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FIRST-YEAR SURVIVAL AND GROWTH OF BOTTOMLAND OAK SPECIES FOLLOWING INTENSIVE ESTABLISHMENT PROCEDURES

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Abstract—Oak seedlings are annually planted on thousands of acres in the South. While the majority of these seedlings are planted for timber production, there is increasing interest in oak establishment for mast production. In this study, seedlings of nine oak species were grown under a protocol developed by Dr. Paul Kormanik designed to produce an "enhanced" seedling of larger above-ground parameters and well-developed roots. These seedlings were planted by non-forestry technicians at seven locations across Mississippi using a 20 feet by 20 feet spacing. Seedlings were planted in augered holes, and a slow-release fertilizer was added at planting. Pre-emergent competition control was applied by Mississippi State University personnel and post-emergent competition control was to be applied during the first growing season by tree planting personnel. Initial above-ground height and groundline diameter (GLD) were recorded prior to the onset of growth and again in November, 2004. Survival and first-year growth results for all species indicated that problems had been encountered during plantation establishment. Further research revealed that seedling handling and some post-emergent competition control had been of undesirable quality. Summary of observations indicate that even the highest-quality seedlings will perform poorly if not handled properly.

INTRODUCTION

In the South, thousands of acres are artificially regenerated every year using oak (*Quercus* spp.) seedlings. Annual planting acreage is increasing, and the primary focus of these efforts is timber production. However, there has recently been increased interest in mast production for wildlife. The increased attention given to oaks for mast purposes has been noted in both private and public sectors. As a result, the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) implemented a program in 2003 entitled, "Acorns for Wildlife". This program provides private landowners with an opportunity to purchase "enhanced" oak seedlings capable of relatively quick mast production.

During the first growing season after planting, an oak seedling usually does not produce much above-ground growth; survival, not growth, is the primary concern. Several factors affect survival of hardwood plantings. Among these are seedling quality, planting quality, and vegetative competition. Seedling quality should not be a concern with seedlings grown under a protocol developed by Dr. Paul Kormanik (Kormanik and others 1994). Seedlings produced under this protocol are of larger above-ground parameters than normal nursery-grown seedlings and have well-developed root systems. However, planting quality and competing vegetation can still pose a survival threat. Proper planting is a process that includes handling during shipping, storage, and on-site, as well as the actual planting of seedlings. Seedlings should be kept cool and moist during shipping and storage. Once on-site, seedlings should be placed in a portable cooler or in a shaded area. Seedlings removed from shipping containers should be placed in planting bags immediately and handled singularly during planting. Seedling root systems should not be twisted, balled, or bent when placed in soil. Soil should be packed tightly around roots with root collars just below ground level (Allen and others 2001). These procedures have been tested and reported in many pine (*Pinus* spp.) regeneration publications. Corresponding hardwood work has not been published

in quantity, but planting procedures beneficial to pines are generally thought to be beneficial to hardwood species.

Cultural treatments, both mechanical and chemical, can prove effective in establishing oak plantings in areas of prior agricultural use and/or with established herbaceous vegetation. Soil treatments such as augering and subsoiling in compacted areas may increase seedling survival as well as root and subsequent stem growth. These increases result from better nutrient and water absorption (Rathfon and others 1995, Russell and others 1997). Survival can be positively influenced in the first year and afterwards through chemical herbaceous control in many situations (Ezell and Catchot 1997).

OBJECTIVES

The objectives of the study were (1) to evaluate effects of fertilization, augering, pre-emergent, and post-emergent herbicide applications on first-year growth and survival of oak seedlings under Dr. Kormanik's intensive field management protocol; and (2) to evaluate the economic feasibility of fertilization, augering, initial herbicide application, and follow up herbicide treatments required using this protocol.

MATERIALS AND METHODS

Study Sites

Seven sites were selected across Mississippi for this study. Study sites were on State-owned wildlife management areas and ranged from the northeastern corner to the southwestern corner of the State. All sites were retired agricultural row-crop areas with the exception of one retired pasture. Soil series ranged from marginal upland hardwood soils to excellent bottomland hardwood soils. Most were sandy or clay loams, with some pure loam areas.

Seedlings

All seedlings were grown at the Flint River Nursery in Georgia using acorns collected in Mississippi. These seedlings are

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grown under a protocol developed by Dr. Paul Kormanik designed to produce "enhanced" seedlings (Kormanik and others 1994). These seedlings are of large above-ground parameters and possess well-developed root systems with ample first-order lateral roots. This particular nursery was chosen due to prior experience with "enhanced" seedling production. The purpose of Dr. Kormanik's protocol is to produce seedlings capable of acorn production within 6 to 7 years. Seedling species were selected to match planting sites and included water oak (*Quercus nigra* L.), Nuttall oak (*Q. nuttallii* Palmer), Shumard oak (*Q. shumardii* Buckl.), willow oak (*Q. phellos* L.), swamp chestnut oak (*Q. michauxii* Nutt.), post oak (*Q. stellata* Wangenh.), southern red oak (*Q. falcata* Michx.), cherrybark oak (*Q. pagoda* Raf.), and white oak (*Q. alba* L.).

