# Propagating Trees for City Spaces©

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## INTRODUCTION

Trees grown conventionally and planted in city spaces typically experience high stress and a short life. A city environment is especially tough for trees. Exaggerated heat and wind, plus pollution, shading, and other factors all restrict leaf functions. Soils range from fair to poor to a mixture of construction debris with a bit of soil mixed in. Drainage can range from poor to extreme. The problem is often compounded by the ridiculously small space where trees are planted. This subject is reviewed in detail including many photos (Whitcomb, 2006a).

Planting trees in spaces with less than 2.8 $m^2$ (30 $ft^2$) of exposed soil surface (roughly the area of a sheet of plywood) leads to slow decline and death, even with the toughest species. Getting landscape architects and designers to provide adequate room for tree root development is comparable to dealing with the IRS (Figs. 1 and 2). The public continues to be enamored with planting trees in cities, yet appreciates little about tree requirements for survival and growth. Hence, if progress is to be made in this area, it will be up to the nursery industry to grow trees in such a way that they can better survive deplorable conditions, some of which include:

1) Insufficient space / volume for proper root growth.
2) Poor to terrible soils.
3) Drainage problems ranging from poor to excessive.

**Figure 1.** This dead tree had been planted in an extremely small space (note the pen) had little chance of surviving beyond the first year or two.

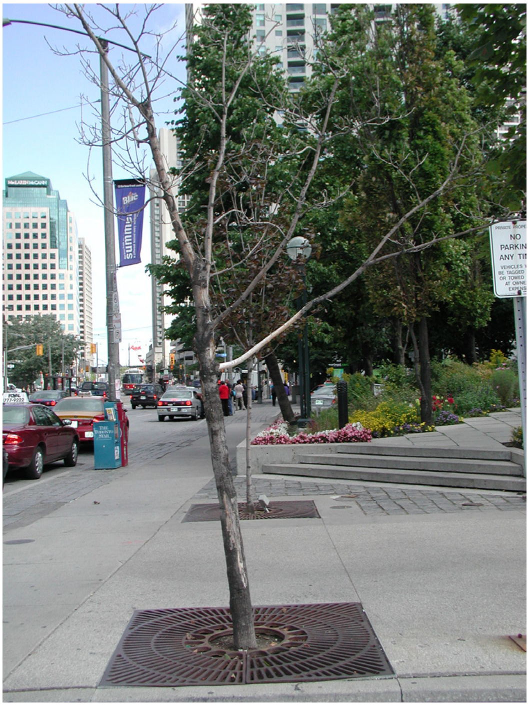

**Figure 2.** The dead tree in the foreground survived 5 years with minimal contribution to the city green space, while the group of trees in the background in a 12 × 18 m (40 × 60 ft) elevated bed had sufficient space for root growth, allowing the trees to function for a number of years.

**Figure 3.** After removal of all field soil, this bare-root 10-cm (4-in.) caliper ash had very few functioning roots; development of new roots must come from ends of cut roots.

**Figure 4.** When large roots are cut during harvest, new root production occurs mostly from the cut surface to within the first 2.5–5 cm (1–2 in.).

## ROOT SYSTEMS OF B&B TREES

A conventional field-grown, balled-and-burlaped (B&B) harvested tree has lost nearly 90% of its roots, while a portion of those roots is in the bottom half of the root ball (Fig. 3). To establish the plant after transplanting, new roots must first be produced from the cut surfaces of old roots (Fig. 4). Establishment therefore requires a two-stage process: (1) adventitious root initiation forms below the surface (periderm) of the cut and new root initiation from the pericycle (close to the vascular system), and (2) subsequent root extension or elongation. In this respect, establishment of B&B trees is similar to rooting of cuttings. Oxygen plays a crucial role in root primordia development and is the primary reason for using a more porous and well aerated mix at this stage. However, once root primordia are formed and begin to elongate, the new roots are no more or less sensitive to oxygen limitations than is typical of the species. This is why we routinely use a mix that is less well aerated and holds more water for growing plants on in larger containers. Marginal soils and limited aeration are major contributors of reduced root production of B&B produced trees planted in city environments, which leads to poor tree performance (Fig. 5). Improper handling of B&B trees also contributes to root damage and poor performance (Koeser and Stewart, 2008).

