

Bare Root to Bare Root – Coming Full Circle
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Abstract. If the production, harvest, shipping, and planting of trees for landscape use is looked at historically, our industry didn't start with root balls packaged in burlap, rope, and wire, or in containers of varying sizes, shapes, and colors. It started with bare root fruit trees sold by itinerant salesmen. Today a perceived epidemic of tree decline exists in the United States, with an estimated 80 percent of all landscape tree problems originating below ground and relating to quality and placement of the root system. Structural root defects and root planting depth issues can occur during all stages of tree production and establishment including nursery propagation and production, landscape specification development and planting, and post-planting and transplanting maintenance. A proposed technique for revealing tree roots prior to finishing the planting or transplanting process, so that root defects can be seen and if possible, corrected, and planting height can be properly adjusted, is bare rooting. Bare root planting of landscape caliper-sized trees has both advantages and disadvantages compared to planting intact field or container-grown root balls per current industry standards, but bare root planting is the planting technique that was successfully used when the nursery and landscape industry began in the United States.

“It has been said that 80 percent of all landscape tree problems start below ground” (Watson 1994). With increases in the sophistication of tree production and harvest methods at nurseries in the United States has come an apparent increase in root-related establishment and growth problems. Add to this the confounding problem of improper installation (namely root depth and lack of defective root system modification), and a perceived, whether real or not, epidemic of tree decline in the United States is said to exist (Chalker-Scott 2005).

Tree root evolution relative to nursery production, harvest, and shipping method

Trees nursery-produced in the 1700's and 1800's were all harvested and planted or transplanted bare root, and were predominately fruit trees. In the latter half of the 1800's a significant increase in non-food or landscape and ornamental plants was added to commercial production including such trees such as American elm, Lombardy poplar, magnolia, larch, mountain ash, American holly. Again, trees were harvested, sold, and planted bare root (Davidson et. al. 1988).

During the 1800's and early 1900's trees that were not harvested bare root were dug by hand with a soil ball, thus the beginning of balled-in-burlap (B&B) harvest, shipping, and planting. The production, harvest, and shipping of trees with container-grown root systems started at the end of World War II with the use of #10 egg and fruit cans. The first record of the hydraulic digger harvest of nursery trees is 1956 (Davidson et. al. 1988), again producing plants that were then shipped and planted B&B.

Tree root handling relative to landscape planting and transplanting

In the 1906 fourth edition of the *New Cyclopedia of American Horticulture*, Liberty Hyde Bailey, the father of American horticulture, described transplanting as “...a general term used to designate the removal of living plants whereby they may become established in new quarters.” He stated that only small herbaceous plants were sometimes transplanted while actively growing, but that most plants should be transplanted when dormant. He went on to describe a dormant transplanting method for large trees that involved “picking out and caving down” soil from

within a tree root system. As the roots would be uncovered they were tied in bundles with lath yarn, and if they were to be out of the ground over one day in dry weather the bundles were to be wrapped in clay mud, damp moss and straw, or burlap. When placed in their final landscape destination the roots were systematically uncovered and then settled into their planting hole by means of a mud slurry and “planting sticks”.

In a 1943 National Shade Tree Conference and National Arborist Association publication, a technique similar to the above is recommended: “Digging Specifications: Remove the loose soil or soil above the roots, from the area to be dug. Planting Practices: After the B&B specimen is set in the hole, it is advisable to remove the burlap. Puncturing or breaking the ball - often times plants dug from heavy clay soil will arrive at the planting site with the outer inch or more of the soil ball sufficiently dried out to form a hard crust. Balls planted in this condition are not satisfactory for rapid re-establishment of the roots. The crust may be so hard that it inhibits ready movement of air and water to the roots, and furthermore, the new roots penetrate the crust very slowly, if at all. A method of removing soil from the roots uses a tined spading fork to comb out the roots by inserting the fork into the soil ball and prying against the root ball. Continue working inward until most of the roots are exposed. If practical leave a partial ball or some soil clinging to the roots.”(Anonymous 1943).

