Effects of Three Transplant Methods on Survival, Growth and Root Regeneration of Caliper Pin Oaks[1]

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Abstract

Twenty-nine 7-15 cm (3-6 in) caliper *Quercus palustris* Muenchh., pin oaks, were transplanted 1) bare root, 2) bare root, but treated with auxin impregnated toothpicks (toothpicks were soaked in a 10,000 ppm solution of the potassium salt of indolebutyric acid and one inserted into each of 15 roots per tree), or 3) with a Vermeer 44 Tree Spade. Transplant survival for all treatments was 100%. Leaf expansion, lateral shoot growth, and terminal shoot growth were greatest in mechanically dug trees. However, mechanically dug trees flushed once, while bare-root trees flushed twice. In bare-root trees, leaf expansion for both growth flushes, total lateral shoot growth, and terminal shoot growth were greater in auxin-treated trees than in bare-root trees. More roots of greater diameter and length were regenerated by auxin-treated trees than in untreated bare-root trees.

Index words: *Quercus palustris* Muenchh., root regeneration, IBA

Introduction

There are three common methods of transplanting trees: 1) bare root, 2) with an intact soil (balled and burlapped); and 3) from containers (4). Generally, bare-root and container methods are used in transplanting smaller sized plants, while balling and burlapping is used for large sized trees.

Trees moved balled and burlapped have a higher survival rate (2) and greater initial growth than trees transplanted bare-root. However, balled and burlapped plants are costly to harvest, ship, and transplant. Further, balled and burlapped operations remove valuable nursery soil. On a seven year rotation, approximately 4.2 inches of soil per acre are removed when 44 inch balls are dug (3). Therefore, alternative methods of harvesting and transplanting large trees would result in significant savings to nurserymen and landscapers.

When a tree is dug, as little as 2% of the soil volume originally exploited by the root system is retained (17), resulting in reduced growth for 3 to 6 years following transplanting (6). Also, the majority of the roots left after digging are old and suberized. These roots can absorb appreciable quantities of water (1,7,8), but can obtain water only from a limited soil volume. Therefore, survival of transplanted trees depends on rapid regeneration of a new root system (10,12,15,17).

Regeneration of a new root system is a gradual process affected by many factors. Various methods of accelerating root regeneration have been employed. Principally, auxins have been used to stimulate root initiation, especially indole-3-butyric acid (IBA), and naphthaleneactic acid (NAA) (5,9). The most common method of auxin application has been via root soaks or dips (11). Auxin impregnated toothpicks inserted into tap and/or major roots are an effective means of stimulating root regeneration (13,14,16). The toothpick method has been used to stimulate root regeneration in large sized trees (14).

The objectives of this study were the following: To determine if large caliper pin oaks could be transplanted bare-root; to compare survival and growth of bare-root trees with mechanically dug trees; and to determine if auxin impregnated toothpicks inserted into the roots of bare-root trees could stimulate root regeneration.

Materials and Methods

The 29 pin oaks used in this study were grown in a silty-clay loam soil at The Ohio State University Horticulture nursery. The trees were lined out as one-year-old seedlings in 1974 and grown under clean cultivation between sod strips. The plants were not root pruned, irrigated, or fertilized between 1974 and 1982. On March 21, 1982 the trees ranged in height from 4-6m (13-20 ft) and had trunk diameters between 7-15 cm (3-6 in). Approximately one-third of the branches were removed by pruning prior to transplanting.

On March 21 and March 24, 1982, the trees were dug with a Vermeer 44 mechanical tree spade. The soil was carefully removed from the root system of 19 trees and the number of roots greater than 1 cm (0.39 in) in diameter were counted. Nine of these bare-root trees were transplanted immediately to a site 0.95 km from the nursery, staked and mulched.

The remaining 10 bare-root trees were treated with auxin impregnated toothpicks in a manner similar to that used by Romberg and Smith (14). Round toothpicks were soaked overnight in a 10,000ppm K-IBA

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Table 1. Effect of three transplanting methods on leaf expansion, lateral shoot growth, and terminal shoot growth of 7-15 cm caliper pin oak trees.

Treatment	Leaf expansion[y] 1st flush (cm)	Leaf expansion[y] 2nd flush (cm)	Lateral shoot[x] growth 1st flush (cm)	Lateral shoot[x] growth 2nd flush (cm)	Total lateral growth (cm)	Terminal shoot growth (cm)
Vermeer tree spade	10.8a[z]	——	12.1a	——	12.1a	16.9a
Auxin treated bare-root[w]	8.0b	9.0a	4.6b	2.5a	7.1b	11.6b
Bare-root	6.1c	6.8b	3.3b	1.5b	4.8b	7.5c

[z]Mean separation within columns followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test. Each treatment has 10 single tree replications, except the bare root treatment, which had 9.

