

Tree Stabilization: Current Products and Practices

Bonnie L. Appleton, Carolyn M. Cannella, P. Eric Wiseman, and Alexis A. Alvey

Abstract. Products and systems used to stabilize trees at transplant should be prescribed based on site conditions, tree characteristics, and planting and maintenance practices. Alternatives to traditional aboveground trunk staking and guying methods exist, generally consisting of products that anchor tree rootballs rather than supporting tree trunks. When assessing the need for tree stabilization at transplant, several factors should be considered, including material costs, time required for installation and maintenance, product persistence in the landscape, and aesthetics.

Key Words. Balled and burlapped (B&B); container-grown; guying; rootball anchoring; staking; transplanting; trunk support.

The requirement for some form of tree stabilization is a component of most landscape tree installation guidelines and specifications. This practice is the subject of ongoing debate and controversy within the green industry. Nurserymen, landscape designers and architects, landscape contractors and managers, and arborists often disagree about the need for stabilization and the most appropriate products or systems to use.

Unfortunately, trees are often the inadvertent victims of these disagreements. When a tree dies as a result of injury from a stabilization product or system, there is often finger-pointing to assign blame. The landscape manager might blame the landscape architect for specifying a system that injured the tree. The arborist removing the same dead tree might blame the landscape manager for not removing the system in a timely fashion to prevent injury. Proper prescription of stabilization systems, based on an assessment of site, tree, and management factors, can prevent such conflicts and, more importantly, minimize tree injury.

REASONS FOR TREE STABILIZATION

For successful establishment, trees must be kept upright and relatively motionless while their roots grow from the rootball into the surrounding soil. Root development includes the plagiotropic growth of large structural roots along with the lateral growth of small absorbing roots. In time, a sufficient number of roots grow into the soil to anchor the tree. However, excessive tree movement, or repeated blowover, can hamper root development. Stabilization systems minimize tree movement, facilitating root development and tree establishment.

Regardless of tree production and harvest method at the nursery, installation of tree stabilization systems should not be mandated, but instead a system should be prescribed based on assessments of site, tree, and installation and management factors. Systems should be prescribed when one or more of the following conditions threaten the stability of newly planted trees:

- Site conditions: strong or unidirectional winds; compacted, wet, or shallow soils; sandy soils; steep slopes;
- Tree characteristics: bare root; large or spreading crowns; tall or weak trunks; lightweight rootballs; underdeveloped/coarse root systems; improperly harvested root systems; improperly handled rootballs; dormant versus active root systems;

- Planting practices: bare root planting; wire basket removal; rootball manipulation; elevated planting in wet soils;
- Maintenance practices: use of lawnmowers and string trimmers close to tree trunks; and
- Site uses and problems: playgrounds and recreation fields; high-traffic sidewalks, curbs, and parking areas; tree theft and vandalism.

DISADVANTAGES OF TREE STABILIZATION

Just as there are compelling reasons to stabilize trees at planting, there are also disadvantages of stabilization systems that are improperly prescribed, installed, or maintained. Some of these disadvantages are:

- Detrimental tree growth effects: decreased caliper and trunk taper; increased trunk height; asymmetrical trunk growth; reduced root growth (Harris 1969; Burton and Smith 1972; Wrigley and Smith 1978; Appleton and Whitcomb 1984; Ellyard 1984; Harris 1984; Svihra et al. 1999; Schuch and Kelly 2004);
- Hazardous tree growth effects: trunk compression, girdling, or abrasion; development of less trunk flex response to wind (may snap above guying or when guying removed) (Neel 1971; Leiser et al. 1972; Fulmer and Jones 1974);
- Aesthetics: unattractive; visually distracting;
- Hazards: can cause personal injury or equipment damage; can encourage vandalism; and
- Economics: costs for materials or products; installation labor; follow-up maintenance to adjust or remove; costs to remove or replace damaged trees.

