SUCCESSFUL TRANSPLANTING IS EASY

by William Flemer, III

One of the most serious financial drains in the nursery industry is the loss of plant material, at transplanting time. Plants which die in home owners' gardens erode the profits of garden centers and mail order nurseries. Even moderate transplanting losses squeeze the profit margins of wholesale nurseries engaged in field production, and many landscape contracting nurseries have faced bankruptcy because of excessive plant losses on big highway or municipal jobs. While there are plenty of articles and texts available on labor management and finance, and nursery conventions and short courses frequently feature talks and panel discussions on these and other important aspects of nursery management, transplanting problems are usually neglected. It is the purpose of this discussion to review the important techniques for successful transplanting because, if neglected, it is the largest hidden enemy of nursery profits. Elaborate pre-planning and the most efficient use of labor and machinery are all done in vain if a substantial part of the planting dies and has to be replaced, with a complete duplication of all costs of labor and materials. In fact, replacement on a landscape job can be more expensive than the original planting because the dead plants have to be individually located and very often the location of surviving plants bars the access of mechanical equipment for digging holes for the replacements.

When a plant is moved to a new location the parts above the ground are not markedly changed, except when a plant from a shady location is moved to the full sun. It is therefore largely the root system of a plant which is affected by the transplanting operation. In the case of a B&B plant, the roots are cut or shortened when the ball is dug. If a plant is moved bare root, the roots are shortened, and exposed to air and sun as well, to cause dessication. A container grown plant suffers the least shock at transplanting time, but even so its roots may be subjected to stressful conditions in contact with a wholly different soil type from that in which they were grown. It is therefore useful to consider what does *not* happen to the roots of a plant which is growing on without disturbance. To begin with, the roots do not dry out, even though drought conditions may be severe enough to cause the leaves to wilt. Conversely, except under unusual floods or improper growing locations, the roots do not become waterlogged and rot from excess moisture. Furthermore, except for unusual attacks by root weevils or underground rodents, the roots are all intact and lose none of their ability to absorb water and minerals. Successful transplanting therefore involves handling plants and in particular their root systems in a manner which most closely approximates the conditions of a plant which has not been disturbed by transplanting.

There are three methods of handling nursery stock at transplanting time; moving them in a bare root condition, digging them with a ball of earth (B&B), and planting out container-grown trees or shrubs. Each has its advantages and its drawbacks, so each should be considered separately from the others.

Bare root transplanting

This is historically the oldest method of moving trees and shrubs in the nursery industry and in forest planting. In pioneer times in our country, when the production of fruit trees was essentially the *only* nursery industry, all nursery stock was moved in a bare root condition. Even today, although substantial and increasing portions of nursery production are moved as B&B or container grown plants, there are advantages to bare root transplanting. To be sure it is impractical for transplanting conifers and broadleaf evergreens except in nursery production when special care and irrigation are readily available. It is practical and desirable for moving deciduous trees and shrubs during the dormant seasons. The one striking advantage is low cost. Shrubs and medium sized trees cost one third to one half as much when dug bare root as when they are dug with a ball of earth. The difference in the cost of digging

bare root plants as opposed to B&B has widened rather than narrowed in recent years because of the invention and improvement of specialized mechanical digging equipment. In digging shrubs, the same crew can easily lift ten times as many bare root plants as they can dig B&B in a normal working day. Similar differences apply to shade trees up to 2 inches in diameter, after which point the differential begins to narrow very rapidly. Similar or greater savings in transportation costs favor bare root plants over B&B plants of the same size. The same trailer can carry 8,000 bare root shrubs but only 800 B&B plants of the same size, and so as transportation costs escalate, this factor becomes increasingly significant. While bare root plants are ill adapted to garden center sales, it is no surprise that this method of handling is favored for municipal street tree planting, highway landscaping, orchard planting, and of course the mail order nursery business.

