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Root Growth Near Vertical Root Barriers after Seven Years

E. Thomas Smiley, Liza Wilkinson, and Bruce R. Fraedrich

Abstract. Vertical root barriers are used to redirect root growth to greater depths in the soil, thus reducing damage to the sidewalks. This study was conducted to examine root growth patterns near a variety of vertical root barriers. Thirty willow oaks (*Quercus phellos*) were planted in November 2000 and one of the following treatments was installed on two sides of each tree: Biobarrier, DeepRoot Universal Barrier, DeepRoot Universal Barrier with Spin Out, Tex-R, Typar Geotextile 3801, or a no-barrier control. In March 2007, the second 15-tree block was excavated to reveal the root system outside the barrier. All five root barriers significantly reduced the amount of root growth compared with the control trees. There were no differences among the products tested.

Key Words. Biobarrier; copper hydroxide; DeepRoot; Geotextile; infrastructure damage, sidewalk lifting, Spin Out; Tex-R; Typar.

Roots from trees growing near sidewalks are known to grow under and take advantage of cracks in pavement, often resulting in additional cracking or lifting of the pavement (Wagar and Barker 1983; D'Amato et al. 2002; Costello and Jones 2003). A study that looked at tree-related concerns of city residents in Toledo, Ohio, found that the greatest concern of citizens was the damage done to sidewalks by tree roots (Heimlich et al. 2008). The cost of repairing sidewalk damage is in excess of $100 million per year in the United States (McPherson and Peper 1995; McPherson 2000).

Vertical root barriers are one treatment that has been found to redirect root growth deeper in the soil and reduce root growth under pavement, thus reducing damage to the sidewalk (Wagar 1985; Barker and Peper 1995; Gilman 1996; Costello et al. 1997; Smiley et al. 2000; Costello and Jones 2003; Smiley 2008). These products tend to work better in well-drained soils than in poorly drained soils (Gilman 2006). It has been determined that there are differences among root barriers in their initial degree of effectiveness (Smiley 2005; Gilman 2006). Because vertical barriers are known to be effective at diverting or reducing root growth under pavement, numerous products are commercially available (Peper and Barker 1994). This study was conducted to determine if there are root growth differences among a number of root barrier products.

MATERIALS AND METHODS

Two rows of 15 willow oak (*Quercus phellos*), 4 cm (1.5 in) caliper, were planted on a 3 m (10 ft) spacing at the Bartlett Tree Research Laboratory in Charlotte, North Carolina, U.S., on 8 November 2000. Soil at the site is a moderately well-drained Cecile sandy clay loam (thermic typic hapludults). For installation of root barriers, parallel trenches 45 cm (18 in) deep were dug on opposite sides of each row of trees at a distance of 60 cm (24 in) from the center line of the tree trunks. A 3 m (10 ft) long and 45 cm (18 in) deep section of root barrier was inserted into each trench centered on the tree. Each treatment was replicated ten times in two randomized blocks. Trees were irrigated and fertilized with granular Boost (24N–7P–7K) at a rate of 2.4 kg N/100 m^2 (6 lb N/1000 sq ft) at the time of planting. Irrigation was applied as needed after planting.

Treatments installed on 19 December 2000 were as follows:

1. DeepRoot UB18-2 Universal Tree Root Barrier (DeepRoot Partners, San Francisco, CA). Panels are a copolymer polypropylene 2 mm (0.08 in) thick and 45 cm (18 in) high × 61 cm (24.4 in) wide. Referred to as "DeepRoot Standard";
2. DeepRoot UB18-2 Universal Tree Root Barrier with Spin Out, UB18-2 Barrier coated with Spin Out (Griffin L.L.C., Valdosta, GA), a copper hydroxide resin coating (6 g $Cu[OH]_2/m^2$). Referred to as "DeepRoot Copper";
3. Typar Geotextile 3801, a heavyweight (272 g/m^2 [8 oz/yd^2]) nonwoven polypropylene geotextile fabric (Reemay Inc., Old Hickory, TN);
4. Biobarrier, a medium weight (130 g/m^2 [4 oz/yd^2]) nonwoven polypropylene geotextile fabric with attached nodules containing the herbicide trifluralin (17.5% A.I.) (Reemay Inc., Old Hickory, TN);
5. Tex-R Barrier, a heavyweight (415 g/m^2 [12.5 oz/yd^2]) needle punched nonwoven polypropylene/polyester coated with Spin Out (6 g Cu [OH]2 /m^2) (Texel, St. Elzear, Beauce Nord, Quebec, Canada). Referred to as "TexR Cu Geotex"; and
6. No-barrier control treatment.

