Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-07-19 via free access

Horticultural Research Institute

This Journal of Environmental Horticulture article is reproduced with the consent of the Horticultural Research Institute (HRI – www.hriresearch.org), which was established in 1962 as the research and development affiliate of the American Nursery & Landscape Association (ANLA – http://www.anla.org).

HRI's Mission:

To direct, fund, promote and communicate horticultural research, which increases the quality and value of ornamental plants, improves the productivity and profitability of the nursery and landscape industry, and protects and enhances the environment.

The use of any trade name in this article does not imply an endorsement of the equipment, product or process named, nor any criticism of any similar products that are not mentioned.

Copyright, All Rights Reserved

Cultural Practices Can Influence Root Development for Better Transplanting Success[1]

Gary W. Watson[2]
MSU-DOE Plant Research Laboratory
Michigan State University
East Lansing, MI 48824

Abstract

Stress in transplanted nursery stock is caused primarily by the drastic reduction of the root system. Unsatisfactory soil conditions at the planting site reduces root regeneration and prolongs the stress. Root pruning can be used effectively to increase the amount of fine root surface area in the root ball. Careful preparation of the planting site will provide a favorable environment for root growth following transplanting.

Index Words: Root pruning, planting pit, planting hole, soil compaction, root regeneration

Introduction

Transplanting results in a great deal of stress on landscape plants and is a difficult procedure, even under the best conditions. When accepted nursery practices are followed, less than 5% of the root system may be moved with the tree (1). The extreme state of imbalance between the root system and the crown results in an extended period of stress and slow growth, often described as transplanting shock. Cultural practices used in both the nursery and landscape can have a significant influence on root growth and development, thus helping to reduce the severity and duration of this period of post-transplanting stress.

Root Pruning in the Nursery

Root pruning is no longer as commonly used in the field production of landscape plants as it is not considered to be economically feasible. If the proper technique is used, root pruning can produce a root ball with several times the amount of fine roots compared to an unpruned plant (unpublished data, G.W. Watson). This would no doubt aid in survival and establishment at the new site. The timing and location of the pruning is critical.

In order to root prune properly, it is important to understand how and where root regeneration takes place. When a root is severed, nearly all of the replacement roots are regenerated from the callus formed at or near the wounded surface (2, 3) and like most roots, these new roots grow in a nearly horizontal orientation. Usually, many roots are produced from each severed root end and these replacement roots can average 45 cm (18 in) of growth per year. Recent evidence (unpublished data, G.W. Watson) indicates that one (or at most, a few) of these roots become dominant within a year or two and the remainder of the small roots eventually die (Fig. 1). Thus, after several years, the root system again begins to resemble the original root system in both structure and distribution.

Root pruning practices can be designed to take full advantage of natural root regeneration. Figure 2A illustrates a root system which has never been pruned with that portion included in a typical root ball outlined. Note the evenly distributed, but diffuse fine root system. Figure 2B illustrates how root pruning could be used to produce a dense root system. A greater portion of the root system can be moved along with the tree, without altering the ball size. The pruning should be performed between the 2nd and 5th years before the tree will be harvested. The final root ball cut should be made at least 10–15 cm (4–6 in) away from the pruning cut. Preliminary studies have shown this method to be effective in producing a root ball with several times the root surface area (unpublished data, G.W. Watson). This should help to alleviate post-transplanting stress and aid in holding the root ball together during handling. Additional research is needed to refine the root pruning techniques to optimize the horticultural and economic benefits of root pruning.

Planting Site Modifications

Urban planting sites are often characterized by artificial soil horizons with dense, compacted subsoils and very thin topsoil layers. On this type of site, water is often in excess and oxygen is unavailable in sufficient quantities to support root growth or even for roots to survive (4, 5). Water cannot easily infiltrate into the subsoil and eventually flows to the lowest point, the planting hole, where it can remain for weeks, suffocating the root systems (Fig. 3). Some of these planting holes never dry out. Above ground symptoms (chlorosis, leaf scorch and twig dieback) resemble drought stress (4) and the trees are often watered, compounding the problem.

