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Root Barrier and Extension

Pau

Abstract

In California, repairing sidewalk damage associated with tree roots exceeds $62 million annual
this study, three types of root barriers were installed and evaluated to determine whether 1) int
(12 in.) of soil. The three barriers tested included 1) a modified production container, partially le
intended to prevent circling roots and 3) a commercial product with vertical ribs spaced 12.5 cm
and grown for three years with and without root barriers. The extension casing reduced root bio
largest roots outside of the casing was also significantly smaller. Mean root diameters and bion
the barrier walls, then grew upwards to depths similar to the controls (37 cm [14.5 in]). Althoug
diminished when commercial barriers with internal vertical ribs were used. Mean top growth wa

Key words:

root physiology, sidewalk, infrastructure, root biomass, urban forest, urban trees

Introduction

In the United States and abroad, public works officials, engineers, street tree managers and arl
and buildings (Rolf *et al.,* 1995; Kopinga, 1994). Several methods for re-directing root growth a
1993). Additionally, integrated approaches to site design are being discussed and studied, inclu
tree growth rates and maintenance requirements, and tree proximity to structures and open spa

Barriers guide initial root development downward, potentially resulting in a spatial separation be throughout a greater volume of soil, consequently delaying the time when sidewalks are advers Southwestern black cherries (*Prunus serotina* subsp. *virens* var. *virens*) and European hackber applied to two sycamore species (*Platanus acerifolia* and *P. wrightii*) showed nearly a 50% red herbicide-impregnated fabric and a rigid plastic material without internal vertical ribs. However, system and possibly impair sap movement. Other studies using chemical and plastic barriers h 1995; Wagar and Barker, 1993). Typically, barriers have been installed at approximately 60 cm deep (Barker, 1995 a,b). Beyond these two studies, little has been done to determine optimum dense and/or poorly aerated soils).

The objectives of this study were to determine 1) if the use of root barriers, installed at a 30 cm root development in the top 33 cm (13 in.) of soil and 2) if the use of barriers with internal vertic

Materials and Methods

The study plot was located at the Solano Urban Forestry Research Area (SUFRA), Suisun City Mean high and low temperatures (30-year) are 21.6 and 9.4C (71 and 49F). The soil, classified loam without mottling. It has a pH range of 6.5-7.5 and an electrical conductivity for soluble salt

Fifty-six Chinese hackberry (*Celtis sinensis*) trees were seed-propagated and grown the first tw containers, with extension casings where applicable. Extension casings were custom fabricate in previous studies (Barker 1995a,b, 1994). Casings measured 26 cm (10 in.) deep and 18 cm top of the soil medium filling the 26-liter (7-gal) containers (Figure 1). Combining the extension produced in the non-extended 26 liter (7-gal) containers. New growth on the cuttings was prune

Trees were planted in a randomized complete block design with 4 levels of barrier treatments: (3) Tree Root Planter barrier with internal vertical ribs spaced at 12.5 cm (5 in.) intervals, and (disced and leveled. A tractor-mounted 60 cm (24 in.) diameter auger was used to drill planting casing treatments were then backfilled by hand until reaching a 31 cm (12 in.) depths, and Dee x 30 cm (24 in. x 12 in.) panels connected by plastic interlocking strips to form circular planting in.) above ground, with depth below ground at 28 cm (11 in.). Holes for the extension casing tre planted and staked. Tops of extension casings also extended 2.54-cm (1 in.) above ground to

Differences in the two commercial barriers included anti-lift tabs on the DeepRoot barriers desi features notches on the bottom edge of each barrier designed to tear as tree roots enlarge (Pe

Trees were irrigated for 24 hours every 10 days from April through mid-October each year. In A m^3 (1.3 yd^3) pit was excavated manually around each tree to expose roots in the top 33 cm (13 four-tine cultivator, soil was removed from around roots into the trench. For the control and exte radius as barriers) so that regardless of treatment type, all trees were uniformly excavated from exposed to the 33 cm (13 in.) depth, data were collected as delineated below. The second stag were collected from this 'inside barrier' area.