Planting

Seedlings were planted mid-March, 2004, at all sites. Seedling transport, handling, and planting were performed by MDWFP personnel at each wildlife management area (WMA). A wide spacing (20 feet by 20 feet) was utilized with each seedling being planted in an augered hole. These holes were approximately 6 inches in diameter and 2 to 3 inches deeper than seedling root systems. Thirty-gram slow-release fertilizer (22-10-7) packets were placed in the bottoms of all holes, which were then backfilled one third and tamped. Seedlings were then placed in the hole with root collars 1.5 to 2.0 inches beneath ground level, and another third of the hole was backfilled. This soil was in turn tamped and the remainder of the hole filled and tamped. All field planting procedures were completed in an attempt to satisfy requirements dictated by Dr. Kormanik's protocol. Species planted varied by site according to soil/site quality.

Treatments

Both pre-emergent and post-emergent herbicide applications were to be implemented per Dr. Kormanik's instructions. A post-plant pre-emergent banded application of sulfometuron methyl [Oust XP® at 2 ounces per acre] was banded at all sites mid-March 2004 prior to seedling bud break. Post-emergent directed glyphosate applications were to be completed as needed, by WMA personnel when herbaceous vegetation emerged in the control bands.

Study Design

Pin flags were placed beside each sample seedling for easy recognition in anticipation of fall measurements. Individual sites served as replicates, and 15 sample trees of each species deemed suitable for the site were planted at that location.

Seedling Evaluation

Fifteen trees of each species at a given site were measured for initial GLD and height in mid-March, 2004. Height was recorded in tenths of feet, and GLD was measured to the nearest 0.001 inch. Final height and GLD measurements were taken in November, 2004. Survival of the sample trees was also recorded at that time.

RESULTS AND DISCUSSION

Survival

Initial examination of survival data indicated that further investigation would be required to explain response discrepancies. Several problems resulting from improper project establishment were discovered and objective two was aborted due to overall low or erratic survival rates. Survival for water and willow oak, expressed as a percentage, has some discrepancies between sites (table 1). This is apparent when looking at Sites 4 and 7. Both have survival, yet the remaining sites show no survival for these two species. When investigating this inconsistency, seedling handling was found to have differed. Site 4 was planted first and had 86.7 percent survival. Site 7 was planted next and had 26.7 percent survival. Water and willow oak seedlings for the remaining sites were transported separately and remained on a truck for approximately 1 month. Additionally, personnel at these sites reported that these seedlings were held on-site for approximately 3 weeks awaiting arrival of the other seedlings. Mortality of these two species is thought to be attributable to long-term storage without refrigeration and the effects of drying. Results from Site 4 indicate that poor seedling quality was not the deciding factor in water and willow oak mortality.

No sample seedlings survived at Site 5 (table 1). Seedlings were accidentally destroyed before final evaluations could be made in November. Shumard oak displayed the lowest overall survival (Sites 2 and 6). Swamp chestnut and Nuttall oak both displayed excellent survival. In most instances, survival was acceptable for hardwood regeneration. Site 2 had the lowest site index and still maintained acceptable survival levels, indicating that survival is possible when this protocol is followed properly.

Table 1—Survival percentages of hardwood planting sites

Site	WAO	WIO	NO	PO	SRO	SHO	SCO	CBO	WO
1	0.00 ^a	c	33.33	c	c	c	c	c	c
2	0.00 ^a	c	c	61.54	73.33	33.33	c	c	c
3	0.00 ^a	0.00 ^a	86.67	c	c	c	80.00	c	c
4	86.67 ^b	c	c	c	c	c	100.00	c	c
5	0.00 ^{ad}	cd	0.00 ^d	cd	cd	cd	0.00 ^d	0.00 ^d	0.00 ^d
6	0.00 ^a	0.00 ^a	100.00	c	c	40.00	86.68	c	c
7	26.67 ^b	c	93.33	c	c	c	c	c	c

^a Shipped on separate truck and left on site for 3 weeks.

^b Sites 4 and 7 shipped separate from other WAO and WIO seedlings.

^c Species not planted at site.

^d Site 5 seedlings were destroyed before evaluations could be made.

Growth

Another problem encountered with establishment was improper soil tamping. In many instances, backfilled soil settled significantly, indicating insufficient tamping at planting. This resulted in GLD measurements of little or no use. Seedling height measurements were also possibly affected by this settling. Another problