
EVALUATION OF SITE PREPARATION AND PLANTING STOCK ON NUTTALL OAK AND CHERRYBARK OAK GROWTH ON A FORMER AGRICULTURE AREA

Andrew B. Self, Andrew W. Ezell, Andrew J. Londo, John D. Hodges, Derek K. Alkire, and Damon B. Hollis

ABSTRACT

Oaks are an important component of the southern landscape, and are planted on thousands of acres across the region annually. Federal cost share programs, such as the Wetland Reserve Program (WRP), have increased public interest in afforestation of retired agricultural sites in the Lower Mississippi Alluvial Valley. Acorns, bare root, containerized, and potted seedlings of Nuttall oak (*Quercus texana* Buckl.) and cherrybark oak (*Quercus pagoda* Raf.) were tested in a WRP planting near Port Barre, Louisiana to evaluate both groundline diameter and height growth following four mechanical/chemical site preparation treatments. These acorns/seedlings were planted on 16 foot by 36 foot centers. The research site was subsoiled on 16 foot centers with acorn/seedlings planted in subsoil trenches. Control (no mechanical/chemical treatment), subsoil only, subsoil/Chopper EC®, subsoil/Arsenal AC®, and subsoil/OneStep® treatments were applied in an attempt to evaluate which treatment combination provided greatest growth. Growth was measured for the 2005 growing season. No height or GLD differences were observed between species. However, height growth differences were detected among planting stocks types and GLD growth differences were detected among site preparation treatments and planting stocks.

INTRODUCTION

Oaks (*Quercus* spp.) are an ecologically and economically important component of the southern landscape, and many landowners are opting to regenerate their lands with these species. Implementation of federal cost share programs, such as the Wetland Reserve Program (WRP) and the Conservation Reserve Program (CRP), have resulted in increased public interest afforestation of retired agricultural sites in the Lower Mississippi Alluvial Valley (LMAV). Subsequently many thousands of acres across the region have undergone afforestation attempts. According to Schoenholtz and others (2001), survival of planted seedlings and acorns has been low in these areas, resulting in a low percentage of oaks in established stands. This is possibly a corollary of poor soil conditions, poor planting techniques, poor seedling quality, and problems with competing vegetation. These problems can be alleviated through

proper planting of high quality seedlings and through the application of proper silvicultural treatments needed to achieve enhanced survival and growth.

Survival and growth of seedlings could potentially be improved by using both mechanical and chemical site preparation treatments. Many retired fields have substantial levels of compaction due to past land use practices (Allen et al. 2001). Subsoiling can correct some of the problems associated with these sites. Subsoiling has been found to improve growth and possibly survival of various oak species in several studies (Ezell and Shankle 2004, Moree et al. 2010, Self et al. 2010). Potential increases in survival and growth from subsoiling can be the result of improved moisture and nutrient uptake, as well as enhanced root formation. These advantages could be critical on many sites where environmental conditions are stressful.

Possibly the most influential agent in the failure of oak plantings is competing vegetation, and an increase in oak survival and/or growth as a response to herbicide treatment has been documented in several studies (Russell et al. 1997, Ezell and Catchot 1997, Ezell and Hodges 2002, Schuler et al. 2005, Ezell et al. 2007). Both herbaceous and woody competition may pose a threat to the survival of planted oak seedlings, with herbaceous competition posing the greatest threat in the first years of establishment (Smith et al. 1997, Peltzer and Kochy 2001). Many attempts have been made to reduce mortality and increase growth of oak seedlings in plantings across the LMAV that result from competing vegetation problems. Some of these attempts have involved the use of chemical site preparation to achieve control of vegetation on sites where noxious species exist.

In the past, some form of initial vegetation control was generally considered necessary on retired agricultural sites in the LMAV. These agricultural sites are typically

Andrew B. Self, Andrew W. Ezell, Andrew J. Londo, John D. Hodges, Derek K. Alkire, Damon B. Hollis, Graduate Student, Professor, Professor, Graduate Student, Graduate Student, School of Forest Resources, Department of Forestry, Mississippi State University, Mississippi State, MS 39760

John D. Hodges, Professor Emeritus, School of Forest Resources, Department of Forestry, Mississippi State University, Ashland, MS 38603

invaded quickly by herbaceous species which decrease the amount of light and moisture available to seedlings (Gardiner et al. 2002). Land managers must consider that in highly productive areas, an extremely aggressive herbaceous weed complex can completely invade a site after effective chemical site preparation (Self et al. 2010). When site conditions include more aggressive herbaceous complexes, a post-plant growing season application using a broad spectrum herbaceous herbicide should be considered (Stanturf et al. 2004, Schuler et al. 2005, Self et al. 2010).