Current status of handling trees bare root at planting and transplanting

In recent years bare root tree planting has mainly been reserved for the planting of small, mainly deciduous seedlings for reforestation, establishment of riparian buffers, and similar tree replacement projects; for lining-out whips for larger tree production at nurseries; for planting small evergreen seedlings for Christmas tree production; and for the planting of fruit trees. The bulk of these types of planting projects use trees that are dormant. Bare root plants also represent the bulk of the means by which small trees are shipped mail order in the United States.

Web and literature searches (September 20, 2008) regarding bare root planting almost exclusively related to plants harvested and planted or transplanted bare root, not bare rooted at planting or transplant time. *Creating the Urban Forest: The Bare Root Method* by Buckstrup and Bassuk (2003) is the only major publication the authors found that addresses bare root planting in detail, but does not mention bare rooting at planting or transplanting. A search of recent popular literature produced only three articles on bare rooting at planting (Chalker-Scott 2005; Flott 2006; Appleton 2007).

The origin of improper structural root depths

Some deep structural roots get their start during nursery propagation or production. Others start during landscape installation or maintenance, and still other times deep structural roots are a result of cumulative events or handling practices. The following lists enumerate causes of deep structural roots, and can be used to make production, installation, and maintenance changes to minimize or prevent deep structural root development.

Field and container propagation, production, and harvesting

- Seeds planted too deep in direct field or container propagation.
- Deep propagation containers used that tend to concentrate rooted liner roots at the bottom of the container.
- Seedlings and rooted liners potted with their roots too deep in production containers.
- Seedlings, rooted liners, whips, or grafted rootstock roots covered by soil during cultivation for weed control.

- Seedlings, etc. planted too deep because root-to-stem transition zone, root collar, or stem flare not obvious or observed.
- Seedlings, etc. planted too deep to prevent blow over.
- Budded and grafted trees lined out too deep to bury the graft union (or seedling cut back referred to as the “dog leg”).
- Root balls topped with additional soil to create a crowned field root ball at harvest.
- Substrate settling around seedlings or liners over time.

Landscape installation and maintenance

- Roots initially too deep in the nursery container or field root ball resulting in planting hole dug too deep. (Fallacy of using soil mark on stem or stem flare as defining mark for establishing hole depth [Bilderback 2006].)
- Planting hole dug too deep due to incorrect planting specifications or digging errors.
- Soft soil underneath the root ball compacts or settles in the bottom of the planting hole.
- Soil displaced by root ball put atop the roots.
- Excess mulch put atop the roots.
- Post-installation grade changes.
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The origin of defective root roots

As with deep structural roots, root defects can get their start during nursery propagation or production, or can start or be perpetuated during landscape installation or maintenance. They may also be mandated by outdated landscape specifications. The following lists enumerate causes of defective roots, and can likewise be used to make production, installation, and maintenance changes to minimize or prevent development or perpetuation of root defects.

Field and container propagation and production

- Seedlings, liners, whips, or grafted rootstocks started in propagation and/or small production containers and then lined out or potted up without removal or correction of circling roots (Figure 1).
- Seedlings, etc. settled into narrow planting furrows or trenches, or off center into containers, via root dragging or “sweeping” (produces “J” roots) (Figure 2).
- Trees shifted up (“up canned”) to larger size production containers without removal or correction of circling roots.
- Field-grown liners or finished trees potted up into containers without removal or correction of circling of J-roots

Landscape installation and maintenance

- Planting or transplanting field or container-grown trees with deep structural and/or defective roots.
- Not roughing up or creating root passages in planting hole walls when augering creates slicked or impenetrable walls (mainly in heavy clay soils).
- Digging plants holes deeper than the actual depth of the tree root system (leading to stem girdling roots [SGRs]).
- Using outdated landscape planting or transplanting specifications.

