Root Pruning Red Maple and Washington Hawthorn Liners Does Not Affect Harvested Root Length After Two Years of Field Production[1]

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Abstract

Root pruning field-grown trees during production can increase harvested root length, but it is a time consuming and expensive practice. Root pruning before lining out instead of during production is much faster and cheaper. This study tested the effect of root pruning red maple (*Acer rubrum* L.) and Washington hawthorn (*Crataegus phaenopyrum* (L.f.) Medic.) trees. Bare-root liners were root pruned before planting in nursery rows, and top growth, shoot:root ratios, and harvested root length within rootballs were measured after two years of field growth. Pruning root systems back 25%, 50%, or 75% had little effect on top growth or shoot:root ratios for either species.

Index words: transplanting, rootball, shoot:root ratio, nursery.

Significance to the Nursery Industry

This study tested the effect of root pruning red maple and Washington hawthorn liners at planting on top growth and harvested root length after two years of field production. Root systems were cut back 0%, 25%, 50%, or 75%. Harvested root length was not improved, indicating no benefit from root pruning. On the other hand, top growth was not reduced and only slight evidence of a negative effect on harvested root length was found. Nursery operators may therefore trim root systems of these species as needed (e.g. to remove girdling roots) or to fit specialized production systems (e.g. to fit in containers) without negatively affecting plant growth after at least two years.

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Introduction

Post-transplant establishment success varies among species (11, 18). Easy-to-transplant species often have more root length within rootballs (i.e. are more fibrous) than difficult-to-transplant species (5, 12), prompting nursery operators to look for means, such as root pruning, to increase root length within rootballs. Since harvesting of field-grown trees may remove over 90% of the original total root length (7), trees with coarse, spreading root systems have very little root length within rootballs (12) and may especially benefit from root pruning. Increased root length within rootballs of root-pruned trees is a result of both regeneration of branch roots at severed ends and the stimulation of lateral roots behind the cuts (10).

Root pruning of young seedling trees to stimulate root growth and to enhance fibrous root development is a common practice in the production of lining out stock for reforestation (3). Root pruning during production of young forest seedling can decrease shoot:root ratios of transplants (14, 17, 19), which is considered desirable since potential for rapid

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post-transplant establishment is enhanced (15). Root pruning of field-grown landscape trees is also a recommended practice (20). Root pruning Colorado blue spruce (*Picea pungens* Engel.) five years before transplanting increased the root surface area within rootballs four fold (21), and fall root pruning of live oak (*Quercus virginiana* L.) increased fine root root growth within rootballs of spring-harvested trees (9). However, root pruning during field production does not always decrease shoot:root ratios (8), and decreased shoot:root ratios do not always result in improved establishment (4, 14).

Root pruning during production is labor intensive, especially for nursery trees grown to landscape size. The most convenient and least costly time to root prune is at the lining out stage. The objective of this study was to test the effect of root pruning *Acer rubrum* L. (red maple) and *Crataegus phaenopyrum* (L.f.) Medic. (Washington hawthorn) liners at planting on top growth and root length within harvested rootballs. These species were chosen because of previous observation of their contrasting root system characteristics by the authors (unpublished data). As confirmed in the present study (Table 1), red maple has a fibrous root system relative to Washington hawthorn.

Materials and Methods

Forty each of *Acer rubrum* L. (red maple) and *Crataegus phaenopyrum* (L.f.) Medic. (Washington hawthorn) bare-root seedlings were obtained from Laywer's Nursery, Inc. (Plains, MT) on March 20, 1995, and placed in cold (2C) (36F) dark storage with roots covered in moist sawdust. Mean height and stem diameter taken 15 cm from the shoot:root interface (s.e. mean in parentheses) were 52.7 (0.94) cm and 6.1 (0.18) mm, respectively, for red maple and 84.7 (1.96) cm and 7.2 (0.32) mm, respectively, for Washington hawthorn. Four root pruning treatments were randomly assigned to each species. Each treatment removed a predetermined percentage of secondary roots and the remaining tertiary roots by measuring from the root tips to the axis of the primary or secondary roots. Treatments were: 1) 0% (no additional) root removal, 2) 25% of root length removed 3) 50% of root length removed, and 4) 75% of root length removed. Trees of each species were planted in a completely random design in the ground and backfilled with native soil on April 15, 1995. Species were planted in a single row, 1 m between trees, and analyzed separately. Soil type was Groseclose silt loam (clayey, mixed, mesic Typic Hapludults) with pH 6.2. A topdressing of slow-release fertilizer (Osmocote: 18N–2.6P–9.9K (18–6–12)) was applied at 9 g of N per tree at planting and again the following spring. Soil within the nursery row was maintained near field capacity with micro-irrigation throughout the experiment (approximately once every 5 days during the growing season). Trees were harvested in March 1997. Final stem diameters were measured and all tops dried to a constant mass at 70C (158F). Rootballs of all trees were excavated with 50-cm diameters (industry standard for tree size) (2), washed free of all soil and unattached roots, and stored in cold (2C) (36F) dark storage. Each root system (40 trees) was separated into four diameter classes (0–1 mm, 1–3 mm, 3–5 mm, and 5–10 mm). Roots with diameters >10 mm were excluded from the study. Two root systems from each treatment and species were randomly selected for determination of dry mass:length relationships. Root length was determined using a combination of computer imaging software (Desk-Scan II, Hewlett Packard Co., Mountain View, CA) and a computer-image analyzing system (Delta-T SCAN, Delta-T Devices Ltd. Cambridge, England). Subsamples were then dried to a constant mass at 70C (158F) and weighed. Data from the two subsamples were pooled to determine the dry mass:root length relationship for each diameter class of each treatment by linear regression (SAS vers. 6.08, Cary, NC). All remaining roots were weighed and the total root length for each replication was calculated by adding the lengths calculated with the regression equations for each diameter class. Shoot:root ratios for all trees were determined by dividing the dry mass of tops by total dry mass of roots. The relationships between root pruning severity and stem