OBJECTIVES

The objectives of the study were:

1. To evaluate effects of subsoiling on first-year growth in Nuttall and cherrybark oak.
2. To evaluate effects of competition control on first-year growth of Nuttall and cherrybark oak.
3. To evaluate first-year growth of different planting stock types.

MATERIALS AND METHODS

SITE DESCRIPTION

The study area is located five miles northeast of Port Barre, Louisiana (30° 35' 15.19" N, - 91° 52' 41.88" W). The site was fallow for two years following extended soybean production. Watercourses border the site on all sides. The study area encompasses 80 acres within a 250 acre retired agricultural field. The soil is Sharkey clay (very-fine, montmorillonitic, nonacid, thermic Vertic Haplaquepts), with slopes less than one percent. These soils are poorly drained and very slowly permeable. Average yearly temperature is 77.9°F, and average yearly precipitation is 53.56 inches. Soil saturation was observed across the study area from January 2005 until early June 2005. However, by October, drought conditions resulted in a cumulative precipitation deficit of 16.58 inches compared to the area's yearly average.

At site selection and chemical site preparation application during July 2004, there was a well established herbaceous groundcover with a scattered woody component. Dominant herbaceous species onsite included: vaseygrass (*Paspalum urvillei* Steud.), sumpweed (*Iva annua* L.), Bermuda grass (*Cynodon dactylon* L.), beaked rush (*Rhynchospora corniculata* (Lam.) Gray), soft rush (*Juncus effusus* L.), curly dock (*Rumex crispus* L.), coffeeweed (*Senna obtusifolia* (L.) Irwin & Barneby), and Pennsylvania smartweed (*Polygonum pensylvanicum* L.). These species comprised approximately 95 percent of the herbaceous competition onsite. An additional 47 herbaceous species and seven woody species were present in small quantities, but did not comprise a significant component of the species complex. The dominant woody species onsite was tallowtree (*Sapium sebiferum* L.). There were also small components

of green ash (*Fraxinus pennsylvanica* Marsh.), black willow (*Salix nigra* Marsh.), sugarberry (*Celtis laevigata* Willd.), eastern baccharis (*Baccharis halimifolia* L.), honeylocust (*Gleditsia triacanthos* L.), and sweetgum (*Liquidambar styraciflua* L.).

STUDY DESIGN AND PLOT ESTABLISHMENT

Operational constraints strongly influenced the design of this study. Herbicide treatments, planting stocks, and species could not be randomly allocated for reasons of equipment and personnel efficiency. A split, split strip-plot design was utilized in this experiment. The research was conducted on a rectangular area of approximately 72 acres. This area was divided in a vertical (north/south) direction into four, 18-acre blocks. These blocks were established for the purpose of applying site preparation treatments. For replication purposes, the site was divided horizontally (east/west) into three, 24-acre blocks. A total of 48 data cells comprising 1.5 acres each, were established on the research site. Six control (no site preparation, no herbicide application) data cells were established immediately adjacent to study area boundaries. These data cells were used to determine survival of seedlings in areas without chemical or mechanical silvicultural treatment. All exterior and interior boundary lines were delineated using a transit and a 300 foot surveyor's tape.

Data cell corners were marked with five foot sections of one inch PVC pipe. Individual tree rows were marked with two foot sections of one inch PVC pipe. Tree row pipes were also marked with 36 inch pin flags color specific to species. Individual tree/acorn planting locations were determined and marked with 36 inch pin flags color specific to species.

SITE PREPARATION TREATMENTS

Both mechanical and chemical treatments were used in initial site preparation efforts. Mechanical site preparation consisted of subsoiling the entire area using a 16-foot spacing across the site. This subsoiling treatment was performed to reduce "restriction layers" or compaction commonly found in retired agricultural fields. Subsoiling was also utilized to evaluate its effect on survival in oak establishment attempts. The subsoil treatment was performed using a three inch wide single shank subsoil plow pulled by a skidder. The subsoil plow was tipped with an eight inch tiger wing tip followed by two 16 inch closing wheels attached to the rear. Subsoil trenches were installed on December 1-2, 2004.

Four chemical site preparation treatments were utilized in this study: (1) no herbicide application (untreated), (2) 32 oz. Chopper EC®/acre + one percent (v/v) Timbersurf 90®, (3) 16 oz. Arsenal AC®/acre + one percent (v/v) Timbersurf 90®, and (4) 16 oz. OneStep®/acre + one percent (v/v) Timbersurf 90®. These herbicides are commonly used at these rates for chemical site preparation. Site preparation herbicides were applied using 20 gpa total spray volume. Applications were completed using a cluster nozzle sprayer

with a Radiarc® nozzle system and 0.048 tips mounted on an agricultural tractor. All chemical site preparation treatments were applied on July 26-27, 2004.

