Research on Oaks at Cornell's Urban Horticulture Institute – Part I

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Cornell University first began its Urban Horticulture Institute in 1980, and was the first university in the United States to sponsor a research program specifically targeted to the problems of plants in the urban environment. Fifteen years later we have an active, established program with myself and Dr. Tom Whitlow as faculty, a full-time technician, and eight graduate students. Additionally, researchers from this country and abroad often pass through our program while on sabbatic, cross pollinating our respective research perspectives.

If our mission is a broad one, to use horticultural science to improve plant growth in the urban environment, then our goals are more specific. We must concentrate on improving the establishment of urban trees and shrubs in the landscape so that problems can be avoided before they arise. Specifically, we concentrate on four areas:

1. Survey and assessment of the urban environment: the thorough characterization of the urban environment, both above and below ground, to provide a quantitative baseline from which to generate hypotheses and predictions about environmental constraints to plant growth.

2. New plant materials: the selection and propagation of cultivars better suited to identified urban stresses (drought, soil compaction, salinity, alkalinity, flooding, etc.).

3. New technologies to modify sites for improved plant growth: developing innovative methods to mitigate environmental stress through site design, soil modification and site preparation.

4. Transplanting technology and root growth: investigating the nature of transplant setback and other variables affecting transplanting success, and understanding why some trees transplant more readily than others.

In the area of plant selection there are several on-going projects that may have interest for our colleagues associated with the International Oak Society. I would like to highlight the recent work on oaks.

Graduate student Gerald Bond is developing a screening protocol to identify trees tolerant of lime-induced iron chlorosis. Beginning with *Quercus macrocarpa,* we are exploring the variation that exists within this species which is native over a large area of the midwestern and eastern U.S., growing in soils with varying pH and moisture levels.

After collecting seed from many parts of the country with varying soil conditions, we decided to use a hydroponic system to screen for the seedlings' ability to take up iron under conditions of greater or lesser iron availability. We also are running parallel tests using a soil that is known to induce iron chlorosis. However, the hydroponic setup has several advantages in that we can make iron more or less available to the seedling using various iron chelates, while keeping all other factors constant. Simply changing the pH in a nutrient solution would alter too many other nutrients, therefore introducing extraneous factors which could interfere with the plant's response to iron.

Our first challenge came in the mechanics of growing uniform seedlings in a hydroponic setup. Germination, even after three months of stratification, was slow and erratic. By cutting off about a third to a half of the acorn and removing the pericarp, germination occurred uniformly within two to three weeks. Assured of a steady, uniform supply of newly germinated seedlings, we could then remove any remaining cotyledons (and with them their iron supply!) and grow them in a modified Hoagland solution with both air and CO_2 bubbling through. We were faced immediately with the need to force bud break on seedlings that already had set terminal buds. Using GA4+7 at 500 ppm in 50% aqueous ethanol, we wet the terminal buds

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every three days until the buds began to swell and elongate in about one week to 10 days. They grew rapidly thereafter, generally setting another terminal bud in about two months. Although the plants were grown under HD lamps and 16 hour days, we had to reapply the GA to force bud break again if we wanted continuous growth.

After many attempts, we found a solution that provided nutrients in the right amount to give us a good standard - a "control" with good green color and normal leaf development. It appears that oak seedlings are much less efficient at taking up certain micronutrients than many herbacous plants that have been grown hydroponically - many orders of magnitude less than a soybean, for instance.

We also have been experimenting with various chelates that make iron more or less available due to chelate structure and stability at various pH levels. We will begin our next screening experiment later this summer.

An issue related to the screening protocols is the issue of vegetative propagation of oaks. Other than *Quercus robur,* oaks are notoriously difficult to propagate asexually. We would like to achieve this for several reasons. First, we would like to be able to have clonal replicates of the various genotypes we will be screening. It is apparent already that there is enormous variability within each seed source. Either we will have to increase our replicates substantially, which begins to limit the number of treatments we can do at any one time, or we can reduce the variability by using clonal replicates. Fortunately, it is easier getting seedling shoots to root than older stock plants. Using stock-plant etiolation, we have had some success in rooting cuttings and will try to adapt this technique to produce the greatest number of rooted cuttings from a single seedling in the shortest period of time [for original work on this technique see Maynard and Bassuk, 1987 JASHS 112(273-276)].

Another reason we want to produce oaks asexually is so that we can replicate any promising individuals that are identified during the screening process. Even if budding or grafting were more feasible in oak (something problematic in its own right), the site of iron uptake is in the root, and so budding onto seedling rootstocks would serve no purpose.

Just recently we have had a breakthrough with oak propagation. By modifying the ancient technique of stool-bed layering, we have successfully rooted *Quercus alba.* In stool-bed layering, a young plant (approximately five years old) is cut down to the ground and the latent buds at its base are allowed to grow. After they reach a certain height, they are mounded with soil around the base of these new shoots to about two thirds up the stem. During this blanching process, which occurs over several months, roots form on the buried stem. In the autumn the stool mound is undercut, severing the now-rooted individual shoots from the mother plant.

