Editor’s Notes

By Leslie Allen

“October's poplars are flaming torches lighting the way to winter.” ~Nova Bair

Fall is here and northern Nevada is ablaze in a dazzling array golds, reds and oranges. It seems as though trees are calling out for our attention. While our gaze is held steady onto the colorful canopy, we sometimes forget to consider what is happening below ground. This time of year trees are building up their root energy stores so they can survive the winter and burst forth with verdant enthusiasm next spring. This is an excellent time to explore new research on tree roots.

Bonnie Appleton, professor of horticulture at Virginia Tech’s Hampton Roads Agricultural Research and Extension Center, takes a new look at bare root planting on Page 2. Her research on power washing trees so they can be planted bare-root is novel and could decrease tree mortality. Be sure to check out the included resources for more information on bare root planting.

An excellent summary of bare root production by Marc Teffeau starts on Page 3. New research shows that root pruning and subsequent root formation can have a significant impact on tree survival in the landscape.

Another article by Dr. Chalker-Scott follows on page 4. This time Dr. Chalker-Scott aims her debunking pen at tree fertilizer injections. Fertilizer injections are a common practice, yet these injections may have unintended consequences.

Finally, Dr. Sue Donaldson continues the unintended consequences topic with her herbicide damage article on Page 6. Unintended herbicide damage is more common than most people realize. It is often misidentified and misdiagnosed. Dr. Donaldson’s article will help you recognize herbicide damage and learn to take proper care to prevent herbicides from affecting your valuable landscape trees.

Please feel free to share this newsletter with your employees and customers.

It can be viewed online at: http://www.unce.unr.edu/areas/western/newsletters/.

To receive e-mail copies, contact Leslie at allenl@unce.unr.edu.
Getting to the Root of the Matter

By Lori Greiner

Structural root systems of landscape trees that are too deep can cause stress and even death. According to Bonnie Appleton, professor of horticulture at Virginia Tech’s Hampton Roads Agricultural Research and Extension Center, this problem is everywhere, and it continues to be a significant issue despite numerous, easy control strategies.

One of the most effective methods of preventing deep roots is to bare root the trees by removing the soil from the roots at planting time, explains Appleton. “Bare rooting provides you an opportunity to prune the root and remove defects, as well as allows you to plant the tree at the appropriate depth,” she says. “Our industry may be going full circle. Years ago trees were primarily planted bare root, but because people want to plant more tree species at various times of the year, production systems such as B & B (ball and burlap) and container-grown trees were developed. Those systems have introduced problems related to tree roots.”

Jim Flott, a consulting arborist and owner of Community Forestry Consultants of Spokane, Wash., approached Appleton about conducting research on the various tree-root preparation methods. Flott, an advocate of bare root planting, had developed a tub-soak method of removing the soil or container substrate from the roots.

In addition to the tub-soak method, Appleton’s research compared several other techniques including power washing the roots, removing the top of the wire basket/burlap/twine from the tree, and excavating the soil out of the roots using high-pressure air.

“Our research shows that the time of year when the tree was planted relative to the tree species was much more critical than the root-preparation method,” says Appleton. “We found very few differences between the different techniques.”

Landscapers are embracing the practice of bare root planting. Although they have to spend more time preparing the roots before they are put in the ground, there are tradeoffs, Appleton points out. “They don’t need as big a hole to plant the tree,” she says.

There are additional economic benefits as well if the trees were actually available bare root from production nurseries. The industry could save transportation costs by shipping the lighter-weight bare root trees instead of the B & B and containers that are weighted down with soil.

Appleton says that more research is needed to further define recommendations for the different tree species. She plans to expand the research to investigate various types of root treatments that would accommodate the difference in the time of the year, particularly relative to root desiccation.