SEEDLING ESTABLISHMENT

There were 14 subsoil trenches in each data cell. These served as planting rows with the two outside rows being used as buffers (no measurements). The twelve internal rows were specified as evaluation rows. Individual oak seedling/acorn planting sites were spaced using a 36 foot interval along the subsoiled row. Nuttall oak and cherrybark oak seedlings/acorns were planted. Four planting stock types were used: acorns, bare root seedlings, containerized seedlings, and potted seedlings. A total of 4,212 seedlings/acorns were planted. Twelve-inch diameter holes were augered for seedlings planted on potted or bare root stock rows. The purpose of this augering treatment was to facilitate planting of the large root systems of potted and large caliper bare root seedlings. These holes were backfilled to a depth that placed individual seedling root collars at or slightly below ground level. Seedlings were then placed in their respective holes and the holes were refilled with soil being packed around the root systems. Containerized seedlings were planted at or slightly below root collar depth using planting shovels. Acorns were planted approximately one half to one inch deep using a piece of PVC pipe to open a hole, placing the acorn in the hole, and then packing soil over the acorn.

Potted and containerized seedlings were purchased from Five Oaks Tree Nursery in Dewitt, Arkansas and were lifted December 16, 2004. These seedlings were planted on December 18-20, 2004. Bare root seedlings were purchased from Delta Wildlife Consulting, Inc. in Winnesboro, Louisiana and were lifted December 27, 2004. These seedlings were planted on December 28-29, 2004. Acorns were purchased from the Louisiana Forest Seed Company, and were collected from sources within Louisiana. The acorns were float tested and guaranteed 95 percent sound. Acorns were planted April 8, 2005. Bare root green ash, winged elm (*Ulmus alata* Michx.), red maple (*Acer rubrum* L.), hackberry (*Celtis occidentalis* L.), common persimmon (*Diospyros virginiana* L.), and sweetgum seedlings were interplanted between oak seedlings/acorns on nine foot intervals to achieve WRP tree number specifications. These seedlings were not measured, nor assessed for this study.

SEEDLING MEASUREMENTS

Initial seedling measurements were completed January 6-7, 2005. Height was measured to the nearest tenth of a foot using height sticks. Groundline diameter (GLD) was measured to the nearest 0.001 inch using digital calipers. Acorn germinants were sought, but not found throughout the growing season. Final seedling measurements were taken October 8-18, 2005 on surviving seedlings. In situations where resprouting was encountered, GLD was measured one of two ways. If the resprout grew from the base of the original stem, GLD was taken on the original stem. If

the resprout sprouted from subterranean root stock, GLD was taken on the resprout. Data were collected in the same manner as initial measurements.

DATA ANALYSIS

Growth averages were calculated using Statistical Analysis System (SAS) version 9.1®. PROC mixed was used to perform ANOVA to test for main effects and to estimate least square means (LSMEANS) for variables and interactions. When main effects were significant, means separation was performed using Duncan's Multiple Range Test. Differences were considered significant at the $\alpha = 0.05$ level of significance.

RESULTS AND DISCUSSION

HEIGHT GROWTH VARIATION BY PLANTING STOCK

No height growth difference was detected between Nuttall oak and cherrybark oak seedlings regarding planting stock performance. There was no difference in height growth between potted and bare root planting stocks (Table 1). Containerized seedlings exhibited less height growth (0.17 feet) than bare root or potted seedlings, both of which exhibited 0.34 feet of height growth. Overall, growth observed in the containerized seedlings was one half the height growth observed in potted and bare root seedlings.

GLD GROWTH BY PLANTING STOCK

No GLD growth difference was detected between Nuttall oak and cherrybark oak seedlings regarding planting stock performance. Bare root seedlings exhibited greater GLD growth compared to containerized or potted seedlings (0.079 inches, 0.043 inches, and 0.062 inches, respectively) (Table 2). Containerized seedlings exhibited the least GLD growth. Less GLD growth in containerized stock compared to bare root stock is not typically expected. Williams and Craft (1997) found that containerized seedlings exhibited approximately twice the growth of that observed in bare root seedlings after one growing season. Greater GLD growth observed in bare root seedlings compared to containerized or potted seedlings is added evidence that if vigorous bare root seedlings are planted properly, afforestation attempts on retired agriculture areas can be successful using such seedlings.

