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The Root of the Problem:

How Commercial Arborists Play a Vital Role in the Inspection Process

by James Urban • FASLA

In the mid-1990s a number of practitioners and researchers were noticing a disturbing trend. An increasing number of trees were declining just as they began to reach a mature size. The problem was not limited to one species but seemed to affect many nursery grown trees.

A tree that is being strangled by its own roots. Photo © James Urban

In 2005 after years of discussion but little change, Gary Watson hosted a conference, called Trees and Planting: Getting the Roots Right. At the conference, researchers presented thirteen papers that collectively indicate that there are measurable effects on trees from two problems: girdling roots and roots too deep in the root ball. The papers document that the problems are widespread and they often originate in the nursery.

To better understand the problem, it is helpful to understand how trees are grown. Few commercial trees are produced directly from seeds. Most trees are produced at nurseries that specialize in liner production using various asexual methods to create genetically similar trees called cultivars or named plant varieties. For example *Acer rubrum* may be produced from seed but *Acer rubrum* 'October Glory' must be produced asexually. These small trees, sometimes only inches high, may be grown in soil beds, trays or in small, individual containers until they are large enough to be planted out in the nursery field or moved into larger containers where they are grown to about one half to one inch in caliper, called liners. Finished liners are shipped, bare root or in containers, to regional nurseries where they are grown into larger trees—either in fields or larger containers.

Prior to the 1970's, few trees were propagated or grown in containers. Trees were propagated, grown, and harvested in fields of soil. At each shift in the production, trees were most often moved bare root. Since the trees were replanted bare root, the grower could easily plant the tree with the main roots and developing trunk flare close to the surface of the soil. Root systems could be inspected and culls thrown out.

Today, trees are often moved from smaller to larger containers without root inspections and root pruning. Even field grown trees may be started in containers.

When a tree root reaches the wall of a typical container, it must bend in a new direction to keep growing. Usually this bend forces the root to grow around in a circle following the container wall. Some containers are designed with ribs that force the root to bend either up or down. This can be problematic too.

"Straight roots growing from the trunk form a strong, wide root plate," writes Ed Gilman of the University of Florida. "When

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main woody roots are deflected and not straight, there may be no root plate and the tree can become unstable."

Unless the roots are pruned when the tree is transferred to a larger container, the root system will retain the imprint of the smaller container.

And in the larger container, the process can start all over again. With trees often repotted three times before they are sold, the tree may have three sets of roots circling around the trunk.

Containers aren't to blame for all of the circling roots. Deep structural roots and buried trunk flares are another potential problem, facing both field grown and container grown trees. When the trunk flare is deep under the soil, circling roots may grow close to the surface near the tree trunk.

A study by Chad Giblin and four others published as part of the Getting Roots Right Conference Proceedings observed 180 little leaf lindens (*Tilia cordata*) to see how planting them deeply would affect them. After six years, more than 60% of the lindens planted five and 10 inches below the surface had stem encircling roots, compared with just 17% of those planted zero inches below the surface.

Regardless of their origin, as the tree grows, roots growing tangential to the trunk above the main structural roots may begin to compress the trunk, reducing the flow of sap between the canopy and roots. The compression can also weaken the trunk at that point. As the amount of trunk circumference impacted by the root increases, the impact on tree health increases.

Tyson Woods, an arborist with Moore Tree Care in Dallas found girdling roots so common among declining trees that he added an entire crew to address the problem. He reports that once the roots were removed, tree health generally improved.

Several production issues contribute to the structural roots being too deep in the root ball. Watson and his colleague Angela Hewitt have observed that in the process of transplanting tree liners, the primary root of the tree growing downward is often pruned. A new set of roots will grow out from the cut and may become the main roots of the tree. Lateral roots growing above this point may then fail to develop.

At this point the tree's planting depth has already been established. Keith Warren at J. Frank Schmidt and Son Co, a large liner producer in Oregon, reports that maintaining this deeper planting depth actually aids in plant establishment in well drained and tilled field soils. But this depth may cause problems when the tree is placed into a less well-drained soil in the landscape.