Related Information:

American Nurseryman - The Bare Root of the Matter

Creating the Urban Forest: The Bare Root Method (PDF file)
http://www.hort.cornell.edu/UHI/outreach/pdfs/bareroot.pdf
Back to the Roots

By Marc Teffeau

In recent years there has been, at times, animated discussion between arborists, tree nursery producers and others in the green industry about what effect the structure of the tree root system has on the survivability of the tree planted in the urban landscape. Did the urban tree die because of poor and incorrect planting practices or because the root system failed to establish because of nursery production practices, resulting in a deep root system to begin with?

Over the years of my former extension career, I have seen both situations occur fairly often. The quality of the tree stock was questionable, or it was planted like it was a telephone pole. One guarantee for tree mortality was when landscape contractors used an auger to drill the tree-planting holes in heavy clay soil—like they were drilling for fence posts.

There have been ongoing research efforts to address these questions and to help develop appropriate guidelines for tree-planting practices in the landscape and tree liner production in the nursery. As a result, we have learned a great deal about tree roots. Their "architecture," growth patterns and establishment in the landscape. It has been determined that nursery production practices, such as root pruning and transplanting, may alter tree root architecture and contribute to root system development that is too deep and may impact survivability in the landscape.

Researchers Angela Hewitt and Dr. Gary Watson of The Morton Arboretum, Lisle, IL., shed additional light on the impact of nursery production practices in the formation of tree root architecture in their article in the June 2009 edition of the Journal of Environmental Horticulture (27121:99-104). "Bare Root Liner Production Can Alter Tree Root Architecture." Partially funded by the Horticultural Research Institute, this project looked at the issue of bare-root tree liner production practices in greater detail. Their collaborative study with a major Northwest tree liner nursery producer investigated the changes in roots architecture associated with common methods used for landscape tree propagation and liner production that may influence depth of structural roots in landscape trees.

Hewitt and Watson's research objectives were to investigate the fate of natural lateral (root flare) roots along the primary root or cutting, as well as the formation of adventitious roots at the pruned end of the primary root or culling. In their study of field-grown liner production, the production of field root architecture was observed at each stage of the production process, from first-year seedlings or rooted cuttings through 4- to 5-year-old branched liners. Each species was propagated according to the typical protocol in use at the nursery for that species. Five stages of field liner production were included: seedling/cutting: undercut (if applicable); and one, two and three years after transplanting.

Tree species in the study included four seed-propagated rootstocks in densely planted beds in the field: domestic apple (Malus sp.), pear (Pyrus calleryana), honey locust (Gleditsia triacanthos) and sugar maple (Acer saccharum). Two clonally propagated rootstocks—moundpropagated EMLA III (Malus sp.) and hardwood cuttings of 'Columbia' planetree (Platanus x acerifolia 'Columbia') were also included in the study.

Hewitt and Watson observed that by the time the liners reached marketable size, most natural lateral roots emerging from the primary root were lost. The average number of lateral roots of the tree species samples decreased during production for all rootstocks, though at different stages.

Simultaneously, adventitious roots were produced deeper on the root shank at the pruned end of the primary root. These changes in architecture resulted in the formation of an "adventitious root flare" (ARF) that was deeper in the soil than a natural root flare. The

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depth of this new root flare was dependent upon nursery production practices and may influence the ultimate depth of structural roots in the landscape. The architecture of the six rootstocks in this study was altered by typical nursery practices, varying to some degree according to species.

In addition, when the trees reached marketable size as whips and branched liners, the number of persisting natural lateral roots on the primary root (usually two to three per tree) was insufficient to form a root flare in the natural location. The adventitious roots at the pruned end (usually five to 10 per tree) were two to four times larger than the remaining lateral roots and growing rapidly.

The researchers noted that there were approximately three times the number of adventitious roots at the cut end, and they were approximately three times the size of the remaining natural laterals and growing vigorously. As a result, these roots began to dominate the root system even as young liners. These vigorous, adventitious roots at the cut end of the primary root developed into an ARF that supplanted the natural root flare and was somewhat deeper in the soil.