TREE STABILIZATION LITERATURE AND SURVEYS

Many new tree stabilization products and systems have been recently introduced, renewing interest in the science and application of tree stabilization. As part of a research initiative at Virginia Tech, a literature review and manufacturer/practitioner surveys were conducted to better understand the state of knowledge on tree stabilization and the availability and use of products and systems in the green industry.

Published research on tree stabilization is limited. Neel (1971) showed that motion, light, and growth regulators influenced

trunk development (in particular, reaction wood formation) of several species. Harris (1984) reported that trunk staking is often unnecessary and can be detrimental to tree growth. The most recently published, peer-reviewed research compared the effect of three stabilization systems on the growth of *Pyrus calleryana* (Svihra et al. 1999). The investigators observed differences in tree height growth among the systems during the first year after planting; however, growth was similar in the second year, after removal of the systems, with differences in trunk taper persisting into the third year. No research literature was found comparing tree stabilization through rootball anchoring with trunk staking (one article from the United Kingdom mentioned using rootball anchoring but gave no posttransplant results).

Of six arboricultural reference books consulted, all concur that stabilization should only be undertaken when necessary and not as a default practice (Gilman 1997; Watson and Himelick 1997; Lilly 2001; Harris et al. 2004; Watson and Himelick 2005; Whitcomb 2006). They further agree that in most cases, staking/guying should be attached as low on the trunk as possible and left in place no more than 1 year. All references discuss the potential for the common form of guying—hose-covered wire—to cause trunk-girdling injury. They further suggest that guying materials be wide, smooth, flexible, and nonabrasive and, to help with problems of nonremoval, even photodegradable.

Harris et al. (2004) categorize three types of tree staking: protective staking to keep away equipment, vehicles, and vandals; anchor staking to stabilize roots or rootballs until new roots grow into the surrounding soil; and support staking for trees with trunks too weak to stand upright alone. Gilman (1997) describes both anchor and support staking and provides numerous examples of products and systems that can be used. Watson and Himelick (1997, 2005) also discuss the alternative of stabilizing trees through products and systems that anchor rootballs. Whitcomb (2006) urges consideration of an eye screw attachment or guying system (in place of ties) not presented by other references.

Whitcomb (2006) emphasizes that part of the problem, especially for trees grown in containers, is excessive nitrogen application and close spacing of plants during production. These practices encourage dense canopies and poorly tapered trunks. Such trees often will not stand upright when transplanted to the landscape and thus require support staking. Whitcomb argues that trees produced in this manner are not acceptable nursery stock and should be rejected.

In a search of the Internet, extension publications posted by universities contained the most up-to-date, research-based information, although several still listed hose-covered wire as the primary attachment or guying material. Articles posted on commercial sites and written by garden writers and other laypersons were less up-to-date and less accurate; however, an improvement in the quality of information was noted between the initial search conducted in 2002 and a follow-up search conducted in 2006.

STABILIZATION MANUFACTURER SURVEY

To gain perspective on tree stabilization in the United States, surveys were sent to 12 manufacturers of tree stabilization products (100% reply response). Manufacturers (Table 1) were asked what products they made, how the products worked, whether they could be used for both field-grown (balled and burlapped) and container-grown trees, how rigidly the products held the tree, how long they recommended products be used in the field,

and what their long- and short-term goals were in developing their product relative to field performance.

The following is a summary of manufacturer survey responses:

- 83% of the products are for aboveground use (“tree staking”) and 17% are for belowground use (“rootball anchoring”). Within these product lines, 32% use wooden stakes, 32% use a rope or cable anchoring system, and the other 36% use a variety of other materials (metal or fiberglass poles, plastic guying, and so on);
- 87% said their product could be used on both field and container rootballs, and 13% said only on field rootballs; and
- 67% said their product was designed to allow some trunk movement, 22% said their product was designed to allow significant trunk movement, and 11% said their product was designed to hold the trunk rigidly in place.