Another reason trees are planted too deep is to hide an ugly graft. Grafting tends to create a slight crook at the graft point, and many growers found that purchasers preferred it when the graft was hidden. With field grown trees, mechanical cultivation equipment used to till the soil around the tree tends to push soil up against the trunk. With container trees, roots may be buried when the root ball from the previous container is set too low, and potting mix is added to top off the container.

The industry group led by Watson developed a best management practice recommending, "at least two structural roots should be within one to three inches of the soil surface, measured three to four inches from the trunk. Primary lateral roots as deep as 11 inches below the root ball surface have been observed and roots five and eight inches deep are not uncommon. A survey of trees dug for resale in broker yards in Ohio by Richard Rathjens and T. Davis Sydnor in 2004 found that the *average* depth to the main roots was 3.4 inches. Most of the trees they examined would not have met the standard proposed by Watson.

These trees might not meet the American Standard for Nursery Stock- ANSI Z 60.1-2004 either. It specifies standards for root ball depth and states that the "depth of the ball is measured from the top of the ball, which in all cases shall begin at the root flare." A considerable amount of soil would need to be removed from the top of these root balls for the measurement to be done, shrinking the size of the root balls.

At the 2012 International Society of Arboriculture Annual Meeting in Portland, Oregon, there was a day and a half long symposium on understanding the nursery practice problem. Again, Gary Watson lead the discussion, as well as a field session on liner production held at J. Frank Schmidt and Son Co, the largest producer of liners in the US. Other speakers included Keith Warren, Ed Gilman, Dan Struve from Ohio State University, and myself.

All speakers supported root pruning trees at each step in the production process or using container types that prevent circling roots. Gilman's work showed that root pruning does not appear to lengthen the time to produce a healthy liner.

It is unreasonable to specify a perfect tree, Warren cautioned. Maintaining the elevation of the developing trunk flare and first set of main roots close to the soil is difficult for a grower and more work is needed to develop better techniques.

Gilman observed that most of the commercially available containers he has observed, including those that claim to air prune

A proper root ball examination. Photo © James Urban

roots, will produce circling roots if the tree is left in the container too long. He and Struve are developing a new generation of containers that are “root safe.” These include paper containers, spun poly fabric containers, and open mesh air pruning containers that have open voids on up to 80% of the surface area. However, these container ideas each have some production issues that remain to be solved and they have not yet been adopted by the industry.

All speakers agreed that bare root planting can be a reasonable immediate solution to many of these problems.

In extreme cases of girdling roots, the tree may snap off at the point of the constriction. When I was called in to look at a grove of approximately 40 Little leaf lindens (*Tilia cordata*) in Des Moines, Iowa planted in 1979 that were beginning to decline, I found severe girdling roots around most of the trees. Only the most severely impacted trees were removed in 2011. But during a severe windstorm in the spring of 2012, half of the remaining trees snapped off at the root compression point. The rest were removed after inspection by the city’s arborist revealed they were also unstable. The 30 years spent growing dozens of large trees was lost. If arborists seek to prevent similar calamities, they will need to demand better planting and nursery practices.

Landscape architects should make sure their details show the entire top of the root ball above the ground. Many details show the root ball placed with the point where the trunk emerges out of the root ball as the proper location for planting. Since there is often a steep slope on the top of the root ball away from the trunk, this can lead to additional soil being laid on the root ball. Planting details should show the outer edge of the root ball planted flush to the adjacent soil line. They should also call for the contractor to remove any soil above the trunk flare and main roots and any girdling roots prior to planting.
If container trees are to be used on the project, a separate detail is needed to address this type of root package’s specific issues.

The container tree detail should show all potting mix and girdling roots removed from the top of the main roots. Container trees often have a thick matt of fine roots above the main roots which must be removed. The drawing should also show the contractor how to cut off or shave all the roots on the outer edge of the root ball so that all cuts leave root stubs in a radial relationship to the trunk, using a technique developed by Ed Gilman. Pruning these outer edge roots may appear to damage the tree, but Gilman’s research indicates that trees are not impacted by this severe pruning if they are irrigated immediately, and the new roots growing out from the shaved roots tend to continue to grow in radial fashion away from the trunk, producing a more stable, healthy tree.