One block of 30 root barriers (15 trees) was excavated on 26 February 2002 (Smiley 2005) and a second block was excavated on 26 March 2007 for this study. Soil was excavated to reveal the root system at and beyond the barrier using methods similar to Gilman (1996). Excavations were made with a track hoe, which excavated the area between 90 cm (36 in) and 215 cm (86 in) from the tree trunk parallel to the line of root barriers. Additional soil was sliced off the side of the trench with a square-tipped shovel or was removed with an Air-Spade (Concept Engineering Group, Pittsburgh, PA). Root growth was quantified adjacent to the outside of the barrier or at the barrier line for the controls and along a parallel line 15 cm (6 in) outside the barriers. Roots were classified by diameter, either greater or less than 10 mm (0.4 in) diameter, and counted at each line at 15 cm (6 in) depth intervals.

Data were analyzed using SPSS (SPSS Inc., Chicago, IL) analysis of variance to compare differences among treatments.

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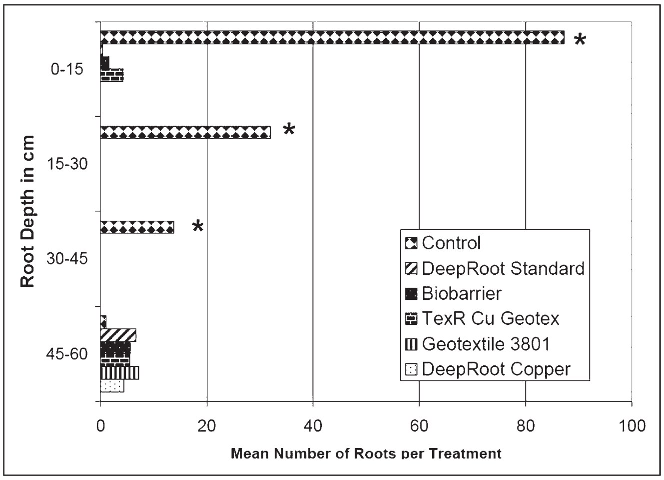

Figure 1. The number of small-diameter roots (less than 10 mm (0.4 in)) at the barrier line. Asterisk (*) indicates a significant difference at the specified depth among treatments using the Student-Newman-Keuls separation of means at the *P* = 0.05.

Student-Newman-Keuls procedure was used for separation of means at the *P* = 0.05 confidence level.

RESULTS

Comparing the root counts from the block harvested on 26 February 2002 after two seasons of growth (Smiley 2005) and the second block harvested on 26 March 2007 after seven seasons of growth, many more roots were found growing under, over, and through root barriers after seven seasons (Figures 1–5).

The mean number of roots in the no-barrier control trees between the surface and 15 cm (6 in) at the barrier line was 10.8 per treatment in 2002 and 94.4 in 2007 harvest (Figures 1 and 2). The mean number of roots in the no-barrier control 15 cm (6 in) outside the barrier line at the same depth was 12 per treatment in 2002 to 24 in the 2007 harvest (Figures 3 and 4).

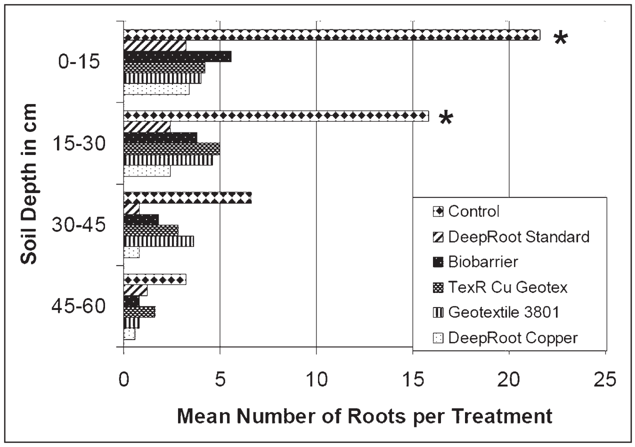

Figure 3. The number of small-diameter roots (less than 10 mm (0.4 in)) 15 cm (6 in) outside the barrier line. Asterisk (*) indicates a significant difference at the specified depth among treatments using the Student-Newman-Keuls separation of means at the *P* = 0.05.

