THIRTY YEARS OF COOPERATIVE OAK RESEARCH AND TECHNOLOGY DEVELOPMENT IN THE SOUTHERN REGION

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EXTENDED ABSTRACT

Southeastern North American forests have a tremendous diversity of oaks (*Quercus* L.), consisting of over 30 different species. These species provide wood, habitat, mast, and ecosystem and aesthetic values integral in consumptive and non-consumptive industries and lifestyles. By the late 1980s, oak recruitment failures and decline were widely recognized, and planting was seen as a potential solution (Crow 1988). Despite the common occurrence of oak and the long history of planting in this country, artificial regeneration protocols remain largely unrefined. The majority of previous research and technology transfer regarding planting oak was generated in central and northeastern forests on sites generally devoid of fast-growing competition like tulip-poplar (*Liriodendron tulipifera* L.) (Dey and others 2008). Additionally, seedlings used in southeastern plantings were generally from unpedigreed seed sources and were small in size (e.g., <2 feet in height), which may not be locally adapted and can be quickly overtopped by competing vegetation (Loftis 1979).

In 1992, a long-term partnership was initiated among three parties: (1) The University of Tennessee's Tree Improvement Program (UT-TIP); (2) the Southern Region, Genetic Resources Program (Region 8) of the Forest Service, U.S. Department of Agriculture (USDA); and (3) the Southern Research Station (SRS) of the Forest Service. Personnel from these participating programs pooled together associated expertise and resources to develop and test artificial regeneration protocols for oak species. The approach involved using high-quality, pedigreed seedlings for restoration and enrichment of the oak component in Southern Appalachian forests, following the pioneering research of Dr. Paul P. Kormanik and associates at the SRS Institute of Tree Root Biology (ITRB). For background, the ITRB began work in the 1980s to improve hardwood planting stock and establish baseline fertility and irrigation guidelines for nurseries that grow oak species (Kormanik and others 1994). These protocols were designed to grow hardwood seedlings in 1 year (i.e., 1-0 bare-root nursery seedlings) to their maximum growth. The oak seedlings were stimulated to flush up to seven times during a growing season, instead of the usual one or two flushes under traditional nursery practices. Because of the inherent variability in oak seedlings, approximately 50 percent of the best quality seedlings could be visually selected through commercial grading practices (Kormanik and others 1995). Resultant seedlings not only had increased above-ground stature, but the root systems showed a corresponding increase

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Citation for proceedings: Willis, John L.; Self, Andrew B.; Siegert, Courtney M., eds. 2022. Proceedings of the 21st Biennial Southern Silvicultural Research Conference. Gen. Tech. Rep. SRS-268. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 262 p. https://doi.org/10.2737/SRS-GTR-268.

in size, particularly the tap roots. The number of first-order lateral roots were shown to be a heritable trait and correlated well to seedling height and root-collar diameter (Kormanik and others 1997).

When the ITRB began working with oaks, they found that pedigreed oak seedlings were a rarity in Southern States, as there were very few seed orchards. Acorn collections from naturally occurring trees could have been made from individual trees, but were problematic. The collections depended on masting years, and most of the naturally occurring oaks in forests had relatively small crowns and did not produce many acorns. Availability and quality of acorns were also affected by mammalian and bird predation or damage from a variety of insects. To partially avoid these problems, Regional Geneticist, James L. McConnell, had the foresight to convert a large northern red oak progeny test on the Watauga Ranger District of the Cherokee National Forest to a seedling seed orchard in the mid-1980s. The resulting orchard (Watauga Northern Red Oak Seed Orchard) is the largest oak orchard (16 acres) in North America and is now capable of producing enough acorns to meet seedling demands on Southern Appalachian National Forests.

Acorn production in the Watauga Orchard was noted as early as 1984, when the orchard was still an 11-year-old progeny test. In 1990, UT-TIP began to study reproductive maturation in the orchard and to characterize acorn production in individual trees (Schlarbaum and others 1994). Eventually, UT-TIP become responsible for managing the orchard in the late 1990s and continues to manage the orchard in conjunction with the Southern Region. Acorn production was found to progressively increase as the trees become reproductively mature in the years after the orchard was created. The first significant crop occurred in 1993 (age 20) and was collected by pedigree for use by the above partnership to initiate a large-scale project to establish progeny tests and seed production areas across the Southern Region. The partnership was intitially distinguished from other research programs by integrating genetics, baseline nursery protocols, characterization of seedling quality, and geography of planting sites (mesic sites in the Southern Appalachians) in widespread experimental field plantings. Over time, the parternship has evolved to test high-quality, genetically improved seedlings across various silvicultural settings; further refine nursery protocols for using pedigreed acorns (fig. 1); characterize variation in seedling quality among mother trees; test the effects of top pruning on seedling development; and develop northern red oak seed orchard management protocols, which can be applied to other oak species (Clark and Schlarbaum 2018, Clark and others 2000, 2015).

Technology transfer to Federal and State agencies and private landowners has been an important part of the partnership since its inception. Results from the varied experiments have been transferred via various publications, meetings, workshops, presentations, and press interviews. Technology transfer opportunities will increase in the future, as the older studies continue to yield results and newer studies are established that build on the knowledge gained over the history of the partnership.

The acorn crops from the Watauga Orchard continue to be a nexus for the partnership, while other recent studies are using acorns and seedlings from other Southern Region and UT-TIP seed orchards of different oak species. Since 2013, the partnership has been formally recognized through a series of Memorandums of Understanding. Despite changes in personnel and scarcity of dedicated long-term funding during the 30-year history of the partnership, the goal of developing successful and economically feasible artifical regeneration of oaks species still remains at the core of this group's efforts.

ACKNOWLEDGMENTS

The authors thank David Mercker and Belinda Esham-Ferro for reviews. The authors thank Forest Service personnel: Glen Beaver, Jim Cunningham, Paul Kormanik, Taryn Kormanik, Jim McConnell, Bill Ostrosina, Susana Sung, and Mike Thompson; Georgia Forestry Commission personnel: Russell Ayres, Wayne Bellflower, Johnny Brannan, Jeff Fields, Russ Pohl, Greg Seabolt, and Jerry Scott; Tennessee Division of Forestry personnel: John Conn, Paul Ensminger, and Gina Sowders; UT-TIP personnel: David Casey, David Griffin, Jason Hogan, Gene Johnson, Allison Mains, Mark Miller, Ken Proffitt, and Ami Sharp; and the U.S. Department of Labor Older Americans Program.

Figure 1—U.S. Department of Agriculture (USDA) Forest Service personnel from the Southern Region and Southern Research Station and The University of Tennessee personnel gather at the Georgia Forestry Commission's (GFC) State Nursery to process and sort seedlings for reforestation and research plantings (top). Dr. Paul Kormanik at the GFC nursery (bottom). (USDA Forest Service photo by Barbara Crane).

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