The depth of the ARF depended on the length of the primary root after root pruning in the nursery. The primary root was commonly pruned to approximately 4 inches. As the roots produced at the end thickened and began to form a root flare, the distance between the soil surface and the structural roots was soon reduced to an acceptable level of 3 inches. Hewitt and Watson also noted that if the primary tree root is pruned substantially longer, then the ARF may be too deep when the liners are planted in the nursery and ultimately in the landscape. They concluded that a deep ARF may not be detrimental in well-drained nursery production soils, but may reduce tree vigor and survivability when planted in urban landscape situations with dense, poorly drained soils.

For more information on Hewitt and Watson's tree root research, consult their very informative Web site, www.mononarb.org/deeptreeroots/index.html. If you would like a copy of the research article referenced, please e-mail me at mteffeau@hriresearch.org or Teresa Jodon at tjodon@hriresearch.org, and we would be glad to provide you a PDF of the Journal of Environmental Horticulture article.

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The Myth of Vitamin Shots
“Fertilizer injection is the most effective way to correct tree nutrient deficiencies”

By: Linda Chalker-Scott, Ph.D., Extension Horticulturist and Associate Professor, Puyallup Research and Extension Center, Washington State University

Advertisements show white-coated technicians with the latest injection equipment for delivering doses of fertilizers and fungicides to ailing plant patients. The memory of the family doctor who would make house calls is embodied in these plant health care professionals and we feel we are providing the best possible care for our shrubs and trees.

A great deal of scientific literature has been dedicated to this practice as well. Leaf chlorosis (yellowing) tends to be the primary signal to landscape managers that fertilizer application is required. Trunk- and soil-injection of fertilizer has been performed on a number of tree species, generally those with landscape amenity or fruit and nut production value. In addition to

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injection of complete fertilizers, specific nutrients such as iron, zinc, and magnesium are also delivered in this way. Proponents of injection fertilization, especially trunk injection, point to the immediate improvement in leaf color and the relatively low cost of application.

The Reality
This is another practice that falls into the “immediate results” category of landscape management. Indeed, trunk injection of nutrients can have an immediate impact on leaf color, but what is routinely missing in published reports and papers is the long-term effect of the practice on leaf color and tree health. Indeed, when studies are carried through for a number of seasons, invariably the authors will report that leaf color of the injected trees is no different from that of the control trees. This is not a practice with sustainable benefits.

Injecting plants with various substances has fascinated humans for many centuries. Both fertilization practices of tree injection and soil injection have been studied for decades and have been recently reviewed in the scientific literature. It is apparent in these reviews that there are no long-term benefits to trunk injection of fertilizer. Though it can have immediate effects in terms of leaf color change, this practice breaches the tree’s bark barrier and leads to numerous health problems. Injection sites are portals for pathogens and pests; they can cause trunk splitting, decay, cankers, and structural defects; and they are especially dangerous to trees already in poor condition. Furthermore, trees injected with fertilizer have been found to become more susceptible to insect pests, presumably because their leaf nitrogen content increases.

Oddly enough, this practice has been repudiated several times throughout the 20th century by agricultural and silvicultural researchers. Unfortunately, it continues to be widely recommended and practiced since it “makes sense” to people who assume that medical and veterinary models extend to the care of plants. Though the value of vaccines and other medical injection procedures for animals (including humans) are clear and documented, it is not a practice that translates to plant species, whose normal physiological functions and biochemical resistance strategies are still poorly understood.

What about soil injection? There are several papers and a few scientific reviews on soil injection of fertilizers, though not nearly as many as on trunk injection. Briefly, researchers have studied application of nutrients such as nitrogen, potassium, and iron to various landscape and crop trees. Though not an invasive technique like trunk injection, this procedure does not significantly improve delivery of fertilizer to tree roots. In fact, a review in 2002 concluded that “surface applications were as effective as soil injection or drilling”. This appears to be a practice that generally is not warranted and adds excessive costs to a landscape.

Finally, we landscape managers need to be more aware of mitigating factors that affect leaf color and overall tree health. Poor soil conditions, including compaction and waterlogging, lack of adequate irrigation and mulch, opportunistic pests and pathogens, weeds, and urban stresses can all contribute to tree decline. Yellowing leaves do not necessarily mean that fertilizer is necessary; they are often a sign of other plant stresses that no amount of fertilizer will correct. A proactive approach to mineral nutrition of trees, especially in obtaining soil and leaf tissue analyses, is more economically and environmentally sustainable than the “quick fix.”

The Bottom Line
• Leaf yellowing and other foliage symptoms are not direct indicators of soil nutrient levels
• Before any fertilizer program is initiated, a complete soil analysis should be performed
• Leaf tissue analysis should be performed before initiating any specialized fertilization program
• Fertilizer will not cure nutritional deficiencies caused by disease, pests, air pollution, mineral toxicity, drought, poor root health, or poor soil health
• Trunk injection is harmful to the long-term health of the tree and should not be used for delivering fertilizers
• Soil injection is no more effective at delivering fertilizer than broadcast application and is not cost-effective
• Woody plants growing in competition with turf will always suffer more nutrient stress than those trees and shrubs partially protected by mulch
• Any fertilizer program that does not include weed management is ineffective and costly

For more information, please visit Dr. Chalker-Scott’s Web page at http://www.theinformedgardener.com.
Unintended Injury from Herbicides

By Susan Donaldson, UNCE Water Quality Education Specialist

Every year, Nevada Department of Agriculture investigates complaints of damage to landscape plants by pesticides. While very often the damage was not caused by herbicides, cases of injury have certainly occurred, with costly impacts to the user. By learning how injury occurs, you can help protect your business from unintended consequences.

These include:
- Mite, insect or disease damage
- Adverse weather, especially wind desiccation
- Soil compaction
- Drought
- Root stress
- Improper soil pH
- Misapplied fertilizers
- Nutrient deficiency
- Genetic mutations
- Salty soils and road salts

Herbicides are pesticides that are applied to kill specific plants such as weeds. In most cases, careful applications will not harm adjacent landscape plants. However, failure to apply herbicides according to label directions can result in problems. Damage to plants can occur in a number of ways. Sprays may drift onto nearby plants when blown by wind, or residues may volatilize as gases from treated areas and affect plants some distance away. Soil residues of persistent herbicides may also damage newly planted specimens.

Definitive diagnosis relies on analysis of plant tissue samples for herbicide residues, which may or may not be accurate, depending upon the amount of time that has passed. Herbicide analysis is expensive, especially if you don’t know the identity of the herbicide. However, products with similar modes of action will tend to produce similar symptoms of damage in non-target plants, especially in new growth. See Table 1 for common symptoms by mode of action, or go to [http://wric.ucdavis.edu/information/herbicideinjury/growthreg.html](http://wric.ucdavis.edu/information/herbicideinjury/growthreg.html) for photos of damage. Chlorosis (yellowing) of plant tissue is a common sign of herbicide damage, but also occurs due to nutrient deficiencies.

Tips for avoiding herbicide injury in the landscape:
- Read and follow the product label. You are liable for damage that occurs as a result of misuse of the product.
- Calibrate your equipment prior to each use to make sure you’re applying the correct rates.
- Avoid drift by applying herbicides on calm days, when wind speed is 10 mph or less
- Use a coarse spray to increase droplet size and decrease drift.
- Do not apply phenoxy herbicides such as 2,4-D on hot days as they may volatilize and injure nearby plants. Herbicides should not be applied when temperatures exceed 85 degrees.
- When possible, use amine formulations or low-volatile esters when volatilization is a concern. Be aware that amine forms are more soluble and more likely to spread to nontarget plants through the soil. Dormant buds can absorb phenoxy herbicides in sufficient amounts to result in distorted leaves.
- Consider the presence of roots under the application area. Roots extend far beyond the dripline of trees, and roots that absorb are present in the top few inches of soil. If you apply an herbicide to the dripline, you risk injury to the tree or shrub.
- Avoid the use of weed and feed type products in lawns, as they may volatilize or translocate through roots of adjacent trees.
- Grass-selective herbicides may cause damage to some broadleaf plants. Consult the label.
- Use great caution when applying herbicides to kill suckers. The
Mobile herbicides will move readily in sandy soils, especially after rain or irrigation. Soils that are high in organic matter will tend to have lower risk of movement.