Data collected included 1) total root dry weight inside barrier, 2) total root dry weight outside ba diameter for the six largest roots growing 33 cm from bole center (4 cm outside of the barriers), largest roots. Outside roots were cut, dried and sorted into three size classes (<10 mm, 10-20

Soil bulk densities at two depths (10-15 cm and 30-35 cm) were measured to determine if soil

excavated pit (1.3 m from each tree bole) using a soil core sampler with a hammer attachment.

Tree responses (stem diameter at 30 cm [12 in.], tree height, crown volumes) were recorded ye formula for the shape of each tree (either horizontal or vertical ellipsoid). Barriers were periodic

A two-way analysis of variance (ANOVA) was conducted on all responses. Block-treatment inte possible pairwise comparisons and comparisons of all treatments against a control, respectivel

Results

Root growth and direction

Mean root dry weights inside and outside of the barriers and outside root diameter on the 6 larg (Table 1). Inside root biomass was reduced nearly five-fold (67 g or 2.4 oz. vs. 308 g or 10.9 oz between control, DeepRoot and Tree Root Planter treatment root weights or diameters. Howev cm (13 in.) from bole center (4 cm outside of barriers), roots essentially grew down to the same respectively. The extension casing ended at 23 cm (9 in.) below ground and mean root depth w surface for all treatments except the control (Figure 2). Controls did not show significant downw cm, respectively. Tree Root Planter and DeepRoot roots changed the most in elevation betwee ascended 2.1 cm (0.8 in.). At 66 cm, all three treatments were significantly deeper than the cor treatments.

Extension casing root diameters were significantly smaller across the three size classes measu

Circling roots

Only one root on each of two trees in the two barrier treatments 'jumped' the internal vertical rib from 1 to 7 per tree. The extension casing treatment, however, had no internal vertical ribs and circling at least half the circumference of the casing.

Tree growth

Differences in stem diameter and total height measurements over the three- year growth perioc per year and mean height growth was 0.40 m per year (1.3 ft). Crown volumes also showed no

Soil Bulk Density

Bulk densities were not significantly different among treatments. Mean bulk density across trea at the deeper level, both levels were below the 1.50 g/cm^3 critical bulk density level that can lim

Barrier structural integrity and tree stability

None of the commercial root barrier panels or connecting devices showed signs of disintegratic reducing the potential of lifting the barrier. Two large roots growing beneath these notches had

Two of the 6 mil polyethylene extension casings had partially disintegrated below ground level, tops which extended 2.5 cm (1 in.) above ground. No trees died or blew over during the 3 years

Discussion

Root biomass and diameter was significantly reduced by the casing treatment, but not by the c
treatment affect root growth. Two previous studies conducted at SUFRA on European hackber
casing alone has a greater effect (Barker, 1995 a, b). Barker found no significant difference in c
fold for both species. Here, a 54 cm deep rootball with top-half encased reduced Chinese hack
merits further investigation.

The studies also reveal variation in different species' responses to barrier treatments. The two
outside biomass of white mulberry (*Morus alba*) in a prior study (Peper, 1998). Extension casin
being tested (Barker, 1995a,b). Such variability in root biomass reduction is a reflection of spec
variability (along with soil conditions) will determine the effectiveness of barriers in reducing ha
planted in urban environments.

The casings also reduced root diameters by nearly half. Additional research is needed to study
treatment might extend the time before damage occurs.

The fact that the casing treatment did not reduce top growth suggests that root development at
thriving 2 years after all roots in the top 30 cm of soil were cut and removed supports this conc
study. There are many urban locations were soils are too compacted to plant a rootball this de

This is the second study at SUFRA where Tree Root Planter and DeepRoot treatments have n
most effective if they reduced both root mass (or number of roots) and diameter. Results from
an effective deterrent to surface root growth and distribution. However, both studies indicate th
were redirected downward by the ribs. The casing treatment lacked internal vertical ribs and ci
a potential for structural weakness in the future.

