Growing Trees for City Spaces

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A city environment is especially tough for trees. Exaggerated heat and wind, generally poor soils only a few inches deep with limited drainage, plus pollution, shading, and other factors make it especially challenging. Trees in general do poorly in city planting spaces for two basic reasons: failure of nurseries to develop tree root systems better suited to these conditions and insufficient space/ soil volume for root growth to sustain the tree following initial establishment.

Persistent poor performance of conventionally grown trees in city spaces suggests a new approach is needed. It is now possible to grow trees in such a way that likelihood of success immediately following planting is assured in all but the most deplorable locations. Further, if trees are provided additional space, the appearance and functional lifetime can be increased substantially.

Planting trees in spaces with less than 30 square feet of exposed soil surface typically provides only a brief glimpse of green in the plant top, then a slow decline and death even for the toughest species (Figures 1 and 2). It is far better to plant one tree with a shallow, fibrous root system in locations with space of at least 50 square feet or more instead of three or four trees with inadequate space.

Figure 1. These trees were planted into openings about four by five feet. But once planted, concrete units were positioned over most of the surface leaving an exposed soil area of only about 16 by 20 inches. Scale is provided by the ball pen on the concrete.

Figure 2. Contrast the trees in the foreground that are dead or near dead with about 16 square feet each versus the trees in the background that have grown well and are contributing to the city environment with about 400 square feet each. During the time the background trees have been growing and contributing to the landscape, those in the foreground have been replaced --- twice.

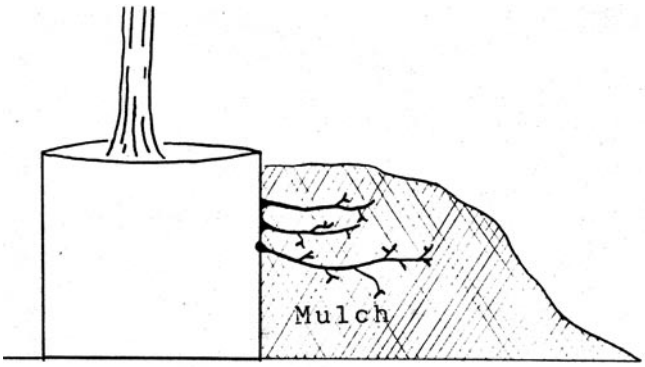
Conventional Production.

Trees grown conventionally in field nurseries typically have no roots in the top four to eight inches of the soil ball at time of planting into the landscape. This is due to a combination of deep planting initially of bare root stock and soil moved up and around the stem during cultivation. Bare root liners typically have a very poorly branched root system to begin with. To establish the tree, production of new roots out into the surrounding soil must occur. With recently harvested balled-in-burlap plants, new root buds must first be initiated at the cut face of old roots. But this is a very oxygen-dependent process. It is only after initiation that root extension begins in whatever direction the old roots were oriented. Once initiated, roots are typical of the species in general and more tolerant of poor aeration (Figures 3 and 4). A classic example is that of bald cypress, *Taxodium distichum*, which will grow in swamps. But, plant a bald cypress that was dug balled in burlap in an area where soils stay wet and oxygen is limiting and the tree will die. It is only after establishment and acclimation to the site that bald cypress will tolerate flooding.

Figure 3. The oak tree on the left has a three inch stem diameter and was dug with a 44 inch tree spade. The soil ball weighed an estimated 950 pounds. Cut root ends were found from about four inches below the surface to the bottom which was 28 inches below the original field soil surface. The tree on the right was harvested in a 24 inch knit fabric container about 12 inches deep (RootMaker Products Co.). Stem diameter was 5.2 inches and the soil ball was estimated at 280 pounds. Roots grow out and through the knit fabric sidewall while quite small. However, as root diameter increases, root functions are restricted outside the fabric wall and branching and energy accumulation occurs inside the container. Roots cannot penetrate the bottom of the knit fabric container but are instead tips are trapped which further forces roots to branch and grow horizontally.

Figure 4. Roots cut during harvest must first initiate root buds at or very near the cut surface. This process is very oxygen dependent, much like rooting a cutting. This is why it is important to have roots present near the soil surface at time of planting, especially on poorly drained sites. Once new roots begin to extend from the cut surface, they are typical of the species in terms of oxygen requirement.

The least desirable situation results from trees harvested balled-in-burlap and held above ground surrounded by mulch (Figures 5 and 6). Many roots are typically produced at the cut face of old roots because the mulch is well aerated. However, roots produced at the cut face of old roots consume energy but extend out into mulch material containing few nutrients. Further, these roots are mostly or entirely lost during transplanting. Following planting, new roots must again be initiated only under less favorable conditions of aeration and with fewer energy reserves in root tissues.



Figures 5 and 6. Trees harvested balled in burlap and surrounded by mulch typically produce substantial roots out into the well aerated mulch (drawing). However, when the mulch is moved away all or nearly all of the fine new roots are dehydrated and lost. This substantially weakens the tree, plus new roots must again be produced only under much less favorable conditions.

Maximize Utilization of Soil Volume.

