WHY LARGE TREES ARE DIFFICULT TO TRANSPLANT[1]

by Carl E. Whitcomb

Abstract: Southern magnolia trees from 1 to 5 inch stem diameter were evaluated for total stem surface area. The square inches of stem surface area show that a one inch diameter magnolia has approximately 580 square inches whereas a 3 inch tree has 5,200 square inches and a 5 inch tree has in excess of 25,000 square inches. This emphasizes the importance of stored carbohydrate reserves in the stems and roots prior to transplanting. The larger the tree the more critical the stored reserves and the demand for stored reserves immediately following transplanting. A schematic diagram of the sequence of events following transplanting is included.

The demand for large trees following construction and grading continues to increase. In many instances 2 to 3 inch diameter trees are not of acceptable size to the client. On the other hand, landscape contractors and nurserymen have observed that large trees transplanted by tree spades generally perform poorly.

Preaus and Whitcomb (3) studied tree spade transplanting techniques and found that when tree spade dug trees were planted in a larger hole they grew much better than when tree spade dug trees were planted in a hole dug by the same tree spade. They concluded that the superior growth of the trees following transplanting was due to the aerated soil around the root ball, thus providing a better environment for the development of new roots. Bridel and Whitcomb (1) evaluated several techniques to fill the void between a tree spade dug tree and a tree spade dug hole. They found that tree growth in the larger planting hole was superior in all cases.

These studies show that a well aerated soil around the root ball of a tree following transplanting can assist subsequent growth. However, this benefit cannot compensate for stress incurred at time of transplanting especially the stress incurred when transplanting large trees.

In order to better understand the stress incurred by large trees following transplanting, a study was conducted with southern magnolia *Magnolia grandiflora*. The trees ranged in size from 1 to 5 inch stem diameter measured 4½ ft. above the soil. The diameter and length of each limb on each tree was measured and grouped according to size in ½ in. increments. By multiplying the stem diameter (rounded to the nearest ½ inch) of each ½ inch increment x π(3.1416) the circumference of the stem was obtained. By multiplying this value times the number of linear inches of each ½ inch size class, an estimate of the total stem surface area was obtained. For example, a one inch diameter tree that had 68 inches of stem one inch in diameter and 236 inches of stem ½ to 1 inch in diameter would have 1 x 3.1416 x 68 = 213 square inches of stem surface area on the 1 inch diameter branches and 0.5 x 3.1416 x 236 = 370.5 for a total of 584 square inches of branch surface area. In this study, all branches below ½ inch in diameter were not considered. Ten trees in each ½ inch size class (based on trunk diameter) were measured for a total of 90 trees.

Most of the cells in a woody tree or shrub are dead. However, the cambium and adjacent zone of cell division constitutes a layer of very active living cells surrounding all stems and roots of all dicots (most woody landscape plants except the palms). On either side of the cambium is a zone of young and active living cells, on the inside xylem cells and on the outside phloem cells.

Regardless of the thickness of this layer of living cells, when the branch surface area is plotted proportionate to the size of a particular kind of tree, one begins to gain an appreciation for why the larger the tree the greater the stress following transplanting. As the stem diameter of a tree increases from one to three inches the stem surface area of living cells increases from 580 to 5,200 square inches. (Figure 1). This is more than a 50 fold increase in the surface area of living cells.

This finding in itself is striking. However, consider that there is a priority of distribution of carbohydrates within a woody plant; flowers, fruits, leaves, stems and roots. In other words, if flowers

