turned all containers in the pallet over at one time.

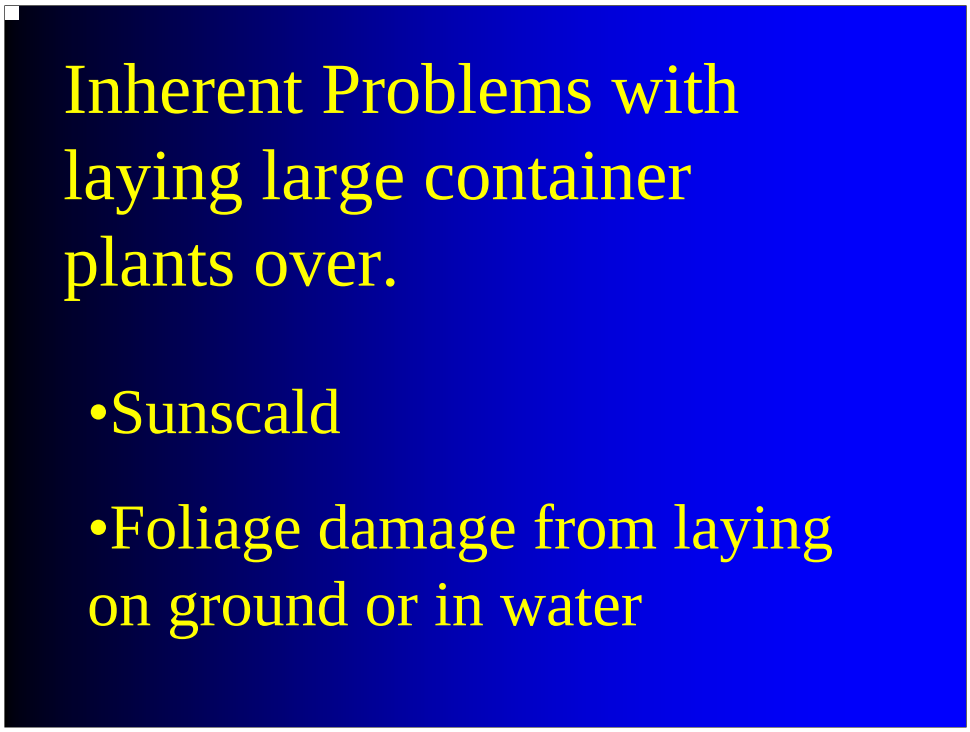
This container anchorage system was developed by a North Carolina nursery and has been modified and installed at other N.C. nurseries. Frame boxes constructed with 2x4's are built to fit the above ground containers. An irrigation distribution line runs down each side of the wooden frames.

Pots are secured to the wooden frames using long spikes driven through pre-drilled holes in the frames and into drainage holes of the large containers. This system has proved to be very stable for tree production.

Although most nurseries have chosen to use plastic, cloth or fabric container growing systems, some nurseries still choose to grow trees in large wooden boxes. Boxes are expensive to construct, but in most cases, trees can be carried to the installation site, sides and bottoms are bolted together, therefore after installation, boxes can be removed and returned to the nursery. Boxes can be used during several production cycles.

Containers in this 400 gallon production area are Cool Rings of Florida containers. This nursery produces trees up to 700 gallon Cool Ring size. One dis-advantage of Cool Rings is that the bottom is a square piece of ground cloth. The trees must be completely rooted out before they can be moved, or there is risk of losing part of the root ball during transporting.

Cool ring trees are guyed as previously discussed.



All of the above ground production systems discussed in this slide set are located in the Southeastern US. Hurricanes present major difficulties in large container production facilities. Pot in Pot containers are often lifted out of socket pots and layed over when hurricanes are imminent. Leaving them in socket pots may result in stems being broken in high winds. Also, high water tables may flood Pot in Pot containers. Above ground containers on hanger systems and staking systems are usually removed from hangers and layed over unless they are not rooted in. Laying newly transplanted large containers results in considerable loss of fertilizer and substrate and most nurseries take there chances and leave them upright. Laying crops over also creates difficulty. Foliage may be exposed to flood waters, damaging foliage and disfiguring crops, followed by foliage disease problems.

Sunscald is also a major problem on trees that are layed over during hurricanes. It frequently requires several days to weeks to set all containers up after a hurricane. While layed over, stems receive direct sun contact which kills cambium on exposed sides. Not only is a large wound developed, destroying the tree or delaying marketing by at least 1 year, but borers are attracted to the wounds, lay eggs and larvae destroy the stem integrity.