# Selection and Propagation of Deep-rooted Ornamental Trees for Urban Environments

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Ornamental trees in urban environments provide myriad biological, physical, economical and sociological benefits. Trees provide habitat for a wide range of animal life, function as cleansing mechanisms for polluted air, shade houses and other structures thus reducing the need for electrically-powered air conditioners during the summer and provide an environment in which human beings can connect with nature. However, some trees have root systems that cause damage to sidewalks, curbs and gutters. This damage is the result of planting trees in planting areas that are too small or too narrow and/or the trees' inherent tendency to have shallow, horizontally-oriented roots. This problem is of major proportions in many cities in California. In a survey of cities in the Bay Area in 1984, 60% of the street trees were estimated to have caused some or severe damage. A more recent survey of sidewalks in San Jose, CA, found the estimated repair cost for tree-related damage to be $14.3 million and annual concrete repair costs attributed to tree damage range from $0.18 to $13.65 per tree. It is quite apparent that even a partial solution to this problem would result in substantial savings for city residents and governments.

**Long-term Studies**

Fifty seed-propagated liners each of *Fraxinus uhdei*, *Pistacia chinensis* and *Zelkova serrata* were planted in field plots in Davis. In late 1998, the root systems of half the trees of each species were exposed using a newly developed supersonic air technique (Gross, personal communication). Each root system was marked and photographed from 3-4 angles (Figure 1). The photographs were scanned and imported into PhotoModeler Pro 3.0 (Eos Systems, Inc.) computer software for the creation of three-dimensional models (Figure 2). The 3-D models will be used to determine the vertical orientation angles of each tree's major roots (in progress). Those individual trees having the largest and smallest mean vertical angle from the soil surface will be selected for further vegetative propagation and subsequent field trial.

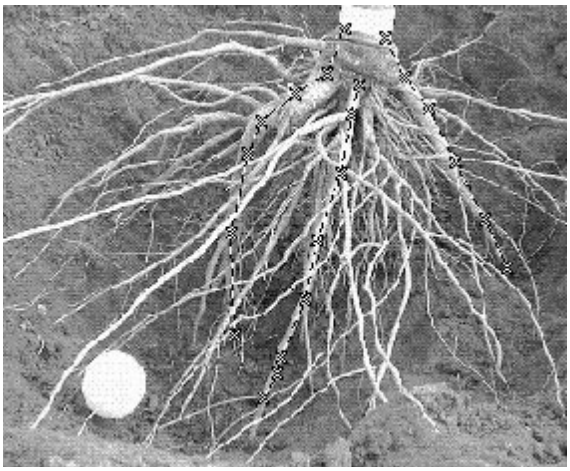

***Figure 1. Photograph of exposed root system that had been marked for creation of 3-D model. White sphere in lower-left corner is 2 in (5.1 cm) in diameter.***

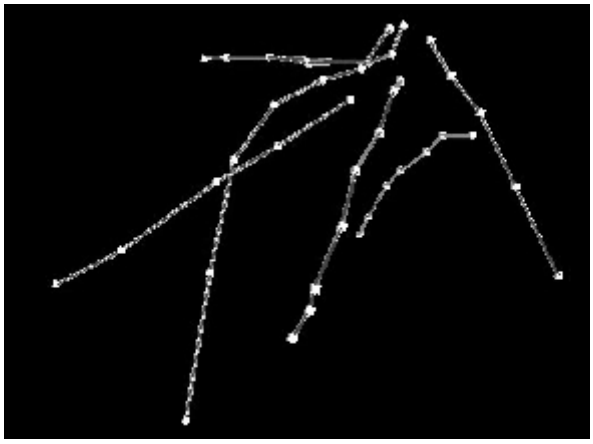

***Figure 2. 3-D model showing position and angle of major structural roots for the root system photographed in Figure 1.***

**Short-term Studies**

Germination experiments have been conducted in the laboratory with *Pistacia chinensis* and *Fraxinus uhdei* seedlings. *Pistacia* and *Fraxinus* seeds were germinated *in vitro* in solutions with and without calcium ion, photographs were taken of the seedlings, lateral roots were counted and their angle from the vertical was measured. Lateral roots with large angles of attachment (relative to the vertical) are oriented outward whereas lateral roots with small angles of attachment are oriented downward (Figures 3 and 4).

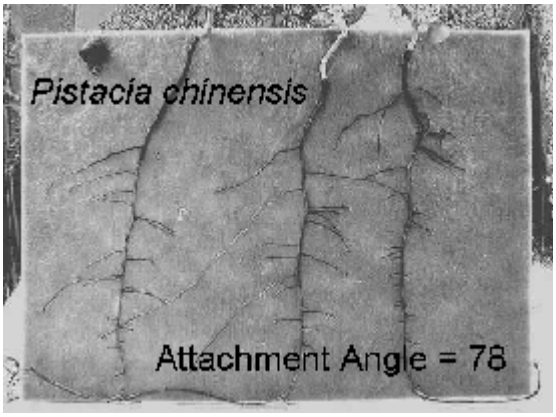


***Figure 3. Lateral root development in Pistacia seedlings germinating in a solution containing calcium.***

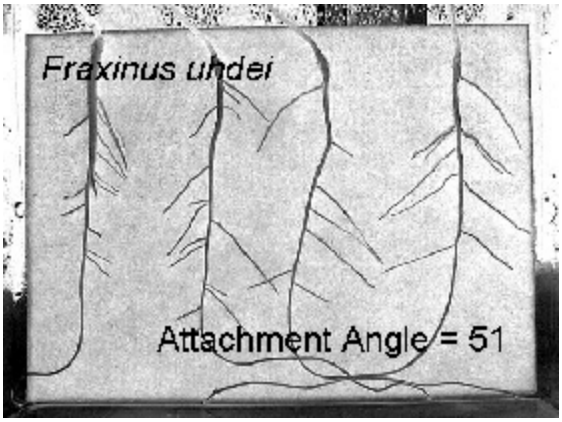


***Figure 4. Lateral root development in Fraxinus seedlings germinating in a solution containing calcium.***

**Results and Discussion**

*Fraxinus uhdei* seedlings had root systems that were more vertically oriented and were comprised of fewer roots than were roots systems of *Pistacia chinensis* (Table 1). The presence of $Ca^{+2}$ had no effect on the *Pistacia* roots whereas $Ca^{+2}$ increased the attachment angle of *Fraxinus* roots.

**Conclusions**

This system will be used to ask the following questions in the upcoming year:

1) Can chemical (EDTA, calcium salts) soil treatments influence root deflection and orientation? (EDTA binds/immobilizes $Ca^{+2}$ ions causing roots to become totally unresponsive to gravity while unilateral $Ca^{+2}$ applications deflect roots toward the source of $Ca^{+2}$)?

2) Will root system architectural characteristics (e.g., root angle from the soil surface) for field-grown trees be maintained after vegetative propagation?

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**Table 1. Attachment angle of lateral roots for *Pistacia* and *Fraxinus* seedlings germinating in solutions without and with calcium.**

| Tree species | Attachment angle of lateral roots (from the vertical) | |
|---|---|---|
| | Without $Ca^{+2}$ | With $Ca^{+2}$ |
| *Pistacia chinensis* | 78 a | 78 a |
| *Fraxinus uhdei* | 61 b | 51 b |

Statistical analyses performed using SAS. Values followed by the same letter for each measured characteristic are not significantly different at p = 0.05.