**Table 1. Symptoms of Herbicide Damage**

<table>
<thead>
<tr>
<th>Mode of action</th>
<th>Examples of active ingredient</th>
<th>Symptoms of damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino acid synthesis inhibitors</td>
<td>Glyphosate</td>
<td>Reduced new growth in spring, distorted growth (twisted, curled, malformed), yellowing and necrosis, shortened internodes resulting in shorter plant</td>
</tr>
<tr>
<td>Growth regulators</td>
<td>Phenoxyxs: 2,4-D, dicamba, Picolinic acids: clopyralid, triclopyr</td>
<td>Stem twisting, new growth has puckered leaves, leaf edges are feathered, leaves are cupped, stems split, bent, or twisted. These herbicides are prone to drift and volatilization.</td>
</tr>
<tr>
<td>Cell membrane disruptors</td>
<td>Paraquat, acetic acid (contact herbicides)</td>
<td>Look for spotting on old leaves (necrosis or chlorosis); new growth will be unaffected</td>
</tr>
<tr>
<td>Cell division inhibition</td>
<td>Dinitroanilines: trifluralin (Treflan, Preen), pendimethalin, oryzalin (Surflan) (preemergence herbicides)</td>
<td>Root pruning; short, thickened roots; red-tinged leaf margins in grasses. Pre-emergence herbicides are unlikely to cause drift problems.</td>
</tr>
<tr>
<td>Pigment synthesis inhibitors</td>
<td>Clomazone</td>
<td>Bleached leaf color, white or purple</td>
</tr>
<tr>
<td>Photosynthesis inhibitors</td>
<td>Atrazine, simazine, diuron</td>
<td>Starts with a pale outside edge, looking similar to a nutrient deficiency or virus; then creeps towards the center of the leaf; look for chlorosis. Chlorosis is also caused by poor nutrition. Chlorosis from herbicides will show as a bright yellow to white interveinal space contrasted with sharply-defined secondary bright green veins.</td>
</tr>
<tr>
<td>Meristematic inhibitors</td>
<td>Metsulfuron-methyl, chlorosulfuron, rimsulfuron</td>
<td>Growth stops immediately, internodes are shortened, chlorotic yellowing, gradual necrosis of leaf and stem tissue</td>
</tr>
</tbody>
</table>

Grapes 2,4-D Injury  
Photographer: Virginia Tech Learning Resources Center, Virginia Polytechnic Institute and State University  
http://www.forestryimages.org/about/imageusage.cfm

American Sycamore 2,4D Damage  
Photographer: Theodor D. Leininger, USDA Forest Service, United States  
http://www.forestryimages.org/about/imageusage.cfm
Calendar of Events
2009/2010

Dec. 2—Coffee With Friends
“Developing a Nursery IPM Program.”
Offered at 6:30 a.m. and again at noon.
Contact Leslie Allen, 784-4848 or allenl@unce.unr.edu

Dec. 16—2009 Turf and Landscape Institute. Contact Janet Hartin, (951) 313-2023 or jshartin@ucdavis.edu

Jan. 5—Nursery Worker Training begins. Contact Leslie Allen, 784-4848 or allenl@unce.unr.edu

Feb. 16—Nevada Landscape Association annual conference and trade show. Contact Debbie Drew, 673-0404 or visit www.nevadanla.com.