## ADVANTAGES OF SHALLOW ROOT SYTEMS

What is needed for trees planted in limited city spaces is a relatively shallow root system that is very fibrous and has active root tips poised to extend in all directions

**Figure 5.** (Left) The oak tree of about 10-cm (3.5-in.) caliper was dug with a 1.2 m (48 in.) spade with the bottom of the ball removed, reducing the ball height to 0.7 m (28 in.). (Right) Conversely, the 13-cm (5-in.) diameter oak was grown in a 0.6 m (24 in.) diameter × 0.3 m (12 in.) tall, knit fabric, in-ground container, and is supported on forklift tines to illustrate the difference in its root ball depth. The tree in the knit fabric container has many more roots closer to the surface, while the field-grown, spade-dug tree has fewer roots, with a substantial portion of roots at depths greater than the 0.3 m (12 in.) — reducing the trees survival and establishment after transplanting.

**Figure 6.** (Right) Air pruning the taproot 10 cm (4 in.) below the seed stimulates rapid production of horizontal roots. (Left) As long as the tip of the taproot remains active, secondary root development is suppressed.

**Figure 7.** (Left) Seeds planted in conventional plug trays or sleeves with solid sides develop a root system with the majority of root tips directed at the base by time of transplanting. (Right) Seeds planted in RootMaker® containers, which are 10 cm (4 in.) deep with a network of ribs, ledges, and strategically placed sidewall openings, develop a root system with root tips directed to grow radially as well as downward; propagation containers with only vertical or horizontal slots in the sides are only slightly better than solid sleeves.

immediately following transplanting. When active white root tips are present at planting, adventitious root initiation is not required, only root elongation of existing roots, which is much less sensitive to oxygen stress. Trees with fibrous root systems and active white root tips at transplanting are poised to quickly exploit the available soil volume and establish the tree. How long the tree remains a viable landscape plant is predicated by conditions of the planting site, volume of available soil, and post-plant care.

## DEVELOPING TREES FOR SUCCESSFUL SITE ESTABLISHMENT

To create trees with greatest likelihood for success in city spaces, it is important to follow the following steps:

For trees grown from seed, air-prune the tip of the taproot at a depth of 10 cm (4 in.). The objective is to stimulate root branching along the 10 cm (4 in.) vertical axis of the taproot and create a more horizontal root system (Fig. 6). This type of root system is the norm in nature for older trees but is slow to develop because the taproot suppresses horizontal (lateral) root production for several years. A fibrous, horizontal root system cannot be accomplished by using cone- or plug-shaped containers, since secondary roots are directed downward in a congested mass (Fig. 7) (Whitcomb, 2001 and 2003).

Propagating trees in RootMaker® containers provides benefits only if the root branching process is continued. Trees propagated in RootMaker® containers then planted into conventional containers quickly deteriorate to circling roots and subsequent root structural problems (Fig. 8).

To maximize fibrous root development, follow the 10-cm (4-in.) rule when shifting seedlings or cuttings to the next size (Whitcomb, 2003 and 2005). For example,

**Figure 8.** These two trees were propagated in 18-cell RootMaker® containers then transplanted into a RootMaker® 11.4 L (3 gal) (left), or a conventional container (right). In the RootMaker® container, roots follow the sidewall arc 45 degrees before being stopped and directed into an opening for air-pruning. The large circling roots in the conventional container, and disrupting roots at planting provided no benefit (Appleton, 1993; Weicherding et al., 2007; Whitcomb, 2006).