STABILIZATION PRACTITIONER SURVEY

To gain perspective on how tree stabilization is implemented at planting, a practitioner survey was developed and distributed at several field days and conferences in the mid-Atlantic region and through regional and national trade publications (e.g., *Tree Care Industry*, *Groundworks*, *Newsletter of the Virginia Nursery and Landscape Association*, *South Carolina Today*, *The Log*). The following is a summary of over 300 responses received primarily from landscape contractors and arborists:

- 81% of practitioners use an aboveground stabilization system with the most common being wooden stakes with hose-covered wire followed by wooden stakes with nylon strap guying. Of those who use belowground systems, the most commonly used system is a wooden frame with anchoring wires or cables followed by metal plates or spikes;
- Practitioners were slightly more aware than manufacturers of the recommendation that trees not be held rigidly in place: 72% said they select products or systems that allow some trunk movement, 21% said they use products or systems that allow significant trunk movement, and only 7% said they use products or systems that hold trunks rigidly in place;
- Manufacturers and practitioners varied in their responses regarding short- and long-term criteria for product development and product/system selection, respectively (Table 2). Practitioners are most concerned with product impacts on tree growth and development rather than product mechanics; and
- 71% of respondents said that they had observed damage (generally girdling) from stabilization systems being left in place too long. Other observations of damage or problems included poor root development, bark injury, trunk breakage, reduced trunk caliper, stem swelling above guying, suckering below guying, and foliage discoloration.

RESEARCH TO TEST PRODUCTS AND SYSTEMS

As a result of the increased number of tree stabilization products and systems in use by the green industry and the lack of published research evaluating the efficacy of the newer rootball anchoring products, two comparative research projects were initiated in 2003. One was conducted at Virginia Tech’s Hampton

Table 1. Manufacturers of stabilization products and systems.

Aboveground staking	Rootball anchoring
<p>ArborGuy Arborguy Supply 29203 State Road 46, Sorrento, FL 32776, U.S. 866-272-6711 www.arborguy.com</p> <p>ArborTie Deep Root Partners, L.P. 81 Langton St., Suite 4, San Francisco, CA 94103, U.S. 800-458-7668, 800-766-8835 www.deeproot.com</p> <p>Cinch-Belt V.I.T. Products, Inc. 2063 Wineridge Place, Escondido, CA 92029, U.S. 800-729-1314 www.strongbox.com</p> <p>Gardeneer Mow-Over Tree Stake Kit Dalen Products, Inc. P.O. Box 30369, Knoxville, TN 37930, U.S. 800-747-3256 www.gardeneer.com</p> <p>Poly Chain Lock A.M. Leonard 214 Fox Drive, Piqua, OH 45356, U.S. 800-543-8955 www.amleo.com</p> <p>Reddy Stake Decorations for Generations, Inc. 2925 Niagara Street, Suite 7 Turlock, CA 95382, U.S. 888-333-3090 www.ReddyStake.com</p> <p>Stake Straight Dewitt Company 905 S. Kingshighway, Sikeston, MO 63801, U.S. 800-888-9669 www.dewittcompany.com</p> <p>Tree-Mate-O T-Mate-O 6921 Stacy Road, Charlestown, IN 47111, U.S. 877-854-5497 www.tmateo.com/treelc.htm</p>	<p>Earthwing Bershire Products, Inc. P.O. Box 591, Sheffield, MA 01257, U.S. 413-229-7919 www.Bershireearthwings.com</p> <p>Duckbill Anchors Foresight Products, LLC 6430 E. 49th Drive, Commerce City, CO 80022, U.S. 800-325-5360 www.earthanchor.com</p> <p>Tomahawk Border Concepts, Inc. PO Box 471,185, Charlotte, NC 28247, U.S. 1-800-845-3343 www.borderconcepts.com</p> <p>Tree Staple Tree Staple, Inc. 139 South Street, New Providence, NJ 07974, U.S. 877-873-3749 www.treestaple.com</p> <p>Hybrid above/below system</p> <p>K & S Stake Arbor Products, LLC. P.O. Box 506, Johnston, SC 29832, U.S. 803-275-0958 www.ksarborproducts.com</p>

Table 2. A ranking of survey responses by manufacturers of tree stabilization products and green industry practitioners regarding selection criteria for tree stabilization products and systems.

Criteria	Manufacturer response	Practitioner response
Short-term	Rapid and easy installation (34%) ^z	Immediate stabilization for root growth (33%)
	Cost-effective (25%)	Rapid and easy installation (23%)
	Immediate stabilization for root growth (22%)	Cost-effective (21%)
	Availability (13%)	Availability (14%)
	Safer and easier on the tree (6%)	Other—reduce vandalism, strength, aesthetics (9%)
Long-term	Ease of product removal (36%)	Allow taper development (31%)
	Safety (23%)	Trunk protection (25%)
	Trunk protection (18%)	Safety (23%)
	Allows taper development (14%)	Ease of removal (15%)
	Other (9%)	Other—reduce vandalism, species, aesthetics (9%)

^zPercent of respondents listing a specific criteria (manufacturer sample size = 12; practitioner sample size = 250).

Roads Agricultural Research and Extension Center (HRAREC) in Virginia Beach, Virginia, U.S., and the other at Riverview Farm Park in Newport News, Virginia. At both sites, all trees used were field-grown, balled and burlapped (B&B). In 2004, a third B&B research site was added at the U.S. Army Transportation Center, Fort Eustis, Virginia. At these first three sites, a 1-year stabilization period was evaluated. In 2006, a fourth B&B experiment was established at Virginia Tech's Urban Horticulture Center in Blacksburg, Virginia.

Realizing that an increasing number of landscape-caliper trees are being grown in containers, a second research plot was established at HRAREC in 2004 to evaluate container-grown trees with both 1- and 2-year stabilization periods. Manuscripts detailing the results of these stabilization research projects are currently being prepared.

The information contained in these various surveys, as well as this ongoing field research, should help arboriculture and urban forestry, as well as other practitioners such as landscape architects, develop or improve tree planting specifications relative to tree stabilization. By better understanding available products and systems, more educated decisions can be made that should translate into more successful tree establishment in the landscape.

Acknowledgments. This project was funded in part by the Tree Research and Education Endowment Fund, the Mid-Atlantic Chapter-ISA Frank S. Santamour, Jr. grant program, and the Virginia Urban and Community Forestry Assistance grant program.



LITERATURE CITED

- Appleton, B.L., and C.E. Whitcomb. 1984. Establishment of container-grown ornamentals. Proceedings of the Southern Nursery Association Research Conference 31:106–108.
- Burton, J.D., and D.M. Smith. 1972. Guying to prevent wind sway influences loblolly pine Growth and wood properties. USDA Forest Service Research Paper SO-80. 8 pp.
- Ellyard, R.K. 1984. Effect of root pruning at planting on subsequent root development of two species of eucalyptus. Journal of Arboriculture 10:214–218.
- Fulmer, J.P., and E.V. Jones. 1974. The effect of four transplant treatments on root growth of container-grown *Ilex cornuta* 'Burford Nana'. Proceedings of the Southern Nursery Association Research Conference 19:27.
- Gilman, E.F. 1997. Trees for urban and suburban landscapes. Delmar Publishers, New York, NY. 662 pp.
- Harris, R.W. 1969. Staking and pruning young *Myoporum laetum* trees. Journal of the American Society for Horticultural Science 4:359–361.
- . 1984. Effects of pruning and staking on landscape trees. Journal of Environmental Horticulture 2:140–142.
- Harris, R.W., J.R. Clark, and N.P. Matheny. 2004. Arboriculture—Integrated Management of Landscape Trees, Shrubs, and Vines. Prentice Hall, Upper Saddle River, NJ. 578 pp.
- Leiser, A.T., R.W. Harris, P.L. Neel, D. Long, N.W. Stice, and R.G. Maire. 1972. Staking and pruning influences trunk development of young trees. Journal of the American Society for Horticultural Science 97:498–503.
- Lilly, S.J. 2001. Arborist's Certification Study Guide. International Society of Arboriculture, Champaign, IL. 222 pp.
- Neel, P.L. 1971. Factors Influencing Tree Trunk Growth. Special Report, I.S.T.C. Research Project. 24 pp.
- Schuch, U.K., and J. Kelly. 2004. Alternatives for Tree Staking. AZ1359 Turfgrass, Landscape and Urban IPM Research Summary. University of Arizona, Tucson, AZ. 5 pp.
- Svihra, P., D. Burger, and D. Ellis. 1999. Effects of 3 trunk support systems on growth of young *Pyrus calleryana* trees. Journal of Arboriculture 25:319–324.
- Watson, G.W., and E.B. Himelick. 1997. Principles and Practices of Planting Trees and Shrubs. International Society of Arboriculture, Champaign, IL. 200 pp.
- . 2005. Best Management Practices—Tree Planting. International Society of Arboriculture, Champaign, IL. 41 pp.
- Whitcomb, C.E. 2006. Establishment and Maintenance of Landscape Plants II. Lacebark Inc., Stillwater, OK. 340 pp.
- Wrigley, M.P., and G.S. Smith. 1978. Staking and pruning effects on trunk and root development of four ornamental trees. New Zealand Journal of Experimental Agriculture 6:309–311.