Advantages to bare rooting during production, harvesting, shipping, and planting and transplanting

Bare rooting, or the removal of field soil or container substrate, at planting and transplanting has many advantages that can address the above mentioned structural root depth and defective root system problems. Bare rooting also has advantages relative to other production, harvesting, shipping, and planting and transplanting components, with the following being a compilation of the major advantages across all phases of plant handling:

- Root defects and structural root depth can be corrected prior to tree harvest if bare rooting occurs during each propagation or production stage, or during planting or transplanting.
- Root pruning stimulates new root growth.
- Field soil and container substrate can be retained at the production nursery.
- Transmission or transport of soil-borne weeds, insects, and pathogens can be minimized.
- May help in dealing with quarantines relative to soil-borne insects and pathogens.
- May give nurseries that produce quality root systems a marketing and pricing advantage.
- Trees may be less expensive and easier to store at the nursery prior to shipping.
- Growers will get a more correct tree inventory if structural roots are correctly located (not too deep) in the soil.
- Trees will be less expensive to ship and therefore potentially less expensive to the buyer.
- Trees can be transported into more confined spaces if both their branches and their roots can be compressed.
- Trees will be easier to handle from a weight perspective.
- Planting holes will be easier to dig and will require less heavy digging equipment (with a side advantage of reduced soil compaction).
- Removes problems that can result from incorrect installation handling of balling burlap, ropes, and straps, and wire baskets.
- Resolves soil and container substrate disparity or hydrologic discontinuity problems.
- Root systems are more uniformly moistened by “mudding in” (creating a soil slurry to settle into and atop the bare root system), and large air pockets are removed.
- All structural and absorbing roots are in contact with the planting site soil, not just the roots/root tips on the outside of the root ball.
- “Mudding in” creates greater direct root anchorage and reduces the need for supplemental stabilization (staking or root anchoring). This in turn reduces maintenance cost and potential tree and human hazards when no stabilization method needs to be removed.
- Fewer injuries should occur to green industry personnel.
- Potential to increase the period of time of the tree guarantee or warranty.
- Trees with poor quality roots can be refused or returned with proof of the structural defect or root depth problem.

An additional, non-production or installation advantage noted by the junior author when employed as a municipal arborist was increased volunteer participation in tree planting activities due to the lighter weight, more consumer friendly bare root tree.

Disadvantages (real or perceived) to bare rooting at planting and transplanting

Just as bare rooting, or the removal of field soil or container substrate, at planting and transplanting has many advantages that can address structural root depth and defective root system problems, there are likewise disadvantages that should be considered. The following is a compilation of the major disadvantages across all phases of plant handling:

- Removal of often significant root volumes due to disease, damage, or structural malformation revealed by bare rooting.
- Improper handling during the bare rooting process including the need to prevent root desiccation.
- The need to dispose of substrate (soil or potting) removed from root systems during the bare rooting process.
- The need to alter tree planting specifications to reflect reconfiguring the planting hole with varying dimensions.
- The need for bare rooting supplies and equipment for either bare rooting off or on the planting site.
- Differences in species adaptation to bare rooting including phenological growth stages (timing of bare rooting, especially relative to bud break) and ability to rapidly recover following planting or transplanting.
- Resistance to the principle of bare rooting by nursery growers, landscape designers, architects, and contractors, and arborists.
- The cost (labor, equipment) to bare root and plant a B&B or container-grown tree vs. the cost to “drill and drop” plant B&B or “pop and drop” container-grown trees, especially if large numbers of trees are being planted.
- Research shows that bare rooting, via “root washing” or soaking for a period of time in water, may remove or dilute stored nutrients and may also remove desirable rhizosphere organisms (mycorrhizal fungi, etc.).
- Nurserymen and landscape contractors may refuse to guarantee or warranty bare root planted and transplanted trees.

Bare rooting at planting and transplanting research

One approach to correcting structural defect and depth problems is to bare root field and container-grown trees at planting time. Though modern horticultural and arboricultural references all give recommendations for how to plant bare root trees (Whitcomb 1987; Gilman 1997; Watson and Himelick 1997; Hartman et al. 2000; Lilly 2001; Harris et al. 2004; Watson and Himelick 2005; Urban 2008), only Gilman addresses to any extent actually bare rooting field or container-grown trees at planting, and two others bare rooting when transplanting (Hartman 2000; Harris et al. 2004). Possible bare rooting techniques are discussed in trade publications (Chalker-Scott 2005; Flott 2006; Appleton 2007) and a few major arboricultural references (Hartman 2000; Harris et al. 2004), but no research into a comparison of possible bare rooting techniques was found in the literature.