GLD GROWTH BY SITE PREPARATION TREATMENT

No GLD growth difference was detected between Nuttall oak and cherrybark oak seedlings regarding site preparation effects. Overall, seedlings in Subsoil/Chopper EC® treatment areas exhibited greater GLD growth (0.077 inches) compared to seedlings in all other site preparation treatment areas (Table 3). Seedlings in Control, Subsoil only, Subsoil/Arsenal AC®, and Subsoil/OneStep® areas did not exhibit significantly different GLD growth (0.053 inches, 0.051 inches, 0.058 inches, and 0.055 inches, respectively).

Greater GLD growth observed in the Subsoil/Chopper EC® areas cannot be readily explained. Initial or growing season vegetative control did not differ substantially among herbicide treatments, site condition differences were not observed among treatment areas, and herbaceous species did not differ appreciably among treatment areas. Subsoil only treatment areas received no chemical site preparation treatment, and seedling GLD growth did not statistically differ between these areas and Subsoil/Arsenal AC®, or Subsoil/OneStep® areas. Lack of statistical differentiation is likely due to inadequate vegetative control provided by these treatments into the growing season following application.

It should be noted that chemical site preparation treatments used in this study provided excellent short term control of competing vegetation. However, adequate control of vegetation was not expected or achieved. A shift in species complex was observed in onsite herbaceous vegetation between initial observations and observations made at the end of the first growing season (Self 2006). Initial herbaceous coverages were comprised primarily of grass species. Coverage composition shifted to one comprised of predominantly broadleaf species. The extremely dense coverage of broadleaf species was thought to negate possible benefits of herbicide treatments. Chemical site preparation should be used only to control species which cannot be eliminated by growing season herbaceous weed control efforts. It is these herbaceous release applications that typically provide longer term control of competition if the proper herbicide is used.

Subsoiling has proven effective in increasing GLD growth in hardwood plantings. Ezell and Shankle (2004) found that subsoiling significantly increased GLD growth in Shumard oak, water oak, willow oak, and green ash seedlings. Russell et al. (1997) reported that subsoiling increased first-year diameter growth of cherrybark oak seedlings. While very little difference in seedling growth was noted among chemical site preparation treatments in this study, greatest survival was observed in areas that received subsoiling as the only form of treatment (68.8 percent) (Self et al. 2010). Ultimately survival prevails, and the much higher survival would generally be more important than slightly less growth in establishing oak plantings.

CONCLUSION

Conventional wisdom assumes that potted and containerized planting stocks will outperform traditional bare root stock. However, results of this study found bare root seedlings to exhibit greater height and GLD growth than containerized seedlings grown under similar site preparation treatments. Furthermore, bare root stock outperformed potted stock with greater GLD growth.

Better growth results would be expected in areas receiving both subsoiling and effective competition control. While

seedlings grown in areas treated with the Subsoil/Chopper EC® treatment exhibited greater GLD growth compared to seedlings in other treatment areas, this is not thought to result from any inherent treatment effects. A more plausible explanation for the lack of statistical difference among other treatments can be found in the lack of herbaceous control during the growing season following application of chemical site preparation.

If an aggressive broadleaf competitor exists onsite and growing season herbaceous control is not an option, the best alternative might be to not perform any chemical applications. If adequate growing season control cannot be achieved, subsoiling can provide improved results when planting hardwoods on retired agricultural areas. Subsoiling is also beneficial as a site preparation treatment in its own right, with a proven track record in influencing increased survival. The excellent performance of bare root seedlings in this study further substantiates the adequacy of planted properly bare root seedlings in afforestation attempts on retired agriculture areas.