[1]Received for publication October 10, 1985; in revised form December 30, 1985. Paper presented at the "Ornamentals/Landscape and Turf Working Group Workshop" during the 82nd Annual meeting of the American Society for Horticultural Science, Blacksburg, VA, July 30, 1985.
[2]Horticulturist.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-07-19 via free access

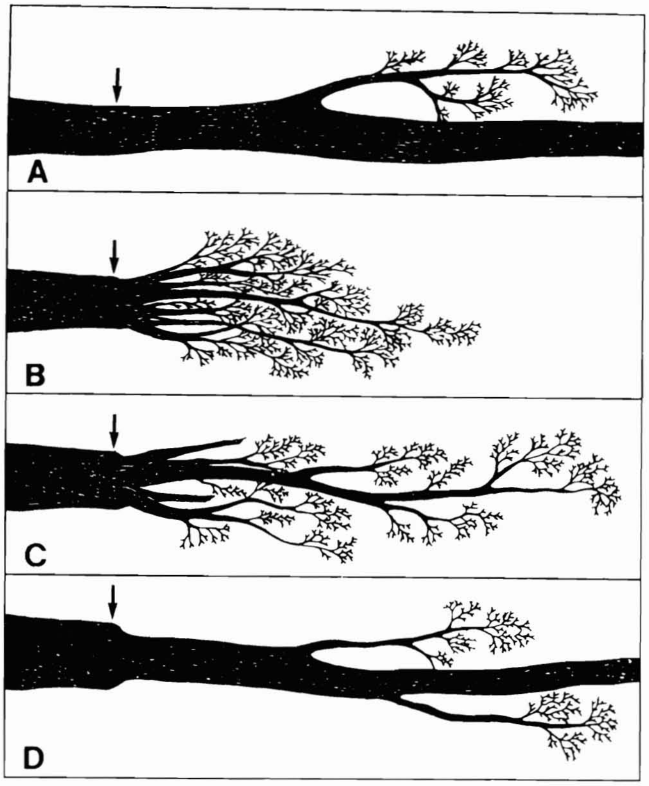

Fig. 1. **Stages in replacement of a severed root. A. Root is severed at the arrow. B. Initially, many small roots are regenerated from the callus collar at the severed end. C. Within 12–24 months, one root becomes dominant and continues to elongate, while the others remain stagnant or begin to die. D. Eventually, only a single root remains in place of the original root.**

When trees are planted on this type of site, the fine root system must develop near the surface where oxygen is most available. There are few roots at the bottom of the hole where soil conditions are the most waterlogged, most oxygen starved and least conducive to root growth. A more effective method of promoting root regeneration might be to redesign a better planting hole. Figure 4 illustrates that as the top of the whole is enlarged, with the sides sloping towards the base of the root ball at a progressively more oblique angle, the amount of back fill soil with favorable

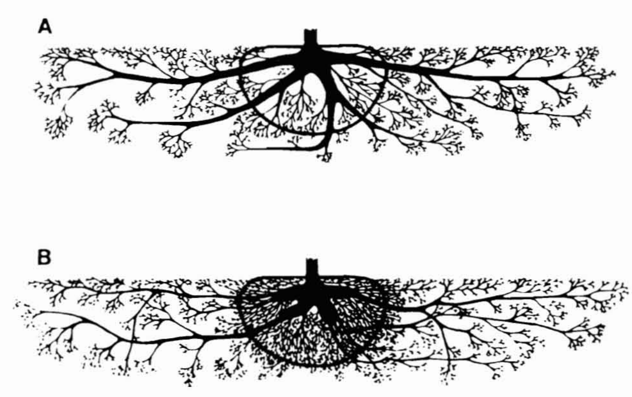

Fig. 2. **A. An ordinary tree has a diffuse fine root system and only a very small percentage is included in the root ball. B. Root pruning can be used to produce a root system where large numbers of fine roots are concentrated in the root ball.**

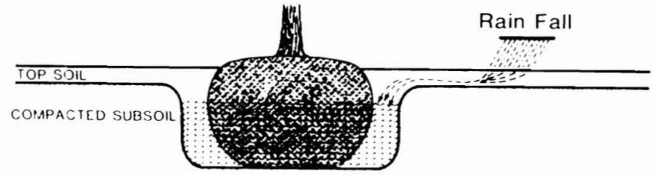

Fig. 3. **Water cannot penetrate compacted subsoils and flows laterally to the lowest point. Planting holes fill up with water and suffocate the root systems.**

growing conditions (near the surface) increases rapidly. Since the diameter of the hole decreases with depth, effort is concentrated in the upper soil layers which are most favorable for root growth.

