AUGER PLANTING OF OAK SEEDLINGS IN NORTHERN ARKANSAS

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ABSTRACT.—Planting oak seedlings to regenerate upland oak forests is a promising but untested silvicultural practice in the Ozark Mountains of northern Arkansas. The stony (cherty) soils of the region make it difficult to dig deep planting holes using conventional hand planting tools. In 2001, we planted 1-0 northern red oak and white oak seedlings in 0.5 to 1 acre group selection openings in a northern Arkansas oak stand. Holes were dug with a one-person auger powered by a 4.7 cubic inch chainsaw engine. At the time of planting, average height of red oak and white oak was 3.4 feet and 1.9 feet. After one growing season, red oak and white oak survival was 87 percent and 96 percent. Mean annual height increment for both species was about 9 inches. We recommend using power augers when planting large oak seedlings on stony soils.

Oaks (*Quercus* spp.) are the dominant taxa in the overstory of mature upland hardwood forests in the Ozark Mountains of northern Arkansas. However, silvicultural efforts to regenerate oak naturally are often unsuccessful due to limited establishment and/or recruitment of oak seedlings. In Arkansas, this has lead to the gradual replacement of oaks with non-oak species such as red maple (*Acer rubrum* L.). Such a phenomenon has been reported throughout the midwestern and eastern United States (Abrams 1998).

Various explanations have been offered to explain why oaks are being replaced over such a large spatial scale. Currently, the hypothesis most widely accepted by scientists is that shade tolerant non-oak species accumulate beneath undisturbed mature oak forests and eventually recruit into the overstory following disturbances such as timber harvesting (Johnson 1993, Lorimer 1993, Larsen and Johnson 1998). The accumulation of non-oaks in lower canopy positions has been facilitated by fire suppression activities beginning in the early 20th century (Abrams 1992, Brose and others 2001).

As an alternative to natural regeneration, planting of oak seedlings on uplands may be a viable method of retaining an oak component in future stands. Planting studies have generally been established in clearcuts and small forest openings (e.g., Johnson 1984, Minter and others 1992, Ponder 1995, Zaczek and others 1997, Demchik and Sharpe 1999) or as underplantings beneath a partial overstory (e.g., Johnson 1984, Johnson and others 1986, Gordon and others 1995, Dey and Parker 1997, Bardon and others 1999). These studies indicate that oak seedling survival, diameter growth, and height growth are increased by competition control, the use of tree shelters, and by planting high quality seedlings with well-developed root systems.

Despite these findings, successfully applying research results to an operational level remains a challenge. In northern Arkansas, for example, planting oak on the Ozark-St. Francis National Forest is a new silvicultural practice. In 1999, the Sylamore Ranger District of the Ozark-St. Francis established a 50 acre field trial in which 2-0 northern red oak (*Quercus rubra* L.) seedlings were planted under a shelterwood. Seedling survival after 2 years was estimated to be less than 10 percent (Bob Rhodey personal communication). Forest Service foresters attributed the lack of success to a number of factors, including poor planting technique, low quality nursery stock, and severe summer droughts. Clearly, additional applied knowledge of artificial regeneration on uplands is needed for oak planting to gain widespread acceptance among resource managers.

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Prescriptions have been developed for planting northern red oak and white oak (*Quercus alba* L.) beneath shelterwoods in the Missouri Ozarks (Johnson and others 1986; Weigel and Johnson 1998a, 1998b). In 2001, we established a planting study in northern Arkansas that would begin to develop a protocol for planting oak in small forest openings in the Arkansas Ozarks. The objectives of this paper are to describe our planting methods and to report survival and growth results after the first growing season.

STUDY AREA

Research was conducted in a recently harvested 66 acre mature white oak-black oak (*Quercus velutina* Lam.)-northern red oak stand in northern Arkansas. The stand is on the Sylamore Ranger District of the Ozark-St. Francis National Forest. Soils are Noark and Clarksville very cherty silt loams. These are deep, well-drained to excessively well-drained soils that formed in residuum of cherty limestone (Ward 1983). Slopes range from 5-30 percent. Site index for white oak (base age 50) is 65-70 feet.