Bonnie Appleton (corresponding author)
Professor
Virginia Tech
Hampton Roads AREC
1444 Diamond Springs Road
Virginia Beach, VA 23455-3315, U.S.
bapple@vt.edu

Carolyn M. Cannella
Former MS Student
Virginia Tech
Hampton Roads AREC
1444 Diamond Springs Road
Virginia Beach, VA 23455-3315, U.S.

P. Eric Wiseman
Assistant Professor
Virginia Tech
Department of Forestry
304 Cheatham Hall
Blacksburg, VA 24061-0324, U.S.

Alexis A. Alvey
MS Student
Virginia Tech
Department of Forestry
304 Cheatham Hall
Blacksburg, VA 24061-0324, U.S.

Résumé. Les produits et systèmes utilisés pour stabiliser les arbres lors de la plantation devraient être prescrits en se basant sur les conditions de site, les caractéristiques de l'arbre ainsi que les pratiques de plantation et d'entretien. Des méthodes alternatives à celles plus traditionnelles des tuteurs et des câbles d'ancrage dans le sol existent, méthodes qui consistent généralement à ancrer la motte plutôt que de supporter le tronc. Lorsqu'on évalue le besoin de stabiliser l'arbre lors de la plantation, un certain nombre de facteurs devraient être considérés, incluant le coût du matériel, le temps requis pour l'installation et l'entretien, la durée d'utilisation du produit ainsi que son aspect esthétique.

Zusammenfassung. Produkte und Systeme zur Stabilisierung von zu verpflanzenden Bäumen sollten anhand von Standortbedingungen, Baumcharakteristika und Pflanz-/Pflegeanforderungen beschrieben werden. Alternativen zu traditionellen oberirdischen Baumverankerun-

gen existieren und bestehen hauptsächlich aus Ballenverankerungen anstatt Stammverankerung. Wenn der Bedarf für Baumverankerung bei der Verpflanzung besteht, müssen verschiedene Faktoren einbezogen werden: Materialkosten, Zeitaufwand für Installation und Unterhaltung, Ästhetik und Einfügung in die Landschaft.

Resumen. Los productos y los sistemas utilizados para estabilizar a los árboles en el trasplante deberían estar prescritos con base en las condiciones del sitio, las características del árbol, la plantación y las

prácticas de mantenimiento. Existen las alternativas a la tradicional plantación con el tronco abajo del nivel del suelo y los métodos de soporte y anclaje. Sin embargo, generalmente consisten de productos que anclan la bola de raíces del árbol antes que soportar el tronco. Cuando se evalúa la necesidad para la estabilización en el trasplante, varios factores deberán ser considerados incluyendo costos de los materiales, tiempo requerido para la instalación y mantenimiento, y la persistencia de los productos en el paisaje, así como la estética.