In addition, there are reported differences in the ease of handling or planting different tree species bare root (Whitcomb 1987; Avent 2003; Buckstrup and Bassuk 2003). Said differences are in part due to root growth periodicity among different species (Harris et al. 1995; Kozlowski and Pallardy 1997). The objectives of the research were therefore to investigate 1) the effect of different bare rooting techniques on tree survival and growth; and to 2) determine whether time of year or phenological growth stage would have an effect on bare root planting success; and to 3) determine whether there might be differences in species response depending on nursery production method, bare rooting technique, or time of year of bare rooting.

Two species of tree – red maple (*Acer rubrum* ‘Red Sunset’) and willow oak (*Quercus phellos*) were selected for use due to anecdotal reports of differences in conventional (not bare rooted – ie, field soil or container substrate not removed) planting success at different stages of

tree growth (dormant vs. active). In 2006, at Virginia Tech's Hampton Roads Agricultural Research and Extension Center in Virginia Beach, four root ball handling techniques were applied to field-grown 3"-4" caliper red maple at planting: 1) no soil removed; 2) bare rooted via air excavation (Figure 3); 3) bare rooted via pressure washing (Figure 4); and 4) bare rooted via drop from 12' in air (Figures 5). Air excavation was achieved using a commercial Air Spade. Root ball dropping was achieved by lifting root balls in the air with a tree spade, opening the blades, and letting the root ball fall to and hit the ground. After dropping all wire baskets, burlap, and ropes were removed and loose soil allowed to fall from the roots. Trees were treated and planted in both March and July to represent dormant and actively-growing planting.

In 2007, three root ball handling techniques were applied to both field and container-grown 3" caliper red maple and willow oak: 1) no soil or substrate removed; 2) bare rooted via pressure washing; and 3) bare rooted via soaking. Pressure washing in both years used a stream of water produced by a 5 mph commercial engine on a water wagon. Root soaking was achieved by placing the root balls in a trough of water for approximately 12 hours, then hand raking out any soil or substrate still remaining within the root ball (Figure 6). Both species were treated and planted as above in March and July to represent dormant and actively-growing planting. The willow oak were also treated and planted in October to represent planting as trees are going dormant.

Trees whose root balls were not bare rooted were planted according to Virginia Cooperative Extension tree planting recommendations (Appleton and French 2004). Trees whose root balls were bare rooted were planted into shallow holes that matched the depth and spread of the bare root system, using a slurry of planting hole soil and water in a process that author Flott termed "mudding in". A similar process is described in by Bailey in 1906.

Data collected and subjected to analysis of variance were percent live trees (which in the case of willow oak included some whose main stem had died but which had sprouted from the base), and increase in caliper measure at 6" above soil level. For field-grown red maple bare rooted in 2006, after two years of growth there were no significant differences in bare rooting technique or whether bare rooted while dormant or actively growing.

This same trend was true after one year for red maple, both field and container-grown, that were bare rooted in 2007. For willow oak, however, significant differences occurred for all treatments, and there were significant interactions. Production method, bare rooting technique, and time of year of bare rooting were all significant.

Most notable was the timing, with most trees bare rooted while dormant, regardless of production method or bare rooting technique, alive and with similar caliper growth. Nearly half of the willow oak bare rooted while actively growing were dead, with more trees alive that had been field rather than container-grown, or in some cases that were bare rooted by soaking rather than by pressure washing. A slightly higher percent of willow oak bare rooted in the fall when going dormant were alive compared to the actively growing bare rooted trees, again with production method and bare rooting technique interactions. (Data will be presented in a follow-up manuscript to be submitted for publication consideration to *Arboriculture & Urban Forestry*.)

Caution needs to therefore be exercised when deciding whether to bare root trees at planting, since tree species vary in their response to bare rooting, especially relative to time of year or growth stage. Further research is planned to continue to examine this phenomenon, and to determine if treating the roots to prevent desiccation or to stimulate new root growth after bare rooting will enhance bare rooted tree planting or transplanting success.