LITERATURE CITED

- Allen, J.A.**, B.D. Keeland, J.A. Stanturf, A. F. Clewell, H.E. Kennedy Jr. 2001. A guide to bottomland hardwood restoration: U.S. Department of Agriculture, Forest Service Southern Research Station, General Technical Report SRS-40. 132 p.
- Ezell, A.W.** and A.L. Catchot Jr. 1997. Competition control for hardwood plantation establishment. Proceedings Ninth Biennial Southern Silvicultural Research Conference; U.S. Department of Agriculture, Forest Service. Gen. Tech. Rep. SRS-20. p. 42-43.
- Ezell, A.W.** and J.D. Hodges. 2002. Herbaceous weed control improves survival of planted Shumard oak seedlings. Proceedings Eleventh Biennial Southern Silvicultural Research Conference; U.S. Department of Agriculture, Forest Service: Gen. Tech. Rep. SRS-48. p. 273-275.
- Ezell, A.W.** and M.W. Shankle, 2004. Effects of subsoiling and competition control on first year survival and growth of four hardwood species. Proceedings Twelfth Biennial Southern Silvicultural Research Conference; U.S. Department of Agriculture, Forest Service: Gen. Tech. Rep. SRS-71. p. 571-573.
- Ezell, A.W.**, J.L. Yeiser, L.R. Nelson. 2007. Survival of planted oak seedlings is improved by herbaceous weed control. *Weed Technol.* 21 (1):175-178.
- Gardiner, E.S.**, D.R. Russell, M. Oliver, L.C. Dorris Jr. 2002. Bottomland hardwood afforestation: state of the art. P. 75-86 in Proc. conference on sustainability of wetlands and water resources: how well can riverine wetlands continue to support society into the 21st century? USDA For. Serv. Gen. Tech. Rep. SRS-50. Southern Res. Sta., Asheville, NC.
- Moree, J.L.**, A.W. Ezell, J.D. Hodges, A.J. Londo, K.D. Godwin. 2010. Evaluating the use of enhanced oak seedlings for increased survival and growth: first-year survival. In: Proceedings Fourteenth Biennial Southern Silvicultural Research Conference; U.S. Department of Agriculture, Forest Service: Gen. Tech. Rep. SRS-121. p.165-169.
- Peltzer, D.A.**, and M. Kochy. 2001. Competitive effects of grasses and woody plants in mixed-grass prairie. *J. Ecol.* 89(4): 519-527.

- Russell, D.R., Jr.**, J. D. Hodges, A.W. Ezell. 1997. An evaluation of hardwood reforestation methods on previously farmed lands in central Alabama. Proceedings Ninth Biennial Southern Silvicultural Research Conference: U.S. Department of Agriculture, Forest Service. Gen Tech. Rep. SRS-20. p. 272-276.
- Schoenholtz, S.H.**, J.P. James, R.M. Kaminski, B.D. Leopold, A.W. Ezell. 2001. Afforestation of bottomland hardwoods in the lower Mississippi alluvial valley: status and trends. *Wetlands*: 21(4):602-613.
- Schuler, J.L.**, D.J. Robison, H. Quicke. 2005. Assessing the use of Chopper herbicide for establishing hardwood plantations on a cutover site. *South. J. Appl. For.* 28(3): 163-170.
- Self, A.B.** 2006. Evaluation of site preparation and different planting stocks as related to first-year survival and growth of oaks planted for afforestation of retired agricultural areas. Master thesis. Mississippi State University, MS, USA.
- Self, A.B.**, A.W. Ezell, A.J. Londo, J.D. Hodges. 2010. Evaluation of Nuttall oak and cherrybark oak survival by planting stock and site preparation treatment type in a WRP planting on a retired agricultural site. In: Proceedings Fourteenth Biennial Southern Silvicultural Research Conference; U.S. Department of Agriculture, Forest Service: Gen. Tech. Rep. SRS-121. p. 159-163.
- Smith, D.M.**, B.C. Larson, M.J. Kelty, P.M.S. Ashton. 1997. *The Practice of Silviculture: Applied Forest Ecology*. 9th ed. John Wiley & Sons, Inc., New York, New York, USA.
- Stanturf, J.A.**, W.H. Conner, E.S. Gardiner, C.J. Schweitzer, A.W. Ezell. 2004. Recognizing and overcoming difficult site conditions for afforestation of bottomland hardwoods. *Ecol. Rest.* 22(3): 183-193.
- Williams, H.M.** and M.N. Craft. 1997. First-year survival and growth of bareroot, container, and direct-seeded Nuttall oak planted on flood-prone agricultural fields. Proceedings Ninth Biennial Southern Silvicultural Research Conference: U.S. Department of Agriculture, Forest Service. Gen Tech. Rep. SRS-20. p. 300-303.

Table 1—Average height growth by planting stock (all species and site preparation treatments)

Planting Stock	Height Growth (feet)
Bare root	0.34a ¹
Containerized	0.17b
Potted	0.34a

¹values followed by different letters are significantly different at $\alpha = 0.05$.

Table 2—Average GLD growth by planting stock (all species and site preparation treatments)

Planting Stock	GLD Growth (inches)
Bare root	0.079a ¹
Containerized	0.043c
Potted	0.062b

¹values followed by different letters are significantly different at $\alpha = 0.05$.

Table 3—Average GLD growth by site preparation treatment (all species and planting stocks)

Treatment	GLD Growth (inches)
Control	0.053b ¹
Subsoil only	0.051b
Subsoil/Chopper EC®	0.077a
Subsoil/Arsenal AC®	0.058b
Subsoil/OneStep®	0.055b

¹values followed by different letters are significantly different at $\alpha = 0.05$.