One concern regarding root barrier use is whether or not they compromise tree stability. There
1994), but little actual research conducted (e.g., excavation of a valid sample size of such trees
analysis). We did not measure in-ground stability of trees, but none of the trees died or blew ov
year after excavation and surface root removal.

Cities that have adopted ordinances regarding root barrier installation for new tree plantings ty
barriers is a first step toward determining optimum barrier depths. Optimum depth depends on
Urban Forest Research Area has few, if any, qualities that would limit plant growth. The deep,
construction rubble, highly compacted, and shallow. However, our studies suggest that species
at SUFRA were adequate for deep-rooting (removal of six year old mulberry and sycamore tre
surface levels within 0.7 m of the trees.

The surface roots of some species can grow at deeper levels because they have broader rang
(*Fraxina oxycarpa* 'Raywood') and poplar (*Populus nigra* 'Italica'), do not appear tolerant of cha
Chinese hackberry is also less tolerant of change. Certainly, the commercial circling barriers in
installed in well-drained, non-compacted soils.

Conclusions

The results add to previous evidence that a rootball casing of polyethylene plastic reduces the
prevalent within the casings, but were deflected downward by the internal vertical ribs on the tw
root biomass and diameter.

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Use of trade or firm names in this paper is for reader information and does not imply endorsem

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Table 1. Results for all possible pairwise comparisons (Tukey) between all treatment means an diameter for the extension casing treatment only. Depths of roots from ground surface were me casing treatment roots were growing at a deeper level.

Treatment	**Root Dry Weight Inside Barrier (kg)**	**Root Dry Weight Outside (kg)**
Control	†0.308 a	0.684 a
DeepRoot	0.389 a	0.616 a
Tree Root Planter	0.376 a	0.633 a
Extension Casing	0.067 b	0.345 b
se	0.047	0.065

† = treatments followed by the same letter are not significant at = 0.05.

Figure 1. The basic growing containers used for producing the study trees were 26 liters (7 gal. removed from containers and planted with extension casings remaining to act as barriers (C). F Root Planter (D) and DeepRoot (E) commercial root barriers. Control trees were planted withou