For all five barrier treatments combined, between the surface and 15 cm (6 in) deep at the barrier line, the mean number of roots increased from zero in 2002 to 1.3 in the 2007 harvest (Figures 1 and 2). The mean number of roots 15 cm (6 in) outside the barrier line at that depth was 0.5 per treatment in 2002 and 4.3 in the 2007 harvest (Figures 3 and 4).

In the 2007 harvest, between the soil surface and 30 cm (12 in), there were significantly more roots in the control treatment than any root barrier treatment (Figures 1–4). Below 30 cm (12 in), there were no significant differences in the number of roots with any treatment. Root penetration of the barriers was present only in one replicate of the DeepRoot Standard barrier. In this replicate, two of the barrier connections were penetrated by roots.

Roots were found growing over the top of all barrier treatments. Larger roots were more often found over the DeepRoot Standard, Geotextile 3801, Biobarrier, and Tex-R Cu Geotex treatments (Figure 5).

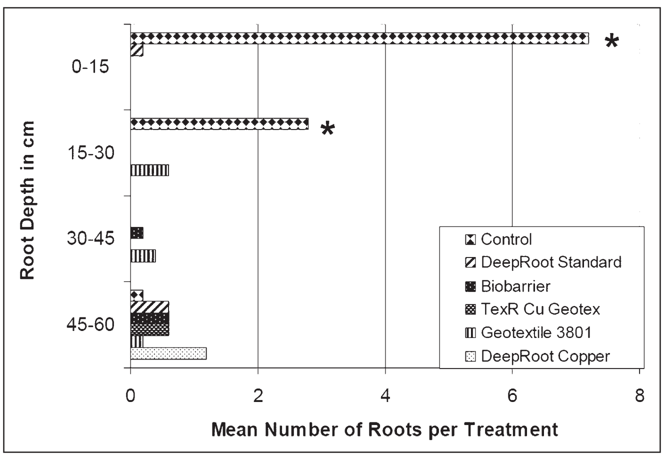

Figure 2. The number of large-diameter roots (greater than 10 mm (0.4 in)) at the barrier line. Asterisk (*) indicates a significant difference at the specified depth among treatments using the Student-Newman-Keuls separation of means at the *P* = 0.05.

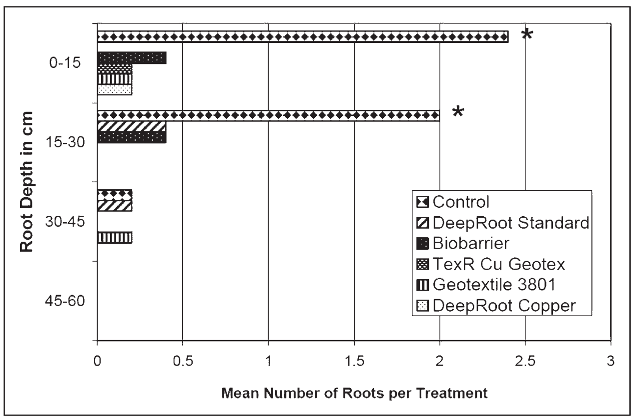

Figure 4. The number of large-diameter roots (greater than 10 mm (0.4 in)) 15 cm (6 in) outside the barrier line. Asterisk (*) indicates a significant difference at the specified depth among treatments using the Student-Newman-Keuls separation of means at the *P* = 0.05.

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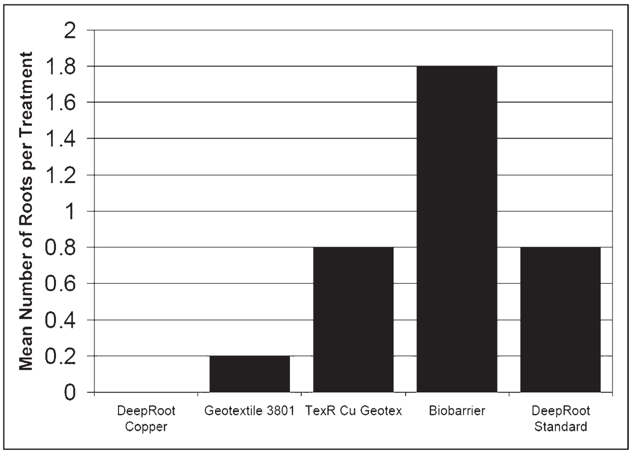

Figure 5. The number of large-diameter roots (greater than 10 mm (0.4 in)) that grew over the top of root barriers. Mean differences were not significant.