There is no question that bare root handling requires much greater care of plant material than is needed for B&B or container-grown plants. However in small sized plants there is one great compensating factor. If properly dug with adequate sized blades, a 6-8 foot tall bare root tree will have 4-5 times as large a root system as the same tree dug with the standard 18 inch ball. So also a 2-3 foot or a 3-4 foot shrub will retain far more intact roots than shrubs dug with the normal 10-12 inch ball used for these sizes. Thus, although digging the plant with a ball protects the roots from exposure and dessication, there are far fewer of them within the ball than would be on a properly dug bare root shrub of the same size.

One of the great nurserymen of the old school remarked that moving a plant B&B was merely a very expensive way of keeping the roots damp! Certainly, viewed from this perspective there are far cheaper and more efficient ways of preventing dessication. A series of steps is involved, starting at digging time in the nursery. Freshly dug plants must be brought into storage buildings as rapidly as possible. If, as in the case of nurseries with widely spaced fields, a long highway trip is involved, the load should be canvassed for the ride. Bare root plants should be sprayed with water as soon as they are unloaded in the storage building. Grading and bundling for sale should be done quickly when these operations are undertaken and large piles of bare root plants should not lie around untended for long periods in the grading room. Prolonged storage of bare root trees and shrubs is as much an art as it is a science. The successful cellar foreman must have as much of a "feel" for plants and their welfare as a successful propagator, for both are dealing with plants in an unnatural condition. Indeed it is far easier for a propagator during the soft wood cutting season to assess the condition of his charges than the cellar man, because cuttings show signs of wilting or leaf drop promptly, whereas plants in storage are very slow to show distress.

Storage humidity should approach 100% as closely as possible because undisturbed roots in the ground are at 100%. Excessive watering of roots is dangerous because if too wet, with water running off them, roots will decay and all is lost. Hand spraying the floors of the storage building, especially if they are cement floors and the use of the "mist blower" kind of humidifiers within the buildings both are effective in producing high humidity. The use of mist nozzles for long periods over piles of plants in storage or the aiming of mist blower humidifiers at them are risky because excessive moisture can rapidly accumulate and rot will set in on waterlogged roots and stems.

Cold is nature's fungicide, and storage temperatures of that ideal level of 33 degrees F (1 degree C) virtually eliminate Botrytis fungi, the scourge of storage plants. Some plants, like strawberries are now routinely stored at temperatures just below freezing without injury, and this technique has transformed what used to be a real problem plant in the cellar into one of the easiest to store. Much systematic research is needed to see which trees and shrubs also can safely withstand prolonged storage at below freezing temperatures.

The real danger period for bare root trees and shrubs normally occurs from when they are loaded on the customer's truck until they are planted in the landscape site or in his nursery. Bare root plants must be protected in transit from the nursery to the job site. Unless a closed trailer truck or van is used, this means that the pick-up or delivery truck should have plenty of heavy canvasses or heavy impermeable covers to protect

the load. It is incredible to see the contractor's trucks which all too frequently arrive at a nursery with a pathetic scrap of burlap or tattered little sheet of polyethylene intended to cover a big load of nursery stock, worth thousands of dollars.

Care on the planting site is equally important; too often a load of nursery stock is thrown off in a dry building and left to dessicate until planted. The benefits of care during planting are clearly illustrated by the methods of two landscape contractors in the East. Firm A hauls shrubs and trees to the planting crews in a closed trailer with a built-in mist system in its roof. Piles of stock awaiting planting are covered with tarpaulins. Firm B hauls stock to the job in open dump trucks. The stock is thrown off in piles at the planting sites early in the morning and there it lies, often in full sun and wind, until the planting crews get to it, perhaps late in the afternoon. Firm A has an incredibly low level of plant losses, an astounding profit margin, and has come to be the preferred contractor wherever invited prequalified bidders are solicited for profitable prestige landscape projects. Firm B struggles mightily just to remain alive and barely solvent. Unless they happen to plant a job in a wet humid spell of weather, their losses and subsequent replacements keep their profit margins at a subsistence level.

