Transplanting Stress - A View from the Plant's Perspective

by Gary L. Koller

Transplanting, a horticultural process as old as civilization, is generally misunderstood and often results in the loss of many beautiful or valuable plants. This is due in part to the fact that many people disregard the living aspect of the plant and treat it as they would a piece of furniture. Even under the most optimum conditions, the first year is full of great hazards for the newly transplanted specimen. Some of the problems it may encounter and some guidelines are discussed below.

Root Loss

Roots are part of the life support system of the plant and function in the uptake of water and minerals, while providing anchorage and support for tall growing woody specimens. During transplanting the components of this vital system often are brutally hacked, mangled, and reduced so that little remains except thick, woody segments shorn of the tiny, actively growing root hairs essential to moisture and nutrient absorption. Since these root hairs also secrete substances aiding the movement of the root into new soil areas, their regeneration is extremely important. Anything that slows this recovery retards the ultimate growth of the plant.

Minute fungus organisms collectively called mycorrhiza often live in association with the root hairs and assist with water and mineral uptake, possibly even synthesizing materials beneficial to the larger host. This symbiotic relationship is not well understood, but may affect the success of a plant in its new location. It is believed that many plants known for transplant difficulty are lost because the proper soil organisms are lacking.

Old horticultural literature often suggests that soil from the old planting location be incorporated into the soil of the new; this would inoculate these microorganisms into the new site. The new soil should be favorable in terms of composition, aeration, pH, and moisture to encourage the fungus to grow and thrive. At present the state of horticultural science has not provided techniques that we can adapt to our home plantings to increase success associated with the microorganisms.
An abandoned plant from which the container has rotted away. Note that the tree rooted through the bottom. With time, erosion may wash the soil from the root ball and leave the upper surface exposed and vulnerable to mechanical damage. Photo G. Koller.
Wilting

The root system, even in the best transplant operation, is greatly reduced; on woody plants this loss must be compensated for by removing at least one-third of the growing vegetative shoots. Neglecting this essential step intensifies the following plant reactions: Preformed vegetative buds, based on the strength and vigor of the plant prior to moving, burst into growth. The plant immediately undergoes moisture stress because there are not enough roots to support the lush growth.

Generally a wilting plant is watered immediately and until the wilt symptoms disappear. What is not obvious is that this wilting causes internal physiological tissue stress that upsets the normal chemical activities of the plant. After a severe moisture stress it may take weeks for the chemical and hormonal balance to readjust so that normal growth may be resumed.

During the normal drought of late summer, newly moved plants generally undergo several periods of wilt and each subsequent occurrence requires a longer period of recovery. As a result of the chemical slowdown, fewer carbohydrates or food are elaborated in the foliage and less material is transported downward to support the growth of a healthy root system. The longer the root is deprived of its full potential food supply, the longer it takes for complete recovery.

Initial damage from lack of water is very insidious and the chemical reactions may slow down before the plant goes limp and droops; therefore it becomes important to supply additional water on a regular basis throughout the first full growing season and beyond depending on rainfall, soil conditions and vigor of the plant. Even if specimens seem to have recovered, the heat and drought of late summer necessitate this precaution.

Insects and Diseases

During the process of transplanting, many plant roots and branches may be cut or broken, creating wounds that allow the entry of disease organisms. In its new site the plant may undergo severe stress from the wind, reflected heat, and inadequate soil moisture. In such a weakened condition, it is particularly prone to the attack of insects as well. The quicker the specimen recovers and resumes full growth, the less likely the chance of these invasions.

Timing the Move

Bad timing seems to be the most frequent error the home owner makes in moving existing plants from one location to another. Most amateurs assume that the plant needs to be in leaf, but the stresses on the root system that are imposed by the lush foliage lessen the plant's chance of survival.
Plants that have been growing in naturally existing soil are most successfully moved when they are in a dormant or quiescent state. In north temperate areas this can occur at two seasons. The first begins any time after spring soil thaw and lasts until the plant begins active vegetative growth (the best rule is "the sooner the better").

The reason for transplanting as soon as the soil can be worked is that the plant produces the most active root growth when soil and air temperatures are low, and before vegetative growth begins. Research indicates that once top growth commences, root growth slows and in some cases halts. Early transplanting will allow maximum root growth to supply necessary water to unfolding leaves, stems and flowers.

The second transplanting season begins in late summer after all vegetative portions have expanded and the tissue has hardened off, therefore requiring less water. Fall transplanting may be most advantageous for those plants considered to be reliably hardy because it will permit active root growth in late fall and again in early spring before new vegetative growth begins. In the autumn it is considered optimum to await frost and defoliation of most deciduous plants. However, in northern areas where weather is severe and deep soil penetration of frost may damage semi-anchored plants, early transplanting prior to defoliation may be preferable.

