ROOT BARRIERS AFFECT ROOT DISTRIBUTION

by Edward F. Gilman

Abstract. No roots of live oak *(Quercus virginiana)* or sycamore *(Platanus occidentalis)* went through Biobarrier™ during a 3-year period after planting. Most roots on both species without a barrier were located in the top 30 cm (12 in) of soil, and root number decreased with increasing soil depth. Roots were located at deeper soil depths beyond the Biobarrier. The roots 15 cm (6 in) from the Biobarrier were mostly 30 to 45 cm (12 to 18 in) below the soil surface. Eighty percent of oak roots and 72% of sycamore roots greater than 3 mm in diameter 0.9 m (3 ft) from the trunk without a barrier were in the top 30 cm (12 in) of soil, whereas, only 42% (oak) and 38% (sycamore) of roots were in the top 30 cm (12 in) for trees with the root barrier. Biobarrier forced roots deeper in the soil but in the high water table soil in this study, many roots returned to the soil surface by the time they had grown 1.2 m (4 ft) away from the barrier.

There are few published reports of a newly planted tree's response to physical barriers designed to deflect tree roots (1,2,4). Wagar (4) showed that a plastic barrier deflected roots to deeper soil layers; however, after growing under the barrier, roots in a poorly drained soil grew quickly back to the soil surface. The barrier was most effective in the parts of the field containing well-drained soil where roots grew back to the surface more slowly. Barker (1,2) showed that in an alluvial, well-drained, silty clay loam soil, roots deflected down by a polyethylene plastic sheet did not grow up toward the soil surface within 1 m of the barrier. Other reports indicate that barriers can deflect roots on established trees; the authors speculate that this could potentially reduce damage to sidewalks (5). Approximately 25% of the nearly 200 urban forestry programs using root barriers in California report them to be effective in reducing sidewalk damage; another 25% report that they are partially effective (3). Most responding to the survey say species selection is nearly 90% effective in reducing sidewalk damage.

The purpose of this study was to compare root growth on recently transplanted trees near and under Biobarrier™ with root growth near trees without the barrier in a soil with a high water table.

Materials and Methods

In late winter 1991, 30 cm deep (12 in) Biobarrier (REEMAY, Inc., Old Hickory, Tennessee) was installed vertically in loose, sandy (Astatula fine sand) soil with a pH of 6.7 in Gainesville, Florida (U.S.D.A hardiness zone 8b). Annual rainfall averages 140 cm (55 in) and temperatures dip below freezing 10 to 15 times each year. Two 5 cm wide (2 in), 30 cm deep (12 in) parallel trenches 1.5 m (5 ft) apart and approximately 15 m (50 ft) long were dug with a carbide-tipped trencher, and a continuous piece of Biobarrier was slipped into each open trench. Soil was manually filled in the trench on the side of the barrier away from the tree. This arrangement was installed in 2 sections of the field (blocks). About 3 cm (1.2 in) of the barrier was left above the ground. The water table at the site was 30 to 45 cm (12 to 18 in) below the soil surface in winter and early spring and about 1.3 m (4 ft) during the rest of the year.

In each of 2 blocks, 4 container-grown (30 gal), 5 cm (2 in) caliper live oaks (*Quercus virginiana*) and 4 sycamores (*Platanus occidentalis*) were alternately planted 1.8 m (6 ft) apart centered between the parallel strips of Biobarrier. Trunks were 75 cm (30 in) from each strip of Biobarrier. As a control, 4 additional trees of each species were planted 1.8 m (6 ft) apart without a Biobarrier in both blocks. The experiment was arranged in a randomized complete block design.

Planting holes were dug approximately twice the root ball width. The top of the root ball was placed even with the soil surface, and the soil originally dug from the planting hole was used as backfill. An 8 cm (3 in) thick mixture of hardwood and

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softwood chips was applied to the soil surface between the parallel strips of Biobarrier and to the same area in the control. The top of the barrier was kept clear of chips so roots would not grow over the barrier. To encourage rapid growth after planting, root balls were irrigated daily for 7 months then every other day until the beginning of winter 1992 when irrigation was discontinued. Fertilizer was applied as ammonium nitrate every 4 months at a rate of 2 lbs N/1000 ft^2/application.