The variation on this technique that has proven successful with white oaks has been to etiolate totally the newly growing latent buds as they are growing in late spring. To accomplish this, we inverted an aluminum foil-wrapped, five-gallon container over the cut shoot just as the latest buds were swelling. These light-tight coverings remained on until the shoots grew to 20-30 cm, after which time the pots were removed and the pale etiolated shoots were sprayed with 8000 ppm IBA at their bases and mounded over completely with peat humus, a lightweight, moisture-holding medium. The shoots then grew through the peat and were exposed gradually to light while their bases were removed in the pristine etiolated state. As of this writing, many long roots have formed in the mounds which had been pre-etiolated. Those treated in the traditional manner did not root.

The propagation maxim is true after all:
"If you want to propagate a tree, cut it down."

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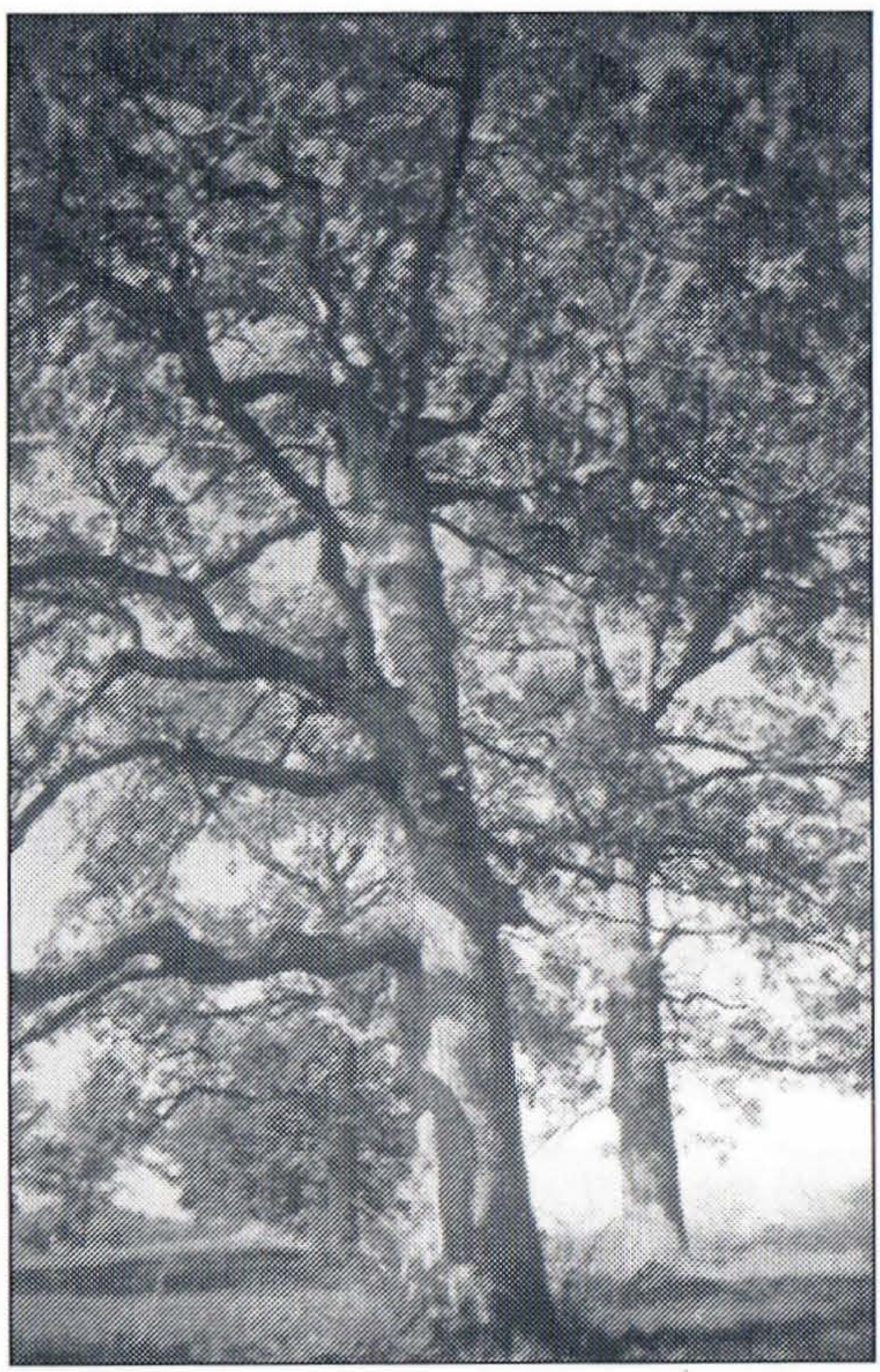

The Urban Horticulture Institute at Cornell University has developed a stool-bed procedure for rooting oak species such as this Quercus alba.