At the Arnold Arboretum we begin moving needled evergreens in early September and try to accomplish this task before the latter part of October. During late October the first killing frost generally occurs, bringing active vegetative growth to a halt. As the soil and air temperatures go down, active root growth begins again and allows some degree of anchorage before frost penetrates the soil deeply. Additional root growing time can be achieved with the use of a thick basal mulch around the plants.

In northern areas with low winter temperatures and sweeping winds some plants should not be transplanted in fall. This group includes all broadleaved evergreens, any plant that is considered to be marginally hardy, and young, poorly rooted specimens.

Cold sweeping winds can dry out the evergreens which, even under ideal conditions, have problems with water uptake from frozen soils. Plants of marginal hardiness are prone to freezing; spring transplanting permits them to have a whole growing season to store carbohydrates for increasing winter hardiness. This additional growing time also benefits semi-anchored plants by allowing them to root fully.

The nursery industry has increased the planting season by growing plants in large containers or digging them with a soil ball and wrapping the soil with burlap. As a result it is now possible to install plants at any time during the growing season, but these modern methods have not reduced the need for good follow-up care.
The nursery industry is now digging trees and shrubs bare-root and potting them for an extended sales period. Occasionally a poor root system results, as in this young pine tree. Prior to purchase it is advisable to carefully remove a plant from its container and check along the sides and bottom of the root ball for adequate development. Photo: P. Chvany.
Most large trees are moved with a firm soil ball which reduces root disturbance, retains moisture from irrigation water, and increases transplant success. Photo. P. Chvany.
Soil Conditions

In the past most nursery plants were grown in natural soil occurring at the nursery site, then they were transferred to natural soil at the customer's house. Generally the soil was prepared to receive the plant by the addition of organic matter and drainage material, using some magical formula as a guide. What usually resulted was a soil aggregate that packed together like cement.

Soil preparation is essential and deserves careful attention. If the existing soil is well drained, it usually is not necessary to add drainage material. A large hole should be dug to loosen the soil and reduce compaction, thereby improving soil structure. In most instances it is advantageous to reuse the excavated soil as return fill. Before doing so, however, the soil should be amended with an equal volume or more of organic matter in the form of compost, leaf mold, wood chips, etc. It is scarcely possible to add too much. The organic matter loosens the soil particles, traps and stores water, and becomes the sponge that captures fertilizer and holds it for long term use by the plant. Because these functions contribute to quick root regeneration, the plant re-establishes more readily.

The soil should be firmly pressed around the plant's roots. Some of the excess may be used to form a saucer around the base of the plant so that water will soak into the proper area.

In many soils drainage is a problem and it becomes necessary to add sand, gravel or drainage pipes to allow for the movement of excess water. In amending the soil, enough coarse drainage material must be added to separate the fine textured soil particles that tend to pack together. Equally important is the incorporation of large quantities of organic matter.

Where drainage is a severe problem, it may be easiest to garden above ground level by using modified, well-drained soil to create mounds or raised beds. This permits free water to drain to the existing grade and away from the critical root zone.

A new soil problem has recently entered the picture. For some time nurseries have been using a lightweight, highly modified soil mix supplemented with time-released fertilizers as well as periodic applications of liquid or granular fertilizer. Plants are grown with supplemental light and watered very efficiently — a cultural combination that gives quick growth, develops good root systems, and produces saleable products in the shortest amount of time.

The trouble occurs when a lush, vigorous plant gets to the customer's yard where it is put into an inferior soil, is lucky to get any fertilizer, and is watered only when it displays severe wilt symptoms. I don't propose that the nursery industry change its growing methods, but we do need to look at what can be done to better assist the transplant at its new site.
This plant is well staked and its trunk is wrapped to prevent sun scald. But the planting demonstrates two major errors: The top of the tree was not pruned; a shallow saucer of soil to hold irrigation water was not provided. Photo: P. Chvany.
In preparation for planting, outer roots of a containerized pine seedling have been gently pulled away from the root mass so they can draw moisture from the larger volume of new soil. This procedure also helps the roots to make the transition from the artificial soil mix to the natural medium. Photo: P. Chvany.
It has been found that plants raised in light soil mixes have great difficulty growing roots into the existing soil substrate at the planting location. While some of the reasons for this are unknown, it may result from varying moisture conditions between the soil mix and the surrounding soil, or the creation of soil interface problems.

