# SIDEWALK AND SOIL AMENDMENT EFFECTS ON GROWTH OF ZELKOVA AND FRUITLESS MULBERRY

by J. Alan Wagar

In a study of tree root response to sidewalks, soil amendments, and root-control procedures, some trees became larger than others after two growing seasons. Reasons for differences in growth were examined and are reported here.

In June 1980, 36 zelkova (*Zelkova serrata*) and 36 fruitless mulberry (*Morus alba*) trees were planted in 12 rows of 6 each on the grounds of the Department of Environmental Horticulture, University of California, Davis (Fig. 1). Fruitless mulberry was selected because its roots are notorious for damaging sidewalks. Zelkova was selected as a slower-growing species to contrast with the mulberry. Trees for each species included 32 experimental trees and 4 extras (to replace any trees that died and to permit practice excavation). Trees were purchased in 5-gallon containers and, when planted, were about 7 feet tall and 0.7 inches in diameter 20 inches above their root collars.

Before the trees were planted, a sidewalk 3 feet wide, 3 to 4 inches thick, and 108 feet long was installed every second row. In each row trees were spaced 18 feet apart, with 18 feet between rows.

During summer 1980, each tree was fertilized

**1. Zelkova and mulberry trees were planted in 12 rows of 6 each at Davis, California.**

and was watered twice weekly. In October 1980, the entire study area was rototilled, fertilized, and seeded to perennial ryegrass to simulate the usual environment of street trees. During the second growing season, the grass was mowed and watered as needed, and fertilizer was applied to each tree as well as to the entire area, including sidewalks. Grass within 3 feet of tree trunks was poisoned to reduce competition.

Each of the 64 experimental trees was assigned a combination of sidewalk, soil-amendment, and root-control treatments, with two trees receiving each combination, as follows:

| | Soil Amended | Soil Not Amended |
|---|---|---|
| **Control**-tree planted with no provision for root control | 2 trees by walk<br>2 trees no walk | 2 trees by walk<br>2 trees no walk |
| **Deeproot**-tree planted in rigid plastic control planter with sloping sides to direct roots to deeper layers | 2 trees by walk<br>2 trees, no walk | 2 trees by walk<br>2 trees, no walk |
| **Polyethylene**-vertical sides of 30-inch square planting hole lined with 5-mil sheet plastic | 2 trees by walk<br>2 trees, no walk | 2 trees by walk<br>2 trees, no walk |
| **Well**-tree planted with root collar 18 inches below soil surface in well 16 inches in diameter | 2 trees by walk<br>2 trees, no walk | 2 trees by walk<br>2 trees, no walk |

The study area was divided into two blocks of six rows each, with each block containing all treatment combinations. Except as constrained by block and sidewalk location, the position of all treatment combinations was assigned at random. Trees in the sidewalk treatment were planted with their trunks about 18 inches from the sidewalk edge; trees in the *no* sidewalk treatment were planted about 18 feet from the nearest sidewalk. For trees assigned amendment treatments, the backfill consisted of equal parts of native soil (Yolo clay-loam), sand, and peat; for trees assigned the no amendment treatments, backfill was of native soil only.

Planting holes for all trees were 30 inches square, with holes for well treatments 42 inches deep and all others 24 inches deep. For the deeproot treatment, backfill of soil or soil-amendment mixture was used only for the bottom 4 inches of the planting hole and inside each planter. Planters were 22 inches square at the top, 29 inches square at the bottom, and 18 inches high. The space between each planter and the sides of the hole was filled with ¾-inch gravel and the top of the planter was also covered with 2 inches of gravel. Each well was formed with a ring of galvanized sheet steel 18 inches high and 16 inches in diameter.

The diameter of each tree was measured in July 1980 approximately 20 inches above the root collar and again in October 1981 6 inches above the root collar. At each time of measurement, two caliper measurements were taken for each tree and averaged. Growth in basal area, the amount by which the cross-sectional area of the trunk increased, was expressed for each tree as:

