The 4-Inch Rule:
Or
How to Maximize Root Branching in Containers

Carl Whitcomb, Ph D
Lacebark Inc. 2104 North Cottonwood Road, Stillwater, OK 74075

Anyone that has ever pruned shrubs or trees to make a hedge has experienced the '4-inch rule'. It has long been known that when a twig or branch is cut, branching occurs, but did you notice where? Typically from the point of the pruning cut and extending back about **4 inches**. Allow the numerous branches produced as a result of the first pruning to grow out 4 to 6 inches then prune again and more branching occurs. **Branching occurs as a result of removal of the terminal bud, and the hormone that suppresses branching** (also known as apical dominance). What has been known only in recent years is the fact that **the 4-inch rule applies to roots as well**. This is especially dramatic with young roots that are the below ground counterparts to the twigs pruned to create a hedge. As roots grow older they become less responsive to pruning just as occurs with larger limbs and branches.

Root tips exert an apical dominance just like twigs. With roots, the white tip is most responsive and when air-root-pruning occurs at the proper location, secondary roots typically begin to form quickly and within 3 to 5 days the 4-inch rule is obvious. By contrast, in nature the tip of a taproot extends downward until conditions become unfavorable (rock, hard subsoil, lack of oxygen, water table, etc.). Only when the tip of the taproot stops growing or dies does secondary branching occur, but by then the tissues just beneath the soil have matured and few branch roots are produced on most species. As a result, only a fraction of the secondary roots form in nature compared to when the tip of the young taproot is air-pruned in a container at a point about four inches below the seed (Figure 1). Horizontal roots respond to the 4-inch rule as well. However, the 4-inch rule does not apply to roots that extend out to the sidewall of smooth conventional containers and circle. The exception is when sun hits the sidewall and kills the roots, which results in heat-pruning. Then the 4-inch rule does apply from the point of root death back around the container.

Figure 1. Young tissues are much more responsive to air-root-pruning compared to older tissues. These two oak seeds are the same age since germination. The one on the left continues downward extension of the taproot. The one on the right was air-root-pruned 4 inches below the seed, has already produced many secondary branch roots, plus the top has begun to develop.

Have you ever noticed that when a plant is shifted from a small container to an overly large container that the root system is slow to develop to the point where the root ball is firm and you can no longer see the root system 'flex' when the wind blows? This can result from circling roots and root-bound conditions in conventional containers (Figure 2). It can also result because up-sizing exceeded the 4-inch rule, and substantial 'extra' time in production is required. The plant may have grown to market size, yet a sale was missed was because of the 'flex' in the root system.

Figure 2. Circling roots and root-bound conditions can prevent proper anchoring and establishment in a larger container. It can also occur when the distance from the side of the smaller container to the side of the larger container exceeds about four inches.

It is important to note that the 4" rule applies primarily to plants grown in containers. Why? Because root tips can extend aimlessly through the porous container growth medium with little resistance and as a result, little natural branching occurs. By contrast, root tips growing through most field soils experience much more resistance to root extension and as a result, root branching is much greater (the exception would be extremely sandy soils).

Therefore, to develop the most fibrous root system depth of the propagation container should be about 4 inches deep and no more than 8 inches wide. To make a propagation container 8 inches wide consumes far too much space, therefore a container 4 inches deep and 2 "to 4" wide is the practical optimum. When transplanting from the RootMaker® propagation container, respect the 4-inch rule in order to maximize root branching. This means that RootMaker® liners should not be planted into containers larger than approximately 10 to 12 "diameter (2.5 or 4"root ball + 4" on either side).

It is important to note that the 4-inch rule DOES NOT compensate or overcome the problem of leaving plants in a given container size too long. RootMaker® air-root-pruning containers stimulate extensive root branching, but the advantages do not last indefinitely -- that is, root branching increases and increases, reaching a maximum, then, if transplanting does not occur, benefits begin to DECLINE. This occurs because there is a limited amount of space in any container and as that space is filled with roots there is little space for new root development. Plants can run out of space and stagnate, even though there is no root circling. The practical solution is to transplant in a timely fashion and when the plant needs to be transplanted, not when you get around to it. (Figure 3).

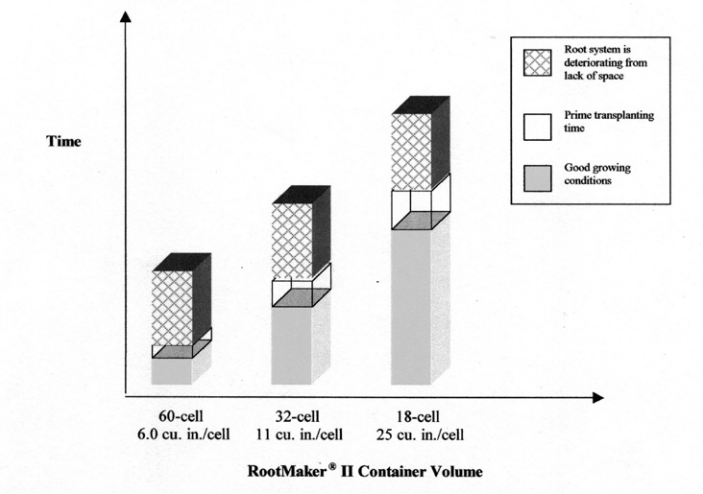

Figure 3. After a certain amount of time, which varies due to growing conditions and species, the root system of a plant will branch sufficiently to exploit the volume of a RootMaker® container and growth will begin to slow. Propagation containers are more sensitive than larger containers. For each container size, there is a time of good growing conditions (gray bar), then a 'window' in which the plant should be transplanted to a larger container (clear bar) in order to prevent stagnation (cross-hatched top bar).

By utilizing the 4-inch rule, and root-pruning containers, root branching is maximized throughout the growth medium, roots have maximum access to nutrients and water, which in turn stimulates top growth and improves plant quality. Combine the 4-inch rule with alert and timely transplanting from one root-pruning container to another and plant growth and quality of both tops and roots takes a giant step forward. Figure 4).

Figure 4. The root ball on this 3.5 inch stem diameter lacebark elm was cut in half using a chain saw. The tree was propagated in an original RootMaker® 4-pack propagation container to stimulate root branching, then grown in a RootMaker® 3-gallon (10.5 inch top diameter) for one year, (Note root mass marked by two white labels showing bottom of 3-gallon root system), then grown in a 15 gallon RootBuilder® container (18 inch top diameter) for 1.5 years. Note the complementary effect of each container size with the next to create an extremely fibrous root system.