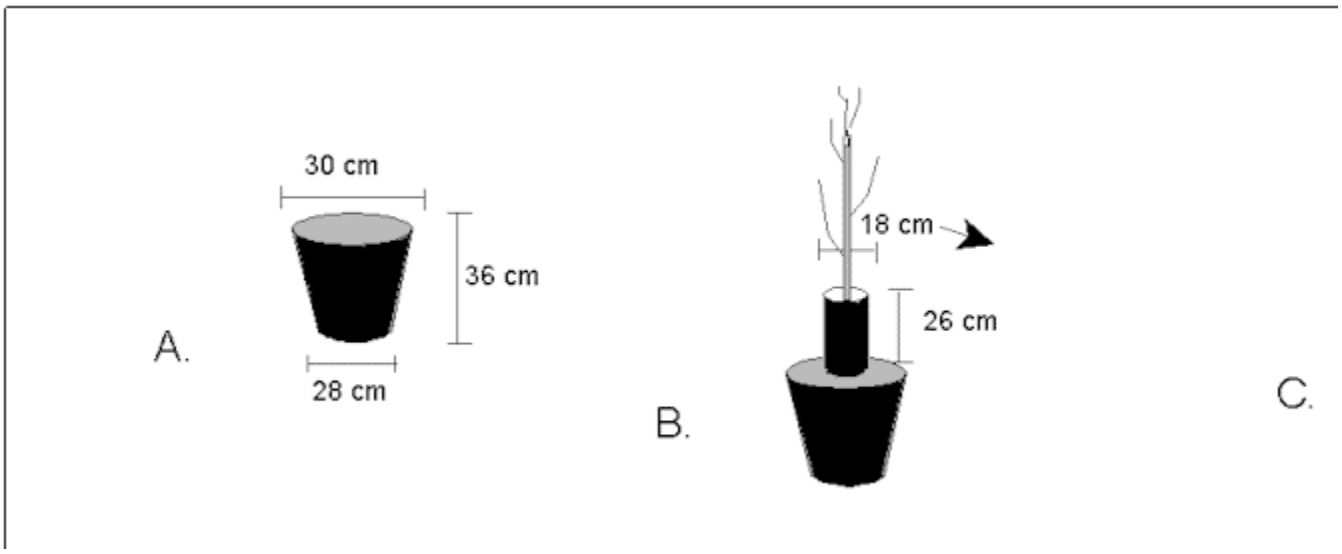
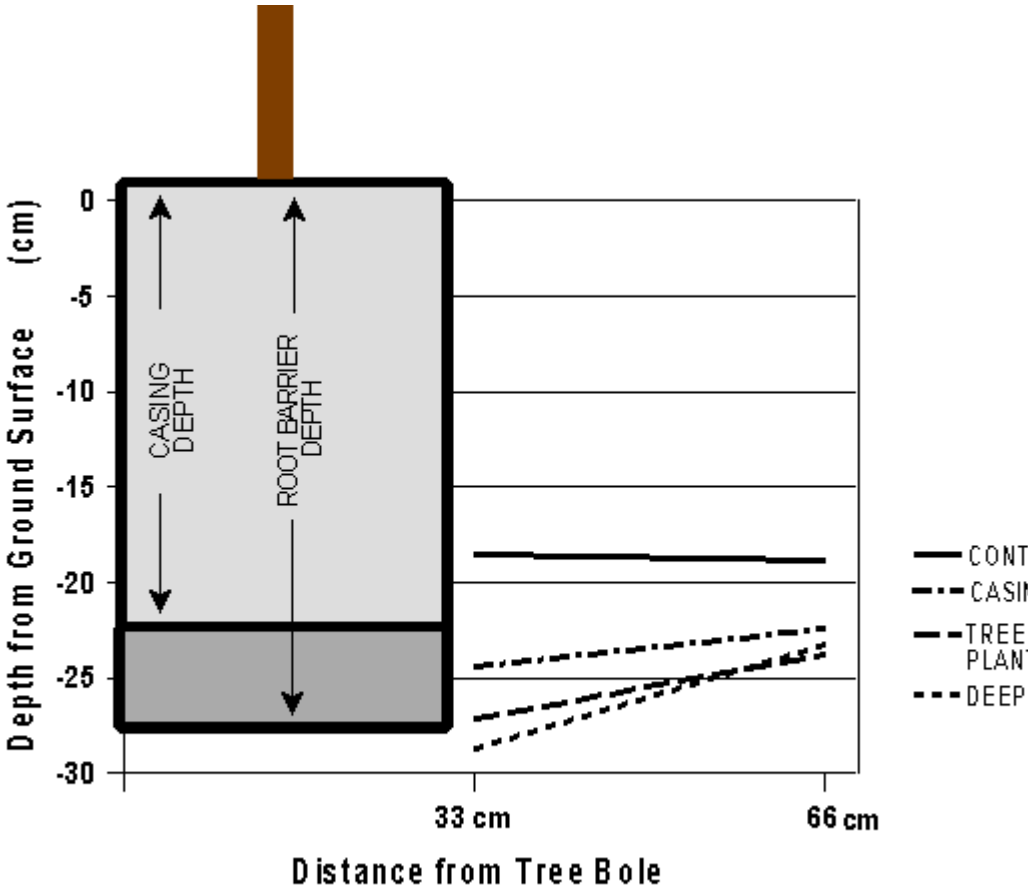
Figure 2. Mean depth of : the six largest roots growing at two distances (33 and 66 cm) from th
or just below the bottom of the barriers and casings. At 66 cm (37 cm or 14.5 in from the barrie