Limited space for root growth in city landscapes functions similar to growing plants in containers. With experience and experimentation it has become clear that a tree will grow and remain healthy in a given volume of container growth medium for a limited period of time. With smooth walled conventional containers, roots become concentrated and congested against the inner sidewall with little root exploration of the central volume of the container. Once that volume is exploited, root exploration and nutrient mining is restricted and the tree begins to stagnate and decline. On the other hand, health and vigor can be retained far longer when a tree starts out with a fibrous root system and roots are stimulated to branch and never allowed to circle and become congested. This allows roots to fully utilize the limited volume available.

Differences among Containers.

In order to grow trees best suited to city spaces air-pruning of the taproot must occur with a few days following seed germination. When air-pruning occurs about four inches below the seed, secondary and more horizontal roots form along the vertical axis of the very short, young, taproot (Figure 7). The key is to maintain roots mostly in a horizontal position with continued branching. This is not an abnormal situation. In nature, mature trees end up with the bulk of their roots horizontal and in the upper 8 to 12 inches of soil. However, this occurs over a period of many years and after dominance by the taproot has been lost.

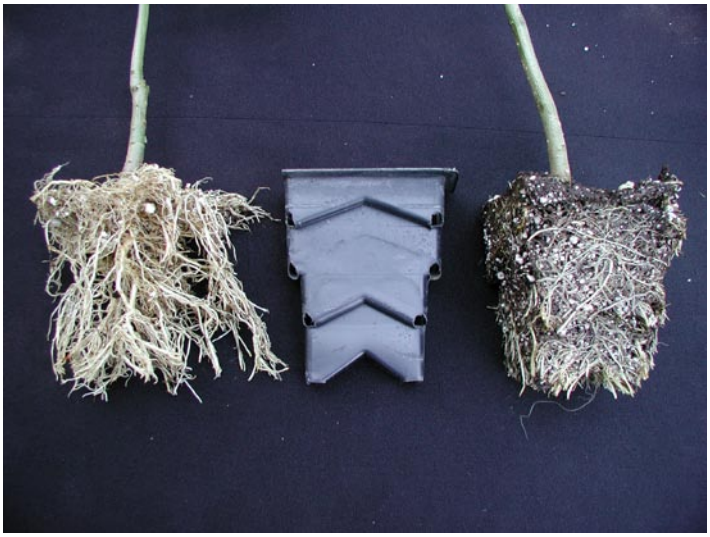


Figure 7. Air root pruning of the taproot four inches below the seed stimulates many horizontal roots. This is because of the very young age and responsiveness of root tissues. The challenge has been in keeping the secondary roots growing horizontally and avoiding root circling and congestion as occurs in smooth round containers. The root ball on the right is as it appears following removal from the 18 cell RootMaker II container. The root system on the left is after the growth medium has been washed away.

When catalpa trees were grown in identical white containers but one was lined with smooth plastic while the other had the capacity to trap root tips and stimulate root branching, (RootTrapper®, RootMaker® Products Co.) root development was very different following transplanting (Figures 8 and 9). Having roots poised to grow horizontally from most of the vertical side of the root ball has distinct advantages but especially in restricted growing spaces.

Figure 8. Roots in the smooth walled container grew out, contacted the sidewall and grew downward. (left) However, roots in the RootTrapper® container grew out contacted the sidewall, the tips were trapped and forced to branch. When the container was removed, only white root tips could be seen (right).

Figure 9. The catalpa trees in the seven gallon containers shown in Figure 8 were transplanted into 30 gallon containers and allowed to grow for 15 days. Note that with the smooth sidewall container, most roots grew out from near the base of the container sidewall and few were more than four inches long (left). With the RootTrapper® container, roots grew out similarly from near the surface to the base of the sidewall and most roots were about 11 inches long. (right).

Strong, healthy trees with fibrous root systems, six inch stem diameter and 12 to 16 foot tall crowns can be grown in 100 gallon RootBuilder® or RootTrapper® containers (Figure 10). These trees have a very fibrous root system with most roots oriented to grow horizontally with a modest number poised to grow downward (Figure 11).

Figure 10. Shumard oak trees in 100 gallon RootBuilder® containers in the foreground and 100 gallon RootTrapper® containers in the background, ready for landscape installation.

Figure 11. When mix is washed away from a portion of a root system grown from start to finish in the RootMaker® system, masses of fibrous roots are exposed. The skeptic believes that a few large roots are essential to keep the top of the tree erect, however, which is stronger a ½ inch diameter steel rod or a ½ inch diameter braided steel cable?

Roots grow where conditions are favorable. If aeration is poor and roots can only function in the upper four to six inches of soil in a city planting site, that may be enough to sustain the plant until drainage progresses and allows root growth to a greater depth.

Trees grown with fibrous root systems and active white root tips at time of planting have a much greater likelihood of success in restricted city spaces. The fibrous root system can immediately begin to exploit any favorable soil volume that exists. However, a fact of life is that at some point, volume of soil suitable for root exploration becomes the limiting factor and tree decline begins just as occurs in a container. However, trees grown with fibrous shallow root systems have the capacity to function well in restricted city spaces much longer than conventional field grown trees.