the RootMaker® 18-cell propagation cavity is 21 $cm^2$ (3.3 $in.^2$). A RootMaker® 3 gal is 26 cm (10.3 in.) in diameter at the top, while the 5 gal is 33 cm (13 in.). The distance from side of the 18-cell propagation container to the side of the 3-gal is 9 cm (3.5 in.) and 12 cm (4.7 in.) with the 5 gal, so both fit the criteria. The goal is to air-prune roots growing horizontal at the optimum distance in order to develop secondary roots back to the face of the propagation container. [Review Fig. 6 and turn the seedling root system 90 degrees to grasp the desired benefit (Whitcomb, 2005).] If a seedling or cutting is grown for a period in a 3-gal RootMaker®, bumping-up to the next ideal container size increase would be 46–51 cm (18–20 in.) or roughly a 15-gal. Beyond the second step using the 10-cm (4-in.) rule, an extremely fibrous root system is created and a container size increase of 15–20 cm (6–8 in.) is acceptable (Fig. 9). Multiple small roots secure and stabilize trees more effectively than a few large roots (Dupey et al., 2005; Genet et al., 2005; Smiley, 2008; Whitcomb, 2003).

The only limitation to size of tree that can be grown using the RootMaker® system is the imagination (Fig. 10). White RootTrapper® containers are available in sizes up to 416 L (110 gal) and RootBuilder® containers are a matter of choice up to 1136 L (300 gal) or more. Transporting shallow containers is also easier than field grown, B & B trees because of the much lighter weight (Fig. 11).

**Figure 9.** A field of live oaks and cedar elm of optimum size for city planting in 227-L (60-gal) RootTrapper® containers; the white sidewall prevents root death from excess heat and the fibrous inside traps root tips and stimulates root branching (Whitcomb, 2006b).

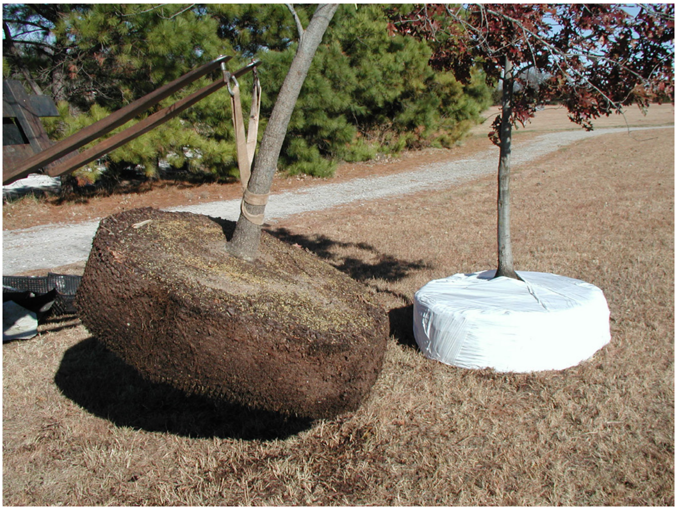

**Figure 10.** (Left) The tree was grown in a RootBuilder® container of 1136 L (250 gal), and the plastic sidewall of outward projections for effective air-pruning was removed. (Right) The root ball will be covered with white stretch wrap to minimize drying during transporting.