In late 1999-early 2000, the stand was commercially harvested using group selection. With this uneven-aged method, approximately one-sixth of the stand will be artificially regenerated with red and white oak seedlings at 10-year intervals in 0.25 to 1 acre scattered openings. We focused our planting activities in the 15 openings created by the harvest. During logging, merchantable trees were felled and saw logs were bucked and removed; tops and other slash were left on site. In January 2001, all stems > 1 inch dbh in the openings (i.e., the unmerchantable trees not felled during harvesting) were girdled by hand and chemically injected with Accord (glyphosate).

MATERIALS AND METHODS

In fall 1999, USDA Forest Service personnel collected red and white oak acorns from 30 phenotypically superior forest trees on the Ozark-St. Francis National Forest. The acorns were sown at the Georgia Forestry Commission's Flint River Nursery in Montezuma, Georgia. Oak seedlings grew at the nursery during the 2000 growing season. The nursery protocol included frequent applications of nitrogen (NH_4NO_3) and is described by Kormanik and others (1994, 2002). The goal of the nursery was to produce tall 1-0 oak seedlings (on average, white oak > 2 feet and red oak > 3 feet) with deep (8 to 10 inches), well-developed root systems.

Large seedlings require deep planting holes. We anticipated the very cherty soils at the planting site would make digging deep holes problematic. Consequently, in December 2000 to February 2001, we tested a number of digging tools at the planting site. We wanted to develop a methodology that would be appropriate both for our research project and for larger, operational planting efforts. Conventional hand tools like planting bars and planting hoes were simply unable to dig an 8-10 inch deep hole in the soil. The same was true of a one-person gasoline-powered auger with a 6 inch diameter auger and a 1.88 $inch^3$ (30.8 cm^3) engine. Planting shovels were somewhat more successful but were extremely time and labor intensive.

Eventually we found our most effective tool consisted of a 6-inch diameter by 31-inch long carbide auger that was connected to a Cannon Tree Planter gearbox and powered by a 4.7 $inch^3$ (76.5 cm^3) chainsaw engine. Smaller chainsaws – including 2.97 $inch^3$ and 3.75 $inch^3$ models – were unable to provide the power needed to drive the auger consistently through rocks and roots. This apparatus, although heavy (about 35 pounds), is well balanced, easy to use, and can be operated by one person.

In late February 2001, the oak seedlings (all 1-0) were graded at the Georgia nursery so as to plant the better quality seedlings. More white oaks were culled than red oaks. The best quality stock of both species was transported to Arkansas and planted in the group selection openings at the planting site on February 24-25 and March 3. Holes were dug with the augers and seedlings were hand planted at 10 foot by 10 foot spacings. Because of the cherty soils, an additional hole was dug several feet from every planting hole to provide soil for packing around the roots of planted trees.

Of the 15 openings that were planted, we randomly selected nine for long-term measurement of oak survival and growth. These openings ranged from 0.5 to 1 acre in size and had northeast aspects. Within each opening, one north-south transect and one east-west transect were established in March after planting was completed. Planted oak seedlings that were on or within several feet of the transects were numbered, tagged, and tallied by species and total height. We measured 35 to 40 seedlings in each opening for a total of 332 seedlings. In October 2001, the tagged seedlings were relocated for 1-year survival counts and height measurement.

RESULTS

About two-thirds of the trees planted were northern red oak (table 1). At the time of planting, the average height of red oak (3.4 feet) exceeded that of white oak (1.91 feet). After one growing season, combined red and white oak survival was 90 percent. Survival averaged 87 percent for the red oak and 96 percent for the white oak seedlings. Red oak remained taller (4.15 feet) than white oak (2.68 feet). On average, both species grew about 9 inches in height during the first growing season. These results are particularly encouraging given that precipitation at the planting site in 2001 was below average (fig. 1).