Table 1. The effect of root pruning red maple and Washington hawthorn at planting on stem diameter increase, top dry mass, shoot:root ratio, and total root length within harvested rootballs two years after planting.[z]

Root pruning (%)	Stem diameter increase (cm)	Top dry mass (g)	Dry mass shoot:root (g/g)	Total root length (m)
		Red maple		
0	2.0	253.2	3.1	289.8
25	1.9	208.2	3.6	225.1
50	1.9	201.4	3.3	244.5
75	1.8	202.8	3.8	168.9
		Washington hawthorn		
0	1.9	317.6	9.7	64.8
25	1.4	208.0	6.8	51.8
50	1.6	237.9	8.1	49.1
75	1.5	252.3	10.2	47.2
		P>F[y]		
Red maple	0.22	0.27	0.18	0.08
Washington hawthorn	0.19	0.37	0.72	0.09

[z]n = 10 for both species.

[y]Test for significance of regression (linear fit; quadratic term = NS).

diameter increase, final shoot (total top) dry mass, shoot:root ratio, and total root length were assessed through the GLM procedure of MINITAB vers. 11.1 (State College, PA).

Results and Discussion

Root pruning did not affect stem diameter increase or top dry mass (Table 1). Root pruning causes a reallocation of growth that results in increased root growth relative to shoot growth (14, 16). This reallocation continues until a functional balance is reached (1). Harvesting trees before this functional balance is reestablished should result in less top growth in root-pruned trees. Since no effect was seen on top growth or shoot:root ratios, this equilibrium was probably reestablished before harvest. Recovery from root pruning can be rapid for young trees. Geisler and Ferree (6) reported that photosynthesis and transpiration decreased for 10 days after root pruning 'Golden Delicious' apple trees, but both were much increased by 20 days. Gilman (8) reported that shoot:root ratios (dry mass:dry mass) of root-pruned *Magnolia grandiflora* were similar to unpruned controls when all were harvested one year after root pruning.

Since root pruning increases the small:large root diameter ratio (8, 21) and small diameter roots weigh less than large-diameter roots, root length may be a better gauge than dry mass of the effect of root pruning on harvested roots. Nonetheless, root pruning did not increase root length within rootballs in our study (Table 1). There is some evidence of a negative relationship ($p = 0.08$ and 0.09 for red maple and Washington hawthorn, respectively), although little variation is explained by the relationship ($r^2 = 0.08$ and 0.07 for red maple and Washington hawthorn, respectively).

Our data do not support the utility of root pruning bare-root liners of red maple or Washington hawthorn at planting to increase root length within rootballs two years later when harvested. Some roots are unavoidably cut during liner harvest. Although nursery practices such as wrenching and harvesting with deeply drawn u-blades can harvest a high percentage of roots, some species may experience severe root loss at harvest. Additional root pruning may have little effect on these trees. Any beneficial effect from further root pruning was transitory and was not detectable after two years on the trees in the present study. Watson theorized that within 12–24 months of root pruning, multiple roots emerging from cut roots are replaced in stages until one root becomes dominant (20). Since our trees were harvested two years after root pruning, many of the new roots may have died. Different results may have been obtained had trees been harvested one year after planting or had trees been root pruned in the field in the fall and harvested the following spring, similar to root pruning procedures reported for live oak in Florida (9). However, in cold soil regions little root growth can be expected during late fall and early spring (13), and little root regrowth would probably occur before spring harvest. Following traditional field root pruning, one complete growing season would therefore probably be required before a beneficial increase in root length within rootballs could be realized. Increased production costs from root pruning after liners are planted and from the increased production time required would then have to be compared to the benefits obtained from increased root length within rootballs.

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