Three years after planting (spring 1994), a 1.2 m (48 in) wide and 1.2 m deep trench was dug with a backhoe 15 cm (6 in) beyond and parallel to the side of the Biobarrier away from the tree on 1 side of a group of 6 trees (3 of each species). The trench was dug this wide to simulate the width of a 1.2 m (4 ft) wide sidewalk. As the trench was deepened with the backhoe, a sharpened square shovel was used to make clean, vertical cuts in the soil at the edge of the trench so roots would be cut cleanly. A trench with the same dimensions was dug the same distance from 6 control trees (3 of each species). One wall of the trench was therefore 90 cm away from the trunk (15 cm away from the Biobarrier) and the other was 2.13 m from the trunk. In essence, if a sidewalk had been poured at the site, 1 vertical wall of the trench would be at each edge of the sidewalk. A 1.8 m long by 0.6 m wide piece of transparent plastic was fixed to the face of each wall centered at the tree trunk. All roots greater than 3 mm diameter were located on the plastic by tracing the outside edge of the root. Roots in each soil depth class (0–15 cm, 15–30 cm, 30–45 cm, and 45–60 cm) were counted. The percentage of the total number of roots on the tree that were located in each root depth class was also calculated. Data were analyzed with analysis of variance.

Results and Discussion

More roots with a diameter less than 10 mm were found in the Biobarrier treatment (108 for oak, 98 for sycamore) than in the control (67 for oak, 63 for sycamore) (Tables 1 and 2). Significant increases in number of roots for the Biobarrier treatment occurred only below the 30 cm depth. There were no differences in number of roots between treatments for the larger diameter roots, with 1 exception: there were fewer sycamore roots in Biobarrier treatment in the top 15 cm of soil. Perhaps the trifluralin in Biobarrier caused an increase in root branching, which increased root number. No roots of either species penetrated the Biobarrier. Wagar and Barker (5) also found that no birch *(Populus papyrifera)* roots penetrated the Biobarrier, but some *Populus trichocarpa* x *deltoides* and *Populus trichocarpa* roots did penetrate.

Most roots on both species without a barrier were located in the top 30 cm (12 in) of soil (Figure 1), and the number of roots decreased with increasing soil depth (Table 1). Roots were shifted

Table 1. Number of live oak roots and sycamore roots in various depth classes 90 cm away from tree and 15 cm outside of the Biobarrier.

Depth from soil line (cm)	Control (no barrier) root diameter class < 10 mm	> 10mm	Biobarrier root diameter class < 10mm	> 10mm
Live oak				
0–15	30	4	22	4
15–30	22	4	20	6
30–45	6a[1]	0	40b	6
45–60	9a	0	26b	0
Total	*67a*	*8*	*108b*	*16*
Sycamore				
0–15	28	11b	14	3a
15–30	18	4	19	8
30–45	11a	3	38b	5
45–60	6a	3	25b	3
Total	*63a*	*21*	*96b*	*19*

[1]Numbers in a row with different letters indicate significant difference at $p < 0.05$ with Duncan's MRT.

Table 2. Percent of roots in various depth classes for live oak and sycamore 0.9 and 2.1 m from the trunk.

Depth from soil line (cm)	Distance from trunk (m) 0.9 m[1] Biobarrier	0.9 m Control	2.1 m Biobarrier	2.1 m Control
Live oak				
0–15	21%	45%	53%	88%
15–30	21%	35%	22%	12%
30–45	37%	8%	7%	0
45–60	21%	12%	18%	0
Sycamore				
0–15	15%	46%	52%	84%
15–30	23%	26%	16%	8%
30–45	37%	17%	12%	8%
45–60	25%	11%	20%	0

[1]This was 15 cm outside the Biobarrier.

Figure 1. On trees without a root barrier, most roots were within the top 30 cm of soil. The large diameter roots near the soil surface could eventually raise a sidewalk nearby. Note the trunk on the left and the irrigation tubing on the soil surface.

Figure 2. Biobarrier forced roots to grow deeper in the soil profile, but once under the barrier, many quickly grew back toward the soil surface. The tree trunk is located off to the left of the photograph.

to deeper soil depths in the Biobarrier treatment. The number of roots 15 cm (6 in) from the Biobarrier increased with soil depth, with most roots 30 to 45 cm (12 to 18 in) below the soil surface. In agreement with Barker (1,2), there appeared to be no question that the barrier encouraged roots to grow deeper in the soil. Despite the increase in the number of deep roots for the Biobarrier treatment, many roots 15 cm (6 in) away from the barrier were still located in the top 15 cm (6 in) of soil. Many of these roots appeared to be in the top 8 cm (3 in). This resulted from roots that grew nearly straight up toward the soil surface once they grew under the barrier (Figure 2). These roots often were only several cm below the soil surface once they turned parallel to the soil surface. Wagar (4) also reported that roots in poorly drained soil quickly returned to the soil surface after growing under a physical barrier.