The artificial soil mix will hold a great quantity of water, but when it becomes totally dry it is difficult to rewet. When a plant is installed in a permanent location, it is usually set at the same depth as it was in the container so that the upper surface of the light soil mix is exposed to the air. A wick-like effect occurs and the artificial soil dries out much faster than the surrounding natural or amended soil. This creates a moisture stress in the soil mix and it may also shrink, causing a gap between the containerized root mass and the surrounding prepared soil.

To prevent this problem, check for root development after lifting the plant from its container, and eliminate all surplus soil mix in the area where there are few or no roots, using your finger or a mechanical device. If possible, loosen roots so that they can be pulled away from the mass. During this process the roots should not be allowed to dry out and a bucket of water should be kept handy for moistening the root ball. A portion of the topsoil also should be scraped away; this will be replaced with soil from the planting site after the plant is reset at its original depth. In planting, care should be taken to spread the loosened roots into the backfill.

Pruning

Pruning is essential to the transplant operation. People are usually hesitant to reduce the size of an expensive plant because they want an instant effect. As a result, they jeopardize the long term survival and health of the plant. The minimum that should be removed is generally considered to be one-third of the growing stems. This reduction accomplishes the following goals: It reduces moisture stress; invigorates the plant and directs more energy into fewer growing points, while stimulating the development of adventitious buds; provides the opportunity to shape and control growth by removing interfering or rubbing branches, dead wood, and lush vegetative growth. As a rule, the pruning should not be in the form of a crew cut which shears all stems back to the same level, but rather a selective thinning.

Equally important to top pruning is root pruning. Removing damaged and broken roots and making clean cuts on ragged edges encourages new growth to cover and protect these sensitive areas that are in intimate contact with soil-borne disease organisms. Root pruning also tends to make roots branch, which is especially critical in the success of tap-rooted plants such as oak, hickory and sassafras.
Staking

One factor that tends to retard root growth is lack of proper support. A newly planted tree or large shrub has a foliage mass that catches the wind and acts like a sail. In addition, the height of tall plants causes an instability due to imbalance. As the wind blows, these plants shift back and forth causing actual movement of the soil ball within the surrounding prepared soil area which is soft and porous. This slow movement and friction tears away minute but critical root hairs, slowing the recovery of the plant. To reduce the amount of sway, all large plants should be securely staked, but the binding should be loose enough so it will not girdle the stem.

Prolonged staking tends to weaken the stem and may lead to top-heavy plants. Normally, a windblown or windstressed tree develops additional wood fiber or support roots to offset or compensate for the stress. With rigid and prolonged staking this natural process is retarded and structural weakness may result. Consequently, it is important to stake the plant during its first full year to encourage the most rapid development; after that time it is equally important to remove the support.

Planting Depth

Most plants have adapted their root growth to soil levels most conducive to maximum growth. After transplanting, the prepared soil becomes compacted and the heavy plants settle down to a depth greater than that to which they were accustomed.

From observation it seems that a plant will adapt more quickly to slightly shallow planting rather than to being set too deeply. The only problem that may result from shallow planting is that the plant may be top-heavy and blow over. To prevent this, initial support or staking becomes critical so that the plant can sink new support roots.

Fertilization

Many people insist on fertilizing a newly planted specimen by applying chemicals to the bottom of the planting hole or mixing the material with the backfill. Often this causes more harm than good, for the chemicals easily burn or dehydrate sensitive young roots.

During the first growing season the plant may be assisted with an occasional application of a liquid or soluble fertilizer applied with the irrigation water. If the soil is extremely dry it should be well watered before the liquid fertilizer is applied.

Once the plant has been in place for a year and is somewhat established, it will benefit by supplemental granular fertilizer applied every second or third year to stimulate vigorous and healthy growth.
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Woody plants frequently are selected on the basis of their rapid growth and quick effect, but the owner subsequently provides no support for this vigorous growth in the form of supplemental nutrition. Slow growing trees and shrubs, generally the most successful over time, can be hastened into growth with periodic fertilization and in many instances will out-perform those rapid growing, unfertilized plants.

If commercial agriculturists operated without catering to the nutritional needs and water requirements of their crops, we would be unable to feed the present world population. Most ornamental plants struggle along on their own and are blamed if they perform poorly; more often it is we who are at fault. As their guardians we must attend to their needs so they will thrive and produce the lush growth that cools, and the brilliant flowers that brighten our world.

References


Planting and Transplanting at the Brooklyn Botanic Garden. A film which visually depicts the planting process. Available from the Brooklyn Botanic Garden, Brooklyn, N.Y. 11225.