[y]Data is an average of 40 leaves per treatment.

[x]Data is an average of 40 shoots per treatment.

[w]Toothpicks were soaked in 10,000 ppm K-IBA solution and then inserted into 15 roots per plant.

solution, removed and dried. The toothpicks were then inserted into holes drilled transversely through 15 roots of each tree. The diameters of treated roots were at least 1 cm (0.39 in). Following treatment, these auxin treated trees were transplanted, mulched and staked. Ten trees were transplanted with an intact soil ball, mulched and staked. These trees are referred to as Vermeer Tree Spade trees.

A completely randomized planting design, with single tree plots, was used.

Beginning April 30, 1982, leaf expansion was determined by weekly measuring the length of 40 leaves from each treatment in the first and second flushes. On September 30, 40 lateral shoots within each treatment, and all terminal shoots were measured.

All trees were irrigated twice during the growing season, as rainfall between April and September was approximately half that normally expected (32 cm compared to 56 cm or 12.5 vs. 22 in).

On October 31, two major roots from five auxin-treated trees and five untreated bare-root trees were excavated to determine the degree and location of root regeneration.

Results and Discussion

For all treatments, survival on November 1 was 100%. This study demonstrated that large caliper pin oaks can be successfully transplanted, even bare-root.

Leaf expansion and shoot extension were greatest on the Vermeer Tree Spade trees, followed by auxin-treated and untreated trees (Table 1). For the auxin-treated trees, the only indexes of plant vigor significantly correlated ($\alpha = 0.05$) with lateral and terminal shoot extension following transplanting were plant height ($r = 0.733$) and number of roots before treatment ($r = 0.666$). There were no significant correlations between indexes of tree vigor and leaf and shoot extension for the untreated bare-root trees (data not presented). The absence of significant correlations indicates that the smallest caliper untreated bare-root tree had similar shoot and leaf expansion following transplanting as the largest caliper tree. Also, the tree with 43 roots had similar amounts of shoot and leaf expansion as the tree with 12 roots.

In a temperature zone like central Ohio, pin oaks generally initiate a second flush of growth by early June. The Vermeer Tree Spade trees had only one flush of growth compared with two for both bare-root treatment trees. By late August, all the Vermeer Tree Spade trees were partly to completely defoliated, whereas neither the auxin-treated or untreated bare-root trees showed any signs of premature defoliation. Water deficits can reduce shoot growth and leaf expansion and cause premature leaf abscision (9). Using the criteria of early defoliation, the Vermeer Tree Spade trees seemed to be under more water stress than the bare-root trees at season's end.

There was greater root regeneration in the auxin-treated bare-root trees than in untreated bare-root trees (Fig. 1). Roots were initiated only at the cut ends and other wounded areas on existing roots of untreated bare-root trees (Fig. 2). In the auxin treated trees, great numbers of roots were regenerated at the points of toothpick insertion. Limited numbers of roots were regenerated at cut root ends and wounded areas of the auxin-treated trees. These roots were also longer and of greater diameter than those produced by the untreated bare-root trees. Previous work has shown that inserting

Fig. 1. Root regeneration in bare-root transplanted oaks. Roots were regenerated at points of toothpick insertion (see arrows). The toothpicks were soaked in 10,000ppm K-IBA solution before insertion.

Table 2. **Comparison of shipping costs per tree between balled and burlapped and bare-root trees.**[w]

Treatment	Tree diameter cm (in)	Ball diameter m (ft)	Approximate weight of one tree kg (lbs)	Number of trees per load[z]	Cost per tree
Balled and Burlapped	13 (5)	1.2 (4)	1360[x] (3600)	5	$76.00
Bare-root	13 (5)	—— (——)	68[y] (150)	25	$15.20

[w]Based on 20,000 lb. load, 200 mile shipping distance, at $1.90 per mile shipping cost.

[x]Data obtained from Tree and Shrub Transplanting Manual, E.B. Himelick (6), includes weight (68 kg) of tree.

[y]Estimated weight

[z]Estimated by Dale Manbeck, Manbeck's Nursery, New Knoxville, OH. The number of bare-root trees per load is limited by the volume rather than weight of the trees.

toothpicks not impregnated with auxin does not significantly increase root regeneration (16). Therefore, the increased leaf and shoot growth of the auxin-treated trees compared to the untreated bare-root trees can probably be attributed to increased root regeneration. Although the results are promising, the data is from one year's trial with a limited number of plants per treatment and therefore caution must be used in any interpretation.