I propose that the container tree detail also require the removal of circling roots from previous smaller containers in the interior of the root ball that are above the main structural roots. However, it’s much harder to deal with roots buried deep within the root ball. Also, there is no research indicating how many of these roots can be removed before the tree health is compromised. So it might be better to reject such trees altogether.
This provision should eventually be added to planting specifications, but it will be hard to enforce. In case the contractor complains about the cost of the additional work or that the root cutting will compromise the guarantee, the specifications should be clear that such modifications are required and the result of the contractor purchasing defective plants.

A definition of defective plants will need to be added to the specification. ANSI Z 60 may not be sufficient to allow rejection of plants. ANSI Z 60 does require that the soil line be “at or near the top of the root flare”, but it does this in the context of how the tree is measured and there is no discussion of circling roots for field grown trees. ANSI Z 60 requires that container trees

Showing the proper root depth for long-term health. Photo © James Urba

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do not have “excessive” encircling roots on the inside of the container but “excessive” is not defined.

At the end of this article are some sample specifications a landscape architect could use to decrease the likelihood of buried trunk flares and girdling roots. But it will not be easy to find trees that meet these specifications and enforcement will be difficult without nursery industry cooperation.

Progress is being made in field grown trees. Since the grower is already processing the root ball at the time of sale it is not much more work to resolve issues with buried trunk flares and remove girdling roots at that time. In Florida and Illinois, tree growers, contractors and landscape architects came together to develop better field grown root ball standards. The Illinois Green Industry Association web site (http://www.ina-online.org/treespecs.html) provides good root ball guidelines for field grown trees including defining the relationship of the roots to the root ball starting with the liner planting. These guidelines could be adopted nationwide.

Finding solutions to container tree production issues appears to be more difficult. Currently growers are not doing any processing of the root package at the time of sale. Modifying the root balls of container grown trees on the construction site or at the time of shipping can be expensive. Research at the University of Florida showed that it takes approximately 12 minutes per tree to shave the outer edges of a 45-gallon tree. More time is required to fix internal root problems.

Container growers and contractors are more likely to be convinced to change their long-term production techniques than to modify the root balls of existing stock. Therefore changing the container industry will take longer and require landscape architects; contractors and growers join together to find workable solutions. In California, the Urban Tree Foundation, led by Brian Kempf, has worked with Gilman to develop a nursery root pruning guide and specifications for container trees. (See: http://www.urbantree.org/nurserytreequality.shtml)

Modifying root systems in container trees will be perceived as impractical by some. However, the alternative is to either plant trees that have known defects and short life expectations or reject trees with these problems entirely. Neither of these alternatives is practical either. The latter would be especially difficult in the southern and western parts of the United States where container growing is the primary production method.
In order to make these improvements and enforce the revised specification, arborist and landscape architects are going to have to become more involved in the process of planting stock approval. The nursery industry does not generally enforce their own standards nor is there currently sufficient inventory that comes close to these standards.

If arborists hope to address the issue, they will need to have the inspection process and the bases for approval or rejection inserted into the contract documents, and demand construction administration contracts include time to monitor plant quality. Inspection of trees at the nursery is critical, as once a tree arrives at the project site, the cost of returning the tree and the implied project delays often make it very difficult to reject trees unless the problems are extreme. Many clients will not support delays for a problem that they cannot see, is not easy to explain and may only impact the long term health of the project, long after the warranty has expired and the development team has moved on to other work or even retired. Rejecting trees at the grower’s nursery gives the grower the opportunity to make modifications to the root ball. Or the contractor may be able to find a better source.

When inspecting a field grown tree, the goal will be to find the depth and distribution of a few main roots. Inspections can be accomplished with hand gardening tools that the arborist brings to the nursery. A typical inspection involves carefully digging around the base of approximately three random trees in each tree block to develop a confidence in the depth of the primary roots. Each tree inspection takes just a few minutes. Most nurseries are quite consistent in their planting techniques so random checks are usually valid. The trees inspected are not harmed by the inspection and I’ve found most growers do not mind the additional scrutiny. But the requirement for this invasive inspection must be in the specification.