Transplanting B&B plants

There is no doubt that B&B trees and shrubs do not require the constant attention to prevent dessication which is necessary for bare root stock. The ball of earth is much slower to dry than exposed roots. However, because B&B plants will survive in spite of much greater neglect, heavy losses can occur in careless hands, both landscape contractors and garden center managers. Both broadleaf and coniferous evergreens are of course the most susceptible to losses from neglect, because their leaves or needles are constantly transpiring moisture and they can have passed the point of no return while still appearing alive and green to the inexperienced manager. Several years ago our local Woolworth store received a trailer load of small B&B evergreens for a special promotional sale. The plants were unloaded on the sidewalk and parking lot and there they sat without further care. The weather was unseasonably warm and windy as well. Dangerously dry when they arrived, they were all dead within 48 hours but the sale continued for two weeks. Finally the remaining plants were marked down to give-away prices, but all of them were a liability even as a gift. The whole incident was a disaster for everybody — supplier, store, and customers, and for our industry as well, because some of the latter sadly decided they did not "have a green thumb" and doubtless refrained from buying nursery stock in future years.

One might expect a harried 10 Cent Store manager to forget that evergreens need watering, but all too often a landscape contractor foreman, lulled by a false sense of security because the plants are B&B and it is early in the planting season, experiences crippling but avoidable losses. Firm C was fortunate enough to get a large airport planting job which involved several thousand 6, 8 and 10 foot Austrian Pines. The trees were delivered, but grading and topsoiling were unexpectedly delayed. The trees were unloaded and stored on the site and received no attention during the hassle over the planting site preparation delays. Daily watering with a spray truck or even the hydroseeder truck which was parked nearby would have saved the trees, but losses exceeded 90%, with attendant disaster for both the contractor and his unfortunate supplier.

B&B stock on top of the ground needs frequent checking to be sure the moisture content of the ball is adequate. In hot windy weather daily watering may be necessary. B&B plants are much easier to maintain for long periods if the balls are heeled in beds of sawdust, wood chips, bark flakes or other moisture-retaining materials. In garden centers, such beds should be above ground, not only to prevent the balls from becoming water-logged but also because the plants will appear larger to prospective customers. Lath houses or other shade structures make B&B stock easier to maintain and reduce the need for watering because water loss or transpiration through the foliage is much reduced by semi-shade. Similarly if planting is delayed on a landscape job, B&B stock benefits by being stored in a wooded area if it is available. In one case in the South, where an unexpected strike held up all work on a big job, a landscape contractor was able to keep

all stock safely alive and well almost throughout the summer in a wooded area through which he cut a couple of access roads. To his surprise, when he finally planted the stock in the late summer, far from an ideal time, losses were negligible because the B&B stock had had an opportunity to overcome the shock of digging and harden up on top of the ground. Needless to say his client was charged for the extra costs of maintaining the stock during the delay.

Just what is really involved in the process of "hardening up" B&B stock is not clearly understood, but the process does exist, and was well known to an earlier generation of landscape contractors. Many skillful landscape nuserymen deliberately dig stock for summer planting ahead of the planting schedule and hold it on top of the ground for a week or so before planting. A cool, shady place is ideal for such a purpose, and some firms have an area equipped with overhead mist lines which are activated by a time clock just as in a propagation area. If unrooted leafy cuttings can be kept alive until they root, B&B stock can benefit at least as much after being dug up in the active growing season. The only problem is to be sure that the misting periods are brief enough so that the earth balls do not become so thoroughly soaked that they collapse during handling and transportation to the planting site.