The effect of the root barrier on root distribution can be presented in another manner (Table 2). Eighty percent (oak) and 72% (sycamore) of roots greater than 3 mm in diameter and 0.9 m (3 ft) from the trunk without a barrier (control) were in the top 30 cm (12 in) of soil. However, only 42% (oak) and 38% (sycamore) of roots were in the top 30 cm (12 in) for trees with the root barrier. On the trench wall another 1.2 m (4 ft) away from trees with the barrier, 75% (oak) and 68% (sycamore) of the roots were in the top 30 cm (12 in). More than half of these roots on both species were in the top 15 cm, and some of these were just under the surface of the soil. If there were a 1.2 m wide (4 ft) sidewalk installed at the site, these roots are likely to be close enough to the under side of the slab to begin lifting it in a few years. Although roots were deflected to the deeper soil layers, once under the Biobarrier enough of the roots made their way to the soil surface layer [top 15 cm (6 in)] to presumably be in position to damage the walk.

Summary

Biobarrier enhanced the root growth deeper in the soil, but in the high water table in this study many of these returned to the soil surface by the time they had grown 1.2 m (4 ft) away from the barrier. Some roots grew nearly straight up after growing under the barrier in what appeared to be the original trench dug to initially install the barrier. They were probably following the less compacted, better aerated soil filled in around the barrier during installation.

This study shows that fewer roots grew in the top 30 cm (12 in) of soil beyond a root barrier installed in a soil with a high water table. It is not known whether this reduction in root number would translate into less root damage to sidewalks. It could be that 1 or 2 roots might cause as much damage as a greater number of roots. More research and field experience are needed with root barriers, especially in poorly drained and com-

pacted soils, to make conclusions about the effectiveness of root barriers in prolonging sidewalk life. Previous studies showed that in well-drained, silty clay loam, roots of 2 tree species were deflected down to deeper soil layers and that these roots did not grow up toward the soil surface for at least 1 m away from the tree (1,2). This suggests that root barriers might be most effective in soils where they are least needed, i.e., in well-drained, noncompacted sites. Further research should compare root barrier effectiveness in well-drained sites with that in compacted sites.

Literature Cited

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Résumé. Aucune racine de chêne vert (*Quercus virginiana*) ou de platane (*Platanus occidentalis*) ont pu passer au travers du Biobarrier au cours des trois années suivant la plantation des arbres. La plupart des racines des deux espèces, en l'absence de barrière, étaient localisées dans les 30 premiers centimètres (12 po) de sol et le nombre de racines décroissait avec l'augmentation de la profondeur dans le sol. Dans le cas du traitement avec le Biobarrier, les racines étaient localisées à des profondeurs supérieures au-delà de la barrière. Le nombre de racines à 15 cm (6 po) de distance du Biobarrier augmentait avec la profondeur du sol, la plupart des racines se situant entre 30 et 45 cm (12 à 18 po) sous la surface du sol. Le Biobarrier forçait les racines à descendre plus profondément dans le sol, mais avec la présence de la nappe phréatique qui se situait près de la surface dans le cadre de cette étude, plusieurs racines ont alors cherché à retourner près de la surface du sol une fois qu'elles ont pu croître 1,2 m (4 pi) au-delà de la barrière.

Zussammenfassung. Während einer dreijährigen Periode nach der Pflanzung durchdrangen weder die Wurzeln der Lebenseiche *(Quercus virginiana)* noch der Platane *(Platanus occidentalis)* die Biobarriere . Die meisten Wurzeln beider Baumarten, die ohne die Biobarriere gepflanzt wurden, waren in den oberen 30 cm Boden angesiedelt und die Anzahl der Wurzeln nahm mit zunehmender Tiefe ab. Die Wurzeln wuchsen in tieferen Tiefen jenseits der Biobarriere. Die Anzahl der Wurzeln nahn 15 cm unterhalb der Biobarriere zu, während die meisten Wurzeln in 30 45 cm Tiefe zu finden waren. Die Biobarriere verursacht tieferes Wurzeln, aber bei dem hohen Bodenwasserspiegel in dieser Studie wuchsen viele Wurzeln, nachdem sie eine Entfernung von ca. 1,2 m von der Barriere hatten, wieder nach oben zu Bodenoberfläche.