If the planting hole is only 25 percent larger in diameter than the root ball, with vertical sides (Fig. 4A), the backfill material volume is equivalent to only 67 percent of the root ball volume. Up to ⅔ of the soil available for root growth

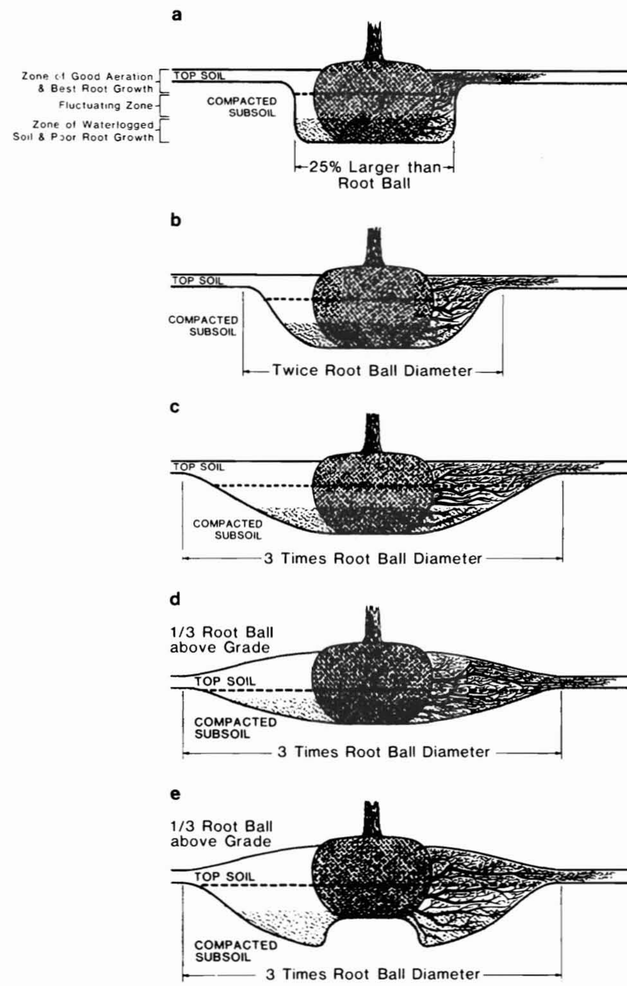

Fig. 4. **Modification of the plant hole. A. Soils near the surface are most favorable for root growth. B–D. As the surface diameter is increased, the well aerated surface soil volume is increased by as much as 10 fold. The interface with the compacted subsoil is also increased allowing a greater chance for root penetration. E. By placing the root ball on a pedestal of undisturbed soil, settling is eliminated and the ball will be raised out of the wettest soils in the bottom of the hole.**

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-07-19 via free access

is often waterlogged. If roots are unable to penetrate the compacted site soil, the root system may never be able to regenerate to even 10 percent of its original size within this planting hole. The abrupt impenetrable vertical interface with the compacted site soil could act to promote circling roots, just as in container grown plants.

If the surface diameter of the planting hole is expanded to twice (Fig. 4B) or three times (Fig. 4C) the diameter of the root ball, with sloping sides, the backfill volume increases to 150 and 400 percent of the root ball volume, respectively. The well aerated surface soil increases up to 10 fold in volume. The majority of this good back-fill soil is in the well-aerated upper layers and a large interface is created with the compacted soil, giving greater opportunity for roots to penetrate cracks and crevices in the otherwise impenetrable, poorly aerated soil. The sloped walls also serve to direct growing root tips up to the surface rather than in a circling direction.

On very wet sites, the root ball can be planted so that at least one third is above grade (Fig. 4D). This will keep the majority of the root system out of saturated soil even during very wet periods. Paterson (4) has recommended placing the root ball on a pedestal of compacted soil to avoid settling. This would also elevate the root ball out of the wet soil at the bottom of the hole (Fig. 4E).

Significance to the Nursery Industry

Trees are subject to tremendous stress when transplanted because of the extremely small amount of root system typically moved with the plant. Reducing the severity and duration of this stress can be achieved by either root pruning to produce a more dense, concentrated fine root system which can be included within the root ball, and/or modifying the planting hole to encourage fine root development in the shallow, well-aerated backfill soil. While it is recognized that these practices will increase the cost of planting, it is very likely that increased survival rates will offset these costs. The improved professional image resulting from higher quality plantings cannot be measured in dollars and cents.

Literature Cited

1. Watson G.W. and E.B. Hemilick. 1982. Root distribution of nursery trees and its relationship to transplanting success. J. Arboriculture 8:225–229.

2. Watson, G.W. and E.B. Hemilick. 1982. Root regeneration of transplanted trees. J. Arboriculture 8:305–310.

3. Watson, G.W. and E.B. Himilick, 1983. Root regeneration of shade trees following transplanting. J. Environ. Hort. 1:52–54.

4. Berrang, P., D.F. Karnowski and B.J. Stanton. 1985. Environmental Factors affecting tree health in New York City. J. Arboriculture 11:185–189.

5. Hammerschlag, S.B. and J.C. Patterson. 1978. Constitution Gardens: The making of an urban park. *In*: The Manual of Site Management, pp 1–10, Evironmental Design Press, P.O. Box 2187, Reston, VA 22090.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-07-19 via free access