All reasonably experienced landscape nurserymen know that bare root plants should not freeze while out of the ground. Fewer landscapers realize that really cold weather can kill unprotected B&B trees and shrubs, since they reason that the ground in northern areas freezes solid in the winter without the slightest injury to species hardy in that area. What they do not realize, however, is that even though the ground is frozen hard, the actual soil temperature surrounding the roots in the ground rarely goes lower than 20 degees to 26 degrees F which is not injurious to the roots of most hardy plants. If a species' roots are injured at these temperatures, it will not survive in such cold areas anyhow. The situation is entirely different for B&B plants above ground in winter. If the air temperatures drops to 0 degrees or lower, the soil in the ball above ground will drop just as low because it is not protected by the buffering effect of the soil mass of the open ground and the heat radiating out from the inner earth. Trees like hollies, magnolias, and dogwoods, which have particularly cold-sensitive roots, are quickly killed above ground if the balls freeze up at air temperatures which drop below 20 degrees F. Whenever a nursery or a contractor is caught with B&B stock above ground in freezing weather, the balls should be heeled in and covered deeply with wood chip or sawdust. Far too often they are covered with a flimsy, loose layer of straw or hay, and prove to be dead when spring arrives.

One word of caution for growers and their customers alike. There are a number of makes of mechanical ball digging machines on the market today. Those in which the blades taper sharply inward to form a pointed ball, cut the roots of the tree to short at the very depth where most of them occur. Where mechanical digging is to be done, special care should be taken not to plant young trees too deeply when they are lined out for growing on. It is also helpful to cut the earth away from the rows of trees with a grading blade deeply enough so that a few surface roots are exposed, prior to using the mechanical digger. These measures will assure that a maximum of the roots are actually preserved within the ball and not cut off unknowingly, so that the end product is a beautiful ball in its wire basket containing what is already a dead tree even though the bark is still plump and green. This problem is most acute with a 24 inch ball and becomes progressively less serious as the ball size increases.

It should not be necessary to remind landscapers and nursery stock jobbers that B&B plants should be unloaded with care. However, horror stories occur frequently enough that unloading deserves a mention. Several landscape contractors save on the cost of having equipment available on a job site by rolling B&B trees off the delivery trailer onto a couple of bales of straw which are supposed to cushion the fall. Equipment rental is expensive in inner city sites, but the losses from shattered balls far outweigh any possible savings in rental costs. Several rewholesaler businesses pick up in dump trucks and unload the B&B evergreens by dumping the load on a pile of straw if the yard employees are busy when the truck arrives. Again, the labor savings are outweighed by the damage to plants.

Squashed balls can be beaten back into shape, but survival is sharply lowered. Such abuses come from thinking of nursery stock as a "product" like lumber or cement blocks and not remembering that it is living plants, easily injured or killed.

Planting container-grown stock

At first glance, container-grown stock would seem to be a happy solution to the landscaper's and retailer's needs. The plants arrive with every single root intact and completely undisturbed in the medium in which they were growing. They have only to be knocked out of the containers and planted. However, container-grown plants have their own unique problems, the most serious of which are interface differences between the growing mix in the can and the soil in which the plant is set out. The problem is worse in plants grown in the "ultra-light" or all-organic mixes. There is no question that beautiful specimens can be grown in them, and very rapidly, too. Their light weight results in substantial savings in transportation costs. However, there the advantages cease and such plants are notoriously difficult to re-establish on a landscape job or in the garden, the more so if the soil on the site is a heavy clay. Establishing the plants in the open soil is much easier if the growing mix has a high proportion of coarse sand or ground shale, as is used by a few large growers. Success rises markedly if the root ball is roughed up and partially separated and the roots stretched out into the planting soil. Plants which have been too long in their containers and have become thoroughly pot-bound are especially difficult to get to grow off naturally. Unless strenuous efforts are made to break up the root ball, such plants may survive but merely sulk along for several growing seasons without really growing. If they are dug up again for examination, it is usually evident that the roots have never grown out from the original ball.

When plants must be used which have been grown in ultra-light mixes, it is helpful to use extra organic matter in the soil mix shoveled back into the planting pit around the root mass. This, combined with opening up the root system, will encourage the roots to grow out into the surrounding mix and then the soil of the site itself.

Garden Center operators often think that they are getting a special bargain if they are shipped plants which are especially big for the size of the container in which they are growing. Such oversize plants can be more of a curse than a blessing because, if they are large enough, it can be almost impossible to keep them watered sufficiently to live. A buyer for one of our eastern mass outlets was especially proud of the purchase of a large shipment of really big hollies and junipers in 1 gallon cans, at exceptionally low prices. His pride turned to ashes however when the branch managers of the garden departments complained that the plants rapidly died in the stores and that customers soon brought back for credit adjustment all the ones which they had purchased and planted out. In other words, it is possible for a grower who is expert at watering to maintain a plant to such a large size in an inadequate container that it cannot survive in the less careful attention of a plant market or long enough in a customer's yard to root fast and grow.

Not becoming pot-bound with the root system spiralling around the bottom of the container is especially important for the future growth of container grown shade trees. There is no question that container-grown plants of low growing species with poor roots like *Juniper horizontalis* varieties, Cotoneaster species and Pyracantha are far better than B&B plants of the same varieties. They grow low to the ground and many kinds form new roots where the spreading branches touch the soil. Trees are another matter, however, because as they mature they become tall enough to offer tremendous wind resistance, particularly in summer when the heads are full of leaves. California pioneered in container production and a number of cities began to plant trees produced in cans because of their almost 100% survival and rapid growth in the early years. In one coastal town virtually every young street tree blew down after a violent wind storm which followed heavy rains. When the city crews went to clean up the mess they found that every single tree had been grown in a 5 gallon can and that the spiral coils of roots were intact, forming what was virtually a solid wooden "barrel" of roots with only a few extending out into the soil. Obviously the trees had been pot-bound when planted and no

one had troubled to cut through the spirals of roots prior to planting. Unless great care is taken in the production and planting of container-grown shade trees, this method will never equal bare root or B&B field grown stock. It is easy to judge the success of a tree planting program for the short term prospect of high survival and quick early growth and not think ahead about the serious problems of girdling roots and wind-throw.

Artificially balled trees

In recent years a number of nurseries have developed a program of artificially balling shrubs and small shade and fruit trees in various mixtures of peat, composted bark, straw and other substances, encased in polyethylene bags. The purpose is to prolong the shelf life of the plants and to reduce the weight of sizeable trees so that the customer can easily carry them home. Unfortunately the balling machines used are almost invariably too small and the roots are tortured and bent into unnatural shapes and volume to fit into the bag. The instructions on the bags often say "just slit the bag and plant" or "carefully remove bag and plant." Unless the trees are fully dormant, the act of removing the ball and restoring the roots to normal positions will badly set back or kill the tree. If this is not done, poor growth and serious root problems later on will result. Even in the case of hybrid tea roses, one comparison made at a state university showed that bare root roses grew 4 times as vigorously and produced many more flowers than the same varieties in "slit and plant" root packaging. The differences in winter survival after the first year were even more dramatic.

Watering at planting time

This paper has been concerned in one way or another with the care of roots during the digging, storage, transportation and the planting process itself. It is true that when a plant is put into the ground with healthy vigorous roots, be it in a home owner's yard or the city street, most of the battle has been won. Proper subsequent watering clinches the deal. Proper watering is of course an imprecise term because there are such extreme variations in time of year, rainfall, heat, wind, etc., that there is no such thing as a general rule. The old generalization of "a thorough soaking once a week unless there has been rain, from May until July 30th" is about as close to a generalization as one can make for the temperate zones.

To trim or not to trim

In recent years there has been a lively controversy as to whether trees in particular benefit from pruning at transplanting time to reduce the top. The traditional view has been that a tree is in a sense a hydrostatic device, that roots (which take up the water needed for survival and growth) are of necessity reduced in digging either bare root or B&B trees, and therefore the tops (which even in a dormant leafless state transpire moisture) should be correspondingly reduced. The opposing theory is that trimming back the tops at transplanting time is of no value or is actually detrimental to the subsequent growth of the tree because a tree's buds produce growth substances which greatly stimulate recovery from the move. Unfortunately the research upon which this theory was propounded is far too incomplete. A few small specimens of very easily transplanted species were set out in a very favorable situation for growth. The differences in survival between the trimmed and untrimmed trees in this experiment were certainly not significant. What might be true for Hopa crab and green ash is not necessarily true for scarlet oak and sour gum, for example. subsequent large scale experiments in a nursery involving hundreds of the difficult oaks and other hard-to-move species were unequivocably in favor of trimming, and these tests were done in nursery conditions where irrigation was available when needed. The differences are even wider when either B&B or bare root trees are planted on city streets or highway jobs, where neglect is the rule and wind burn, heat reflected from pavement and buildings, and impermeable soils all combine to menace tree survival. Hundreds of years of experience have shown, that trimming at transplanting time increases both survival and subsequent growth.

Conclusion

In conclusion, the care of root systems during transplanting should be modeled on the conditions of the roots in a natural state on an *untransplanted* tree or shrub. These roots are uninjured, are

spread out in a natural pattern of growth, are always moist and never at sub-zero temperatures. Every step or method of care and protection which duplicates or approximates these conditions increases survival at transplanting time and rapid regrowth in the new location. Transplanting losses are the greatest drains on profits in any form of the nursery industry. They are worth any effort to reduce and control them.

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NEW METHOD OF INJECTING IRON INTO PIN OAKS

Contributed Abstract

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The use of iron salts to control lime-induced chlorosis in oaks is an accepted horticultural practice. For the past four years, we have used a method of injecting iron sulphate dissolved in water called the Medi-Ject Method® . It only requires 24 hours to treat an average size pin oak. This method can be effective using either gravity flow or low pressure (10-15 psi). This work was done in Lincoln and West Point, Nebraska.

The main disadvantage of iron sulphate over the other recommended materials is its inability to readily solubilize in cold water. We overcome this by injecting large quantities of water over a period of several hours. Holes 2 inches deep are drilled at equal distances around the tree (not to exceed 12 inches apart), preferably into the flare roots which extend out from the tree trunk. A 2½-gallon reservoir filled with ½ gallon of water flushes the lines which connect the tees to the reservoir. One-half the required amount of iron sulphate (Table 1) is dissolved in ½ gallon of water and placed in the reservoir. This is repeated with the other half of the iron sulphate. The reservoir is then filled. When almost empty, refill with plain water to flush the system and carry any residual iron into the tree. (This refill is usually done by the customer.) The number of refills varies according to the size of the tree. The number of holes per tree, the amount of ferrous sulfate used, and the number of water refills are given in Table 1.

In Lincoln, 5 trees were treated in 1978, 26 in 1979, 76 in 1980, and 234 in 1981. In West Point, 17 trees were treated in 1980. The trees averaged 13 to 19 inches in diameter. Of the 358 trees it was necessary to retreat only 6 that either failed to become green after 45 days or reverted to the chlorotic state after 1 year. Phytotoxicity was not observed on those trees treated according to label rates.

Table 1. Injection of ferrous sulfate into pin oaks using the Medi-Ject® method.

Tree diameter (inches)	*Number of holes per tree*	*Amount of $FeSO_4$ (ounces)*	*Number of refills*
1-4	4	0.5	1
5-10	4-5	2.0	1
10-15	5-6	4.5	1-2
15-20	6-7	5.5	2-3
20-25	7-8	6.5	3-4
25-30	8-9	7.5	4-5
30-35	9-10	8.5	5-6

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