Inspecting container grown trees is a much more difficult problem. Due to the complexity of the root system from different containers used in the production process, combined with the dense tangle of roots that can form within and on top of the container, observing root problems within the container is nearly impossible without destructive inspection. If container trees must be used, the root balls of some random plants actually be sawed apart with a hand or electric saw, killing the tree. That may take 15-20 minutes per tree. The purchase of these trees for testing must be included in the cost of the project. Unfortunately, many container grown trees in the United States will fail this inspection. Finding an acceptable solution will take a cooperative effort on the part of arborist, landscape architects, contractors and growers. Trees with poor root systems can be used if there is considerable root modification at the time of planting, but that will be expensive and time consuming, and a limited number of trees will die from the modification—causing a complex warranty situation. For large projects, contract growing, with root pruning required in the specifications, may offer a solution.

The problem of poor quality root systems on trees is one of the great challenges to making healthy sustainable landscapes. Landscape architects, as one of the main specifiers of trees, must help to find practical solutions. Arborists should see cooperation and education of landscape architects as an opportunity to create new relationships with that profession.

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SPECIFICATION CHANGE RECOMMENDATIONS

The following is a suggested specification to deal with the root system of trees currently available in the market.

Plant quality at or below the soil line:

A. A minimum of three structural roots reasonably distributed around the trunk shall be found in each plant. Plants with structural roots on only one side of the trunk (J roots) shall be rejected.

B. The root crown must not be more than 2 inches below the soil line. The top two structural roots shall be no more than 3 inches below the soil line when measured 4 inches radial to the trunk. The top of the other structural roots shall be no greater than 5 inches below the soil line when measured 4 inches radial to the trunk. The grower may request a modification to this requirement for species with roots that rapidly descend, provided that the grower removes all circling roots above the structural roots across the top of the structural roots.

C. The root system shall be reasonably free of root defects including: potentially stem girdling roots above the root collar and main structural roots, vertical roots, and/or kinked roots from nursery production practices, including roots on the interior of the root ball.

   1. Reasonable and Reasonably—when used in this specification relative to plant quality—are intended to mean that the conditions cited will not affect the establishment or long term stability, health or growth of the plant. This specification recognizes that it is not possible to produce plants free of all defects and that some decisions cannot be totally based on measured findings, so professional judgment is required. In cases of differing opinion, the Landscape Architect shall determine when conditions within the plant are judged as reasonable.
   2. The final plant grower shall be responsible for certifying that the plants have been root pruned at each step in the plant production process to remove stem girdling roots and kinked roots, or that the previous liner production system used other practices that produce a root system throughout the root ball that meets these specifications. Regardless of the work of previous growers, the plant's root system shall be modified at the final production stage to produce the required plant root quality. The final grower shall certify in writing that all plants are reasonably free of root defects as defined in this specification, and that the tree has been grown and harvested to produce a plant that meets these specifications.

D. All plants may be inspected at the supplier's nursery. The Landscape Architect may make invasive inspection of the root ball as needed to verify that plants meet the requirements. Inspections of container trees may require random cutting into the interior root ball of up to 2% but not less than 2 trees of each type of tree in a container at each source nursery. Such cutting and inspection may render the container tree unsuitable for planting. Findings of the root inspections shall be considered as representative of all trees of that type from that source.

E. Container Grown Plants: in addition to the above requirement comply with the following.

   1. Container grown plants may be permitted only when indicated on the drawing or this specification.
   2. Container-grown stock shall have been grown in a container long enough for the root system to have developed sufficiently to hold its potting medium together but not so long as to have developed roots that are matted or circling around the edge or interior of the root mass. Plants shall have been root pruned at each change in container size.
   3. Plants that fail to meet any of the above requirements shall be modified to correct deficiencies if approved by the Landscape Architect. Modification shall include:
      a. Shaving all circling roots on the exterior of the root mass deep enough so that all cut roots ends are roughly radial to the trunk.
      b. Removal of all roots above the top of the main structural roots and trunk flare including any roots that are imprints from previous smaller containers.
      c. The above modifications shall not be cause to alter the warranty provisions of this specification.