Economic Considerations

In tight economies, it becomes increasingly necessary for nurserymen to reduce production and shipping costs. There are several ways large caliper bare-root trees would lower costs. First, nursery soil loss is decreased considerably when trees are dug bare-root. Balling and burlapping operations require extensive soil rebuilding programs to maintain soil productivity.

Digging plants balled and burlapped is more expensive than digging plants bare-root, due to the cost of machinery, materials (burlap, wire baskets, nails, twine), labor and time. These increased production costs are reflected in the price of balled and burlapped stock. A balled and burlapped tree lists for nearly twice as much as a similar sized bare-root tree. Also, trees dug with a soil ball weigh considerably more and take up more shipping space than those dug bare-root (Table 2). As a result, the shipping cost per balled and burlapped tree is estimated at more than five times that of a bare-root tree.

Fig. 2. When auxin toothpicks were not inserted, root regeneration occurred predominantly at cut ends of existing roots.

Significance to the Nursery Industry

Large caliper (3-6 in) pin oaks can be successfully transplanted bare-root. Insertion of auxin impregnated toothpicks into large diameter roots stimulated root regeneration. However, shoot and leaf expansion of bare-root trees were less, but still acceptable, compared with trees transplanted with a Vermeer 44 Tree Spade. Shoot and leaf expansion of trees treated with auxin impregnated toothpicks was greater than in bare-root trees. Bare-root trees can be harvested and shipped less expensively than balled and burlapped trees, resulting in significantly lower cost to the producer and landscaper.

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Factors Affecting Colonization of English Boxwood by *Paecilomyces buxi* Related to Root and Stem Rot Development[1]

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Abstract

English boxwood (*Buxus sempervirens* var. *suffruticosa* L.) plants were grown in the greenhouse in association with rhizomes of bromegrass and bindweed. Rhizomes of both species were colonized by *Paecilomyces buxi*. Boxwood plants showed symptoms similar to decline of field grown plants, and boxwood roots were colonized by *P. buxi*. Rooted cuttings of boxwood subjected to temperatures gradually reduced to -5C (23F) were uniformly colonized by *P. buxi* in basal stem lesions where the fungus sporulated at the surface of the stems. Some implications for root-rot development and spread of *P. buxi* related to environmental stress factors are suggested.

Index words: English boxwood decline, *Bromus inermis, Convolvulus sepium,* low temperature stress

Introduction

English boxwood has been grown as an ornamental in the middle Atlantic states since its introduction during Colonial times. Prized for its slow and luxuriant growth in the landscape, English boxwood has relatively few pests or diseases (6). However, Phytophthora root rot and English boxwood decline currently threaten boxwood culture in Virginia.

English boxwood decline was perhaps first described over 50 years ago and has been attributed to many causal factors, including fungi, nematodes, and weather (1, 2, 3, 5). Montgomery *et al.* (4) described the present decline problem and consistently associated the fungus *Paecilomyces buxi* with decline. The total etiology has not been described.

The purposes of these studies were to determine some effects of low temperature stress on colonization of English boxwood by *P. buxi* and on root rot development. In addition, the possible role of two perennial rhizomatous weeds, *Bromus inermis* Leyess (bromegrass) and *Convolvulus sepium* L. (bindweed), in boxwood decline was examined. Both weeds were observed growing in close association with declining English boxwood.

Materials and Methods

Plants used in this research were propagated from cuttings collected from established landscape English boxwood in Colonial Williamsburg, VA, where decline has not been observed. Rooted cuttings were transplanted to a steam pasteurized medium of topsoil and composted ground pine bark (1:1 by vol) in 946 ml (one quart) plastic containers. Osmocote 14N-6.02P-11.6K (14-14-14), 4N-3.87P-2.5K (4-9-3) fertilizer, and ground dolomitic limestone were added to the potting mixture at 85 g (3 oz) ea per .057m^3 (2ft^3). Plants were grown in the greenhouse on wire benches, watered daily, and fertilized monthly with 30 g/l of Peter's 20N-8.6P-16.6K (20-20-20) soluble fertilizer.

Bromegrass or bindweed rhizomes collected from a field in which English boxwood had died were planted with the boxwood as one 2-3 cm long slip per pot of actively growing rhizome in containers. The boxwood were grown in association with the bromegrass or bindweed for 13 mo in the greenhouse. At that point the boxwood was growing in a mat of bromegrass or bindweed. The boxwood plants were then removed from the

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