DISCUSSION

Root barriers have been found to be effective at altering root growth patterns under pavement (Gilman 1996; Smiley 2005, 2008). All five root barriers in this study significantly changed the growth patterns of the willow oak roots. Root growth in the area where a sidewalk would be located was greatly reduced compared with the control trees. Instead of growing horizontally outward, roots on the treated trees were directed underneath the barrier. This diversion of root growth resulted in fewer roots growing beyond the barrier as compared with the unimpeded control roots.

In the 2002 harvest of roots, the DeepRoot Universal barrier appeared to be more efficient at redirecting growth below the barrier and the chemically treated barriers were more effective at suppressing root growth below the barriers (Smiley 2005). However, in the 2007 harvest, these differences were not apparent. In this study, there were no significant underground root growth differences among any of the root barrier treatments.

Roots growing over the top of barriers can cause significant damage to pavement (Smiley 2008). There were no significant differences in root overgrowth among the products tested. It is important that when installing barriers, the top of the barrier is above grade and that this portion of the barrier remains free of mulch and soil that would allow root overgrowth.

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Résumé. Les barrières racinaires verticales sont utilisées pour rediriger la croissance des racines vers de plus grandes profondeurs dans le sol ce qui permet de diminuer les dommages aux trottoirs. Cette étude a été menée pour examiner les patrons de développement des racines à proximité d'une variété de barrières racinaires. Trente chênes-saules (*Quercus phellos*) ont été plantés en novembre 2000 et l'un des dispositifs suivants a été installé sur deux côtés de chacun des arbres: Biobarrier, DeepRoot Universal Barrier, DeepRoot Uninversal Barrier avec Spin Out, Tex-R, Geotextile Typar 3801, et aucune barrière comme groupe témoin. En mars 2007, le second bloc de 15 arbres a été excavé afin de révéler le système racinaire au-delà de la barrière. Les cinq barrières ont permis de diminuer significativement la quantité de racines ayant poussé comparativement aux arbres du groupe-témoin. Il n'y avait pas de différence significative entre les différents produits testés.

Zusammenfassung. Vertikale Wurzelbarrieren werden verwendet, um das Wurzelwachstum umzulenken in tiefere Bodenschichten und damit den Schaden an Pflasterungen zu reduzieren. Dreisig Quercus phellus-Bäume wurden im November 2000 und jeweils eins der folgenden Behandlungen wurde beidseitig

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an jedem Baum installiert: Biobarrier, DeepRoot Universal Barrier, DeepRoot Universal Barrier mit Spin Out, Tex-R, Typar Geotextile 3801, und eine barrierelose Kontrolle. Im März 2007 wurde der zweite 15-Bäume Block aufgegraben, um die Wurzeln außerhalb der Barrieren freizulegen. Alle fünf Wurzelbarrieren reduzierten im Vergleich mit den Kontrollen deutlich die Menge der Wurzeln. Es gab keine Unterschiede zwischen den getesteten Produkten.

Resumen. Las barreras verticales son usadas para redirigir el crecimiento de las raíces a mayores profundidades en el suelo, reduciendo de esta manera el daño a las aceras. Este estudio fue conducido para examinar patrones de crecimiento cercano a una variedad de barreras verticales. Treinta encinos (*Quercus phellos*) fueron plantados en Noviembre del 2000 y uno de los siguientes tratamientos fue instalado en dos lados de cada árbol: Biobarrier, DeepRoot Universal Barrier, DeepRoot Universal Barrier con Spin Out, Tex-R, Typar Geotextile 3801, o un control sin barrera. En Marzo de 2007, el segundo bloque de 15 árboles fue excavado para revelar el sistema de raíces fuera de la barrera. Todas las barreras de raíces redujeron significativamente la cantidad de crecimiento de raíces comparados con los árboles de control. No hubo diferencias entre los productos probados.

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