LITERATURE CITED

- Anonymous. 1943. *Transplanting of Trees and Shrubs in the Northeastern and North Central United States*. Collier Publishing Company, Wooster, OH.
- Appleton, B.L. 2007. The bare root of the matter. *American Nurseryman* 205(10):41-42, 44-46.
- Appleton, B.L. and S. French. 2004. *Tree and shrub planting guidelines*. Virginia Cooperative Extension Publication 430-295. Blacksburg, VA.
- Avent, T. 2003. *So You Want to Start a Nursery*. Timber Press, Portland, OR. 340 pp.
- Bailey, L.H. 1906. *New Cyclopedia of American Horticulture*. (4th ed.). Doubleday, Page & Company, New York, NY. 2016 pp.
- Bilderback, T. 2006. Going straight. *Nursery Notes* 40(3):31-32.
- Buckstrup, M. and N.L. Bassuk. 2003. *Creating the Urban Forest: The Bare Root Method*. Cornell University's Urban Horticulture Institute, Ithaca, NY. 18pp.
- Chalker-Scott, L. 2005. Will the patient live? *American Nurseryman* 201(6):20-23).
- Davidson, H., R. Mecklenburg, and C. Peterson. 1999 (4th ed.). *Nursery Management*. Prentice Hall, Englewood Cliffs, NJ. 530 pp.
- Flott, J. 2006. Don't plant trees, plant roots. *City Trees: Journal of the Society of Municipal Arborists* 42(2):32-36.
- Gilman, E.F. 1997. *Trees for Urban and Suburban Landscapes*. Delmar Publishers, New York, NY. 662 pp.
- Harris, F.W., J.R. Clark, and N.P. Mathey. 2004. *Arboriculture*. Prentice Hall, New York, NY. 578 pp.
- Harris, J.R., N.L. Bassuk, R.W. Zobel, and T.H. Whitlow. 1995. Root and shoot growth periodicity of green ash, scarlet oak, Turkish hazelnut, and tree lilac. *J. Am. Soc. Hortic. Sci.* 120:211-216.
- Hartman, J.R., T.P. Pirone, and M.A. Sall. 2000 (7th ed.). *Pirone's Tree Maintenance*. Oxford University Press, New York, NY. 545pp.
- Laurie, A. and L.C. Chadwick. 1938. *The Modern Nursery*. The MacMillan Company, New York, NY. 494 pp.
- Lilly, S.J. 2001. *Arborist's Certification Study Guide*. International Society of Arboriculture, Champaign, IL. 222 pp.
- Perry, T.O. 1994. Size, design, and management of tree planting sites, pp. 3-15. In Watson, G.W. and D. Neely (Eds.). *The Landscape Below Ground*. International Society of Arboriculture, Savoy, IL.
- Urban, J.R. 2008. *Up by Roots*. International Society of Arboriculture, Champaign, IL. pp.
- Watson, G.W. 1994. Introduction, pp. vii. In Watson, G.W. and D. Neely (Eds.). *The Landscape Below Ground*. International Society of Arboriculture, Savoy, IL.
- Watson, G.W. and E.B. Himelick. 1997. *Principles and Practices of Planting Trees and Shrubs*. International Society of Arboriculture, Champaign, IL. 199 pp.
- Watson, G.W. and E.B. Himelick. 2005. *Best Management Practices – Tree Planting*. International Society of Arboriculture, Champaign, IL. 41pp.
- Whitcomb, C.E. 1987. *Establishment and Maintenance of Landscape Plants*. Lacebark Publications, Stillwater, OK. 618 pp.

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Figure 1. Circling roots on trees from within a field (B&B) root ball (left) and from production in a container (right). The field ball circling roots developed in the initial propagation or production container before the tree was lined out in the field for final caliper growth.



Figure 2. “J” root created by settling a seedling or liner into a narrow planting furrow or trench via root dragging or “sweeping”.



Figure 3. Bare rooting a field-grown root ball while dormant (top) and while actively growing (bottom left) via air excavation. Example of a partially air excavated root ball.



Figure 4. Bare rooting a field-grown root ball while dormant (top) and while actively growing (bottom left) via pressure washing. Example of a pressure washed root ball.



Figure 5. Dormant field-grown tree lifted into air to be dropped to bare root the tree.



Figure 6. Root balls being soaked, and substrate being raked out, to bare root trees.