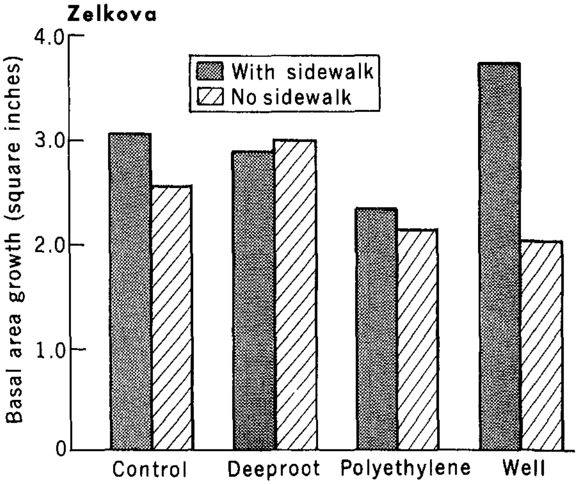
$$\pi \left[ \frac{(1981 \text{ diameter})^2 - (1980 \text{ diameter})^2}{4} \right]$$

Differences in growth rates were tested for significance by analysis of variance.

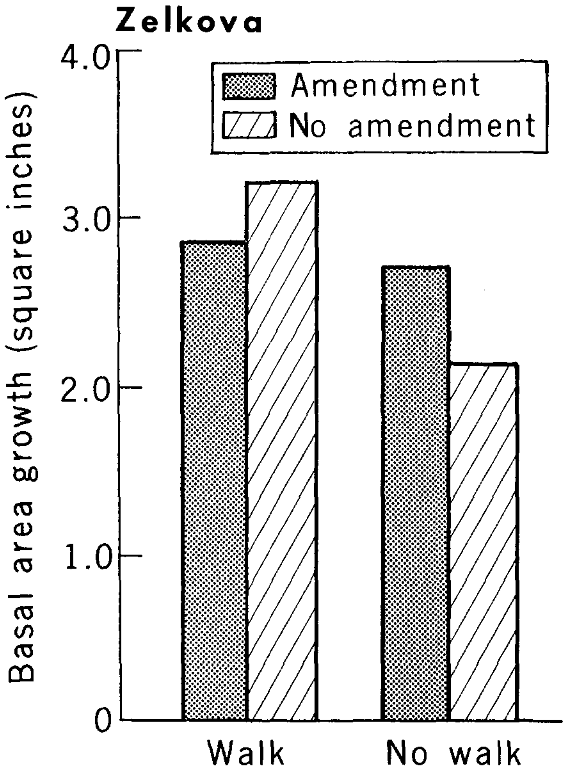
Analysis of basal area growth showed that the two species responded differently to treatments. Growth of zelkova was strongly affected by sidewalks and their interactions with root-control and soil-amendment treatments. Trees planted adjacent to sidewalks grew significantly more than those planted away from sidewalks, and growth was greatest for the trees whose roots were not constrained by barriers that would keep most or all of their roots from growing under the walks (Fig. 2). For mulberry, presence or absence of sidewalks made little difference.

For both zelkova and mulberry, effects of soil amendment depended on what other treatments were applied. Soil amendment increased growth of zelkova in the absence of sidewalks, but slowed its growth when sidewalks were present (Fig. 3). Soil amendment increased the growth of mulberry planted in wells, but slowed its growth in all other treatments (Fig. 4).

The effects of sidewalks on the growth of




**2. Effect of root-control treatments and sidewalks on growth of zelkova trees. Interaction between root-control and sidewalks significant at P = .05; sidewalk effect significant at P = .01.**




**3. Interacting effects of sidewalks and soil amendment on growth of zelkova trees, significant at P = .05.**

zelkova trees seem to result primarily from soil temperature. In contrast with the surrounding sod, concrete sidewalks heat markedly during the sunny summer days at Davis. Some of the heat is undoubtedly transferred to the underlying soil. Among zelkova trees, those in wells beside sidewalks grew faster than all others, and those in wells away from sidewalks grew slower than all others. Trees having their roots deep, in soils apparently warmed by sidewalks, may be exploiting greater volumes of soil — a possibility to be examined in 2 or 3 years when the root systems of all trees in the study are excavated and measured. Slower growth of zelkova trees in wells without sidewalks suggests that the deeper soils are below optimal temperatures in the absence of sidewalks.