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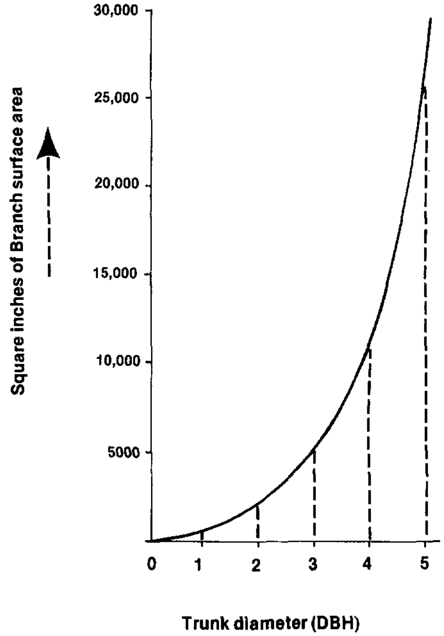
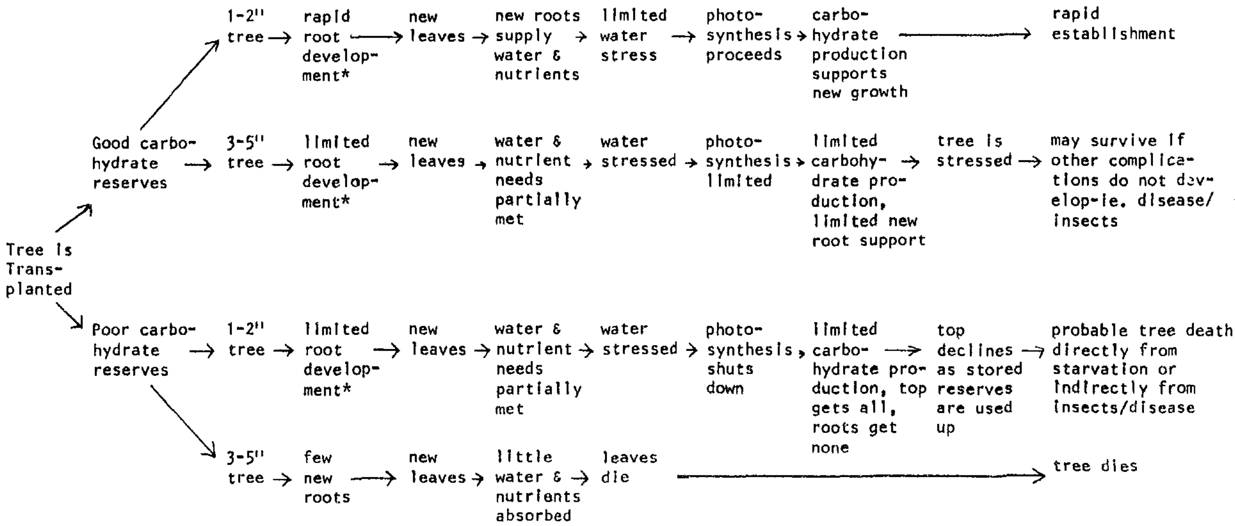


Figure 1. The square inches of branch surface area increase dramatically as trunk diameter of the tree increases.

and developing fruits are present on a tree they will preferentially receive carbohydrates at the expense of other plant parts (2). On the other hand, if no flowers or fruits are present, the leaves utilize the carbohydrates manufactured with any excess being translocated to the stem. If there are sufficient carbohydrates manufactured by the leaves to meet the needs of all leaves and stems, some are translocated to the root system. More and Halevy (2) observed that with a rose plant in full sun, 82% of the carbohydrates produced went to young shoots, 13% went to other above ground plant parts and only 4.3% went to the root system.

When one considers a 3 to 5 inch tree recently transplanted with a substantial reduction in roots, the problem becomes more clear (Figure 1). Unless leaves and/or stored carbohydrates in the stems have the capacity to meet the needs of all leaves and all living cells in the stems, the roots receive little or none for the initiation of new roots. Thus new root growth is dependent on stored reserves in the roots. Therefore, the need for a good balanced nutritional program for the tree



*assuming a well aerated soil with good moisture and a reasonable supply of nutrients.

Figure 2. Probable sequence of events following transplanting of trees with or without good carbohydrate reserves and of small or large size.

prior to transplanting which will build the stored reserves in the stems and roots. If only a few new roots are initiated rapidly following transplanting, the leaves become stressed for water and nutrients and thus carbohydrate production is greatly restricted. This in turn further restricts root growth which in turn places a greater stress on the leaves and thus the sequence of events that will ultimately lead to the death of the tree (Figure 2). On the other hand, the carbohydrate needs of the living leaf, stem and root tissues remains more or less constant.

This emphasizes the importance of stored carbohydrate reserves in the stems and roots prior to transplanting. This study shows that the larger the tree the more critical the stored reserves and the demand for stored reserves immediately following transplanting.

The work by Preaus and Whitcomb (3) and Bridel and Whitcomb (1) emphasizes the importance of well aerated soil around the root ball following transplant to encourage rapid root growth. A larger planting hole at time of transplanting will probably not increase the survival of trees with low carbohydrate reserves, however, it should assist new root development of trees with adequate carbohydrate resources and reduce stress.

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ABSTRACT

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An efficient and accurate street and park tree management plan is composed of several parts, varying in degree of detail and implementation according to the characteristics of the individual municipality or governmental agency being considered. Public policy regarding planting and maintenance must concern itself with both the trees within public lands and rights-of-way, and with trees and planting sites adjacent to or impacting upon public safety and vegetation within public areas. Ideally, performance of planting, maintenance, and removal of public trees, or to public trees within the legal control of the municipality by other than the municipal forestry agency, should be by permit and inspection only. An inventory of existing urban trees and available planting sites is the foundation of an efficient street and park tree management program. A very few species and cultivars, 20 to 30 or so, will actually be well suited to an individual municipality's conditions. Within the limitations of almost universally inadequate budgets, priority maintenance needs must be identified first. Maintenance can be accomplished by staff and/or by contractor. The urban forest manager's most important job is to nourish a close liaison between the public and commercial entities served.