DISCUSSION

To better assess survival and growth trends, results from most oak planting studies are reported 3 or more years after planting. We recognize the limitations of reporting 1-year results. In fact, the high mortality reported in some long-term studies raises the question of whether planting oaks in clearcuts is a viable regeneration method (McGee and Loftis 1986, Demchik and Sharpe 1999). Nevertheless, we are encouraged by the early survival and height growth of seedlings in this study.

Our results compare favorably with 1-year data reported from oak plantings in clearcuts. In Missouri, for example, 2-0 red oak had 91 percent survival but grew only about 2 inches in height during the first growing season (Crunkilton and others 1989). In Indiana, 1-0 white oak and red oak had 1-year survival of 73 and 80 percent, respectively, and height increments of about 4 inches (Seifert and Fischer 1985).

Table 1.—*One-year survival and height growth of 1-0 northern red oak and white oak seedlings planted on the Ozark-St. Francis National Forest*

SURVIVAL			
Species	**Number planted**	**Number of survivors**	**Percent survival**
Red oak	222	194	87
White oak	110	106	96
Both species	332	300	90
MEAN HEIGHT GROWTH (FEET)			
Species	**Height at planting**	**Height after 1 year**	**Height growth**
Red oak	3.4	4.15	0.75
White oak	1.91	2.68	0.77
Both species	2.88	3.63	0.76

The early seedling success at the study area can be attributed to a combination of factors, including high quality planting stock, low levels of woody competition (trees > 1 inch dbh were killed prior to planting during site preparation), a well trained and closely supervised planting crew, and deep planting holes.

When planting many large seedlings in very stony soils like those in northern Arkansas, we feel power augers are a necessity. Operating the

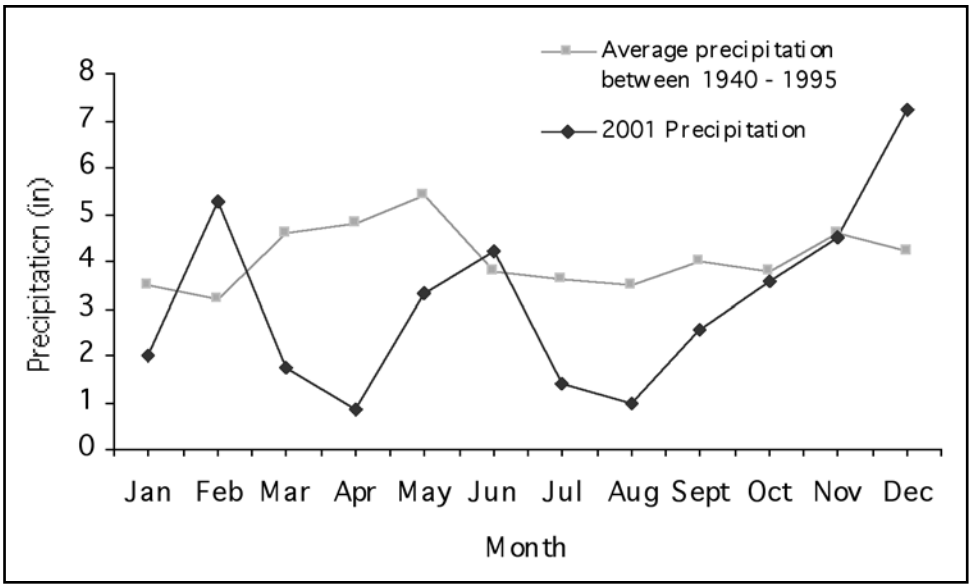

Figure 1.—*Long-term and 2001 precipitation patterns from Arkansas Forestry Commission records for Mountain View, Arkansas, about 10 miles from the planting site.*

type of heavy auger we selected is physically demanding, particularly when, as at the study site, the work requires digging through stones and roots and walking up and down steep slopes through logging slash. Compared to other hand planting tools, augers are relatively expensive. The carbide auger-gearbox-chainsaw equipment we used cost about $1,580. On cherty soils, however, we suggest this is an investment that tree planters need to make to ensure planting success.

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