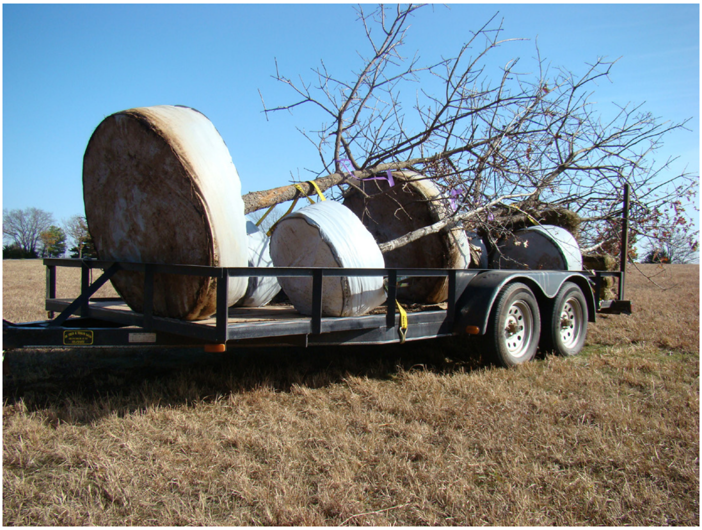

**Figure 11.** Because the containers are much lighter compared to a conventional, field-grown B&B root ball, large trees are easier to load, transport, and handle.

**Figure 12.** This tree was propagated in a RootMaker® propagation container, shifted to a 11 L (3 gal) for additional root pruning before planting in the field. It was harvested with a 1.3 m (52 in.) spade before washing the root system free of soil. Trees grown in this sequence develop fibrous roots in the top 30–36 cm (12–14 in.) which greatly improves chances of good tree performance in a city space.

**Figure 13.** This tree was grown in a 0.6-m (24-in.), 114-L (30-gal) container prior to being planted in the landscape. After 30 days, a backhoe was used to excavate a cavity and soil washed away to expose new root production; the pen near the base of the stem is for scale.

By growing trees using the RootMaker® system during propagation and 3-gal size, and then planting in the field, a similar fibrous root system can be created (Fig. 12). At harvest, networks of fibrous roots are in the upper 30 cm (12 in.) of soil. This allows the bottom of the tree spade dug ball to be made much shallower and shipping weight reduced by 40% or more without significant root loss to the tree.

## SUMMARY

Utilizing the container methods outlined in Steps 1 to 4, or field production in Step 5 helps develop a tree with a root system best poised to survive and utilize limited, city transplanting cites. The key is developing a fibrous root system with many active white root tips for enhanced survival and establishment (Fig. 13). Further information can be found at <www.lacebarkinc.com> or <www.rootmaker.com>.

## LITERATURE CITED

**Appleton, B.L.** 1993. Nursery production alternatives to eliminate circling tree roots. J. Arbor. 19: 383–388.

**Dupuy, L., T. Fourcaud,** and **A. Stokes.** 2005. A numerical investigation into factors affecting root architecture on tree anchorage. Plant Soil 278: 119–134.

**Genet, M., A. Stokes, F. Salin, S.B. Mickovski, T. Fourcaud, J.-F. Dumail,** and **R. van Beek.** 2005. Influence of cellulose content on tensile strength of roots. Plant Soil 278:1–9.

**Koeser, A.,** and **J.R. Stewart.** 2008. Effects of transplanting on growth and survival of nursery stock. HortScience 43:1239.

**Smiley, T.** 2008. Root pruning and stability of young willow oak. J. Arbor. 34:123–127.

**Weicherding, P.J., C.P. Giblin, J.H. Gillman, D.L. Hanson,** and **G.R. Johnson.** 2007. Mechanical root disruption practices and their effects on circling roots in root-bound *Tilia* and *Salix.* J. Arbor. 33: 43–47.

**Whitcomb, C.E.** 2001. Seedling development: the critical first days. Comb. Proc. Intl. Plant Prop. Soc. 51: 610–614.

**Whitcomb, C.E.** 2003. Plant production in containers II. Lacebark Inc., Stillwater, Okla.

**Whitcomb, C.E.** 2005. Use the 4-inch rule to maximize root branching. NMPro April 2005. 21(4):69–70.

**Whitcomb, C.E.** 2006a. Establishment and maintenance of landscape plants II. Lacebark Inc. Stillwater, Okla.

**Whitcomb, C.E.** 2006b. Temperature control and water conservation in aboveground containers. Comb. Proc. Intl. Plant Prop. Soc. 56:588–594.