# Evaluation, propagation, and tissue culture of hybrid white oaks (*Quercus*) for the urban environment©

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Asexual propagation of oaks has proven difficult for the majority of *Quercus* species using traditional methods of grafting or rooting cuttings, with the exception of *Q. robur*. In order to develop improved oaks, clonal propagation methods are required along with an increased diversity of *Quercus* germplasm.

Cornell's Urban Horticulture Institute (UHI) has been working towards addressing limitations in propagation and germplasm diversity through its long-term white oak breeding program. This program was initially developed between 2004-2006, when over 345 unique genotypes of hybrid white oaks were generated using 40-parent species from North America, Europe, and Asia.

The goal of this project has been to develop elite oaks with enhanced characteristics such as stress tolerance (drought, high pH, cold hardiness, pest, and disease resistance) and ornamental quality. On an annual basis, stock plants are coppiced, forcing juvenile shoots from the stumps. These shoots can then be used for tissue culture establishment, to induce rooting using a stool bed method or allowed to grow to be evaluated.

To date the UHI progress has included the development of a modified stool bed technique to asexually propagate oaks via rooting that has successfully been used on a range of hybrid oaks. In 2016 an assessment was done of the hybrid oaks' capacity to osmotically adjust.

Osmotic adjustment, a drought tolerance mechanism in plants, was assessed using a vapor pressure osmometer. Screening of select hybrids was carried out in greenhouse experiments to determine their tolerance of high pH soils, a common stressor in urbanized environments. Hybrid oak seedlings have been field grown at Cornell Horticulture Section's research site in USDA Zone 5b (-15 to -10°F) allowing for assessment of cold hardiness. Disease pressure (anthracnose and powdery mildew) and pest pressure (scale, Japanese beetles, aphids, and galls) was qualitatively assessed and genotypes exhibiting high degrees of resistance were selected as candidates for tissue culture establishment.

Use of the modified stool bed method was successful in the clonal propagation of oaks. The number of trees produced each year remains low, limiting the viability of this method for large-scale nursery adoption. As a result, tissue culture methods are actively being developed by the UHI to overcome these limitations in production. Tissue culture (TC) was first trialed by UHI lab members in 2014 through 2015 with the successful establishment and multiplication of six genotypes of interest using methods developed for *Quercus* species *alba, bicolor,* and *rubra.* Although these TC methods exist for oaks they lack consistency required for adoption by commercial laboratories. Research is focusing on optimization of protocols for oak tissue culture as well as establishment of elite hybrids in culture.

While the methods developed by other researchers to date have been shown to be effective there are still a number of limitations including; failure of specific genotypes to establish in culture, episodic growth causing shoots to eventually die in culture, phenolic exudation from ex-plants reducing establishment and multiplication efficiency and ex-plant death, limited capacity for establishing oaks from mature stock plants, and location on stock plant (basal shoots vs. outer canopy) where shoots are harvested for use in tissue culture significantly affecting establishment success.

Research has continued in the 2016 season focusing on the establishment and multiplication phase of tissue culture. In this growing season successful establishment of an

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additional 14 hybrid white oak genotypes in tissue culture was achieved. Experiments have varied and include; induction of whole shoots into culture compared to individual nodal buds allowing for increased efficacy in establishment of oaks, use of the anti-oxidant PVP-40 as a phenolic exudate inhibitor in oaks and study of its interactions with plant growth regulators in tissue culture, experimentation with cytokinin meta-topolin for shoot multiplication phase, evaluation of combined effects of cytokinins (BAP, Zeatin) and auxin (IAA) on establishment and multiplication of *Q. bicolor*.

Future research aims to increase the total number of genotypes of interest into culture, development of an optimized establishment and multiplication protocol, experimentation with the rooting and acclimatization phases of tissue culture, and eventual release of elite hybrid white oaks to the green industry and public.