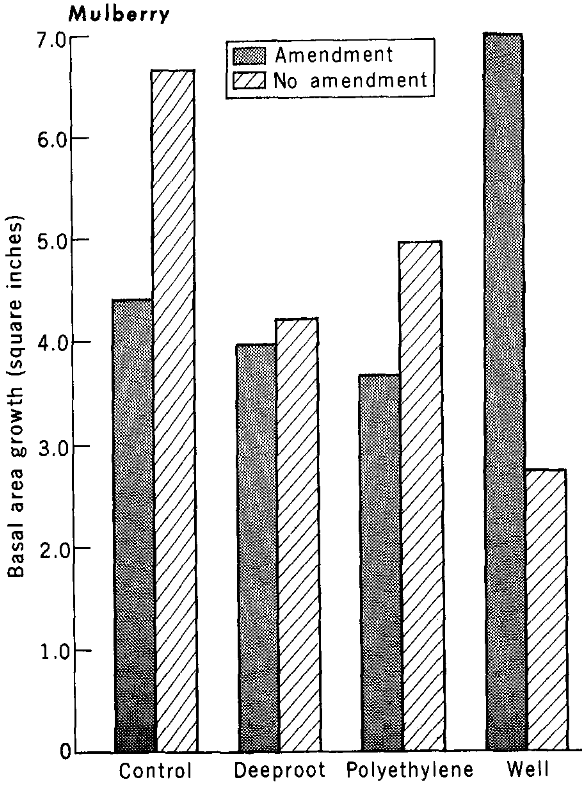
Alternative explanations for sidewalk effects include reduced competition resulting when sidewalks replace sod, improved moisture relations resulting from water concentrating at sidewalk edges and by reduced evaporation, and concentration of fertilizer washed from sidewalks during sprinkler irrigation.

Temperature effects probably outweighed competition, moisture, and nutrient effects for three reasons. All trees were fertilized and watered regularly, making it unlikely that moisture and nutrients were limiting factors. The effects of sidewalks were least for the trees planted with barriers. This probably kept their roots from reaching the soil most warmed by sidewalks. The effects of sidewalks were most pronounced for the well treatment. This caused the roots to be in deeper and normally cooler soil layers.

Wells could have caught extra nutrients when fertilizer was washed off the sidewalks. As compared with trees surrounded by deeproot or polyethylene barriers, control trees also could have had greater access to nutrients concentrated by sidewalks. Growth patterns were consistent with a hypothesis that sidewalks affected growth of zelkova by concentrating nutrients (Fig. 2). But the fact that mulberry had no extra growth associated with sidewalks casts doubt on a link between sidewalk effects and nutrient patterns. Foliar analyses and measurement of soil temperature and moisture patterns are planned to clarify these relationships.

As the trees grow, any temperature effects of sidewalks may diminish. Larger crowns will shade more of the walks, and as root systems enlarge, the portion under an adjacent sidewalk should decrease. Trees adjacent to streets or other extensive paving, however, could have an increasing portion of their root system affected by such pavement.

The slowed growth of zelkovas planted with soil amendment and adjacent to sidewalks could indicate that the peat in the amendment mixture acted as an insulator to reduce the warming effects of the nearby concrete. Again, temperature measurements may clarify relationships. In the absence of sidewalks, the greater growth of zelkovas planted with soil amendment could be explained by light-textured soils affecting plant growth in ways similar to warm sites.




**4. Interacting effects of root-control treatments and soil amendment on growth of fruitless mulberry trees, significant at P = .001.**

The reason mulberry trees grew so poorly in wells without soil amendment may be an artifact of poor drainage. Three of the four trees having this treatment combination became waterlogged on several occasions, with the wells filling to the top and not draining completely for several days. Until the problem was corrected by reduced watering, stress in these three trees was indicated by yellowing of foliage. Amending the soil with peat and sand apparently increased the rate at which the water soaked away in the well treatments.

Mulberry trees planted in wells with soil amendment grew faster than all others of this species. The greater growth may have resulted from improved aeration in an increased volume of soil. Whether or not trees in this treatment are exploiting increased volumes of soil will be examined when root systems are excavated. The slowed growth associated with soil amendment for mulberry trees planted with root collars at ground level suggests that aeration is not a limiting factor in the shallower soil layers. The amended soil is apparently less effective than native soil as a growing medium for mulberry trees.

The fact that two species reacted differently to identical experimental conditions suggests caution in generalizing about treatment effects. The only findings common to both species are that both adding soil amendments and planting in wells can slow growth in some circumstances and speed it in others.

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## CORRECTION

**In the process of preparing for publication the manuscript of Tom Perry on Tree Roots (J. Arboriculture 8(8): 197-211), the diagrams on pages 204 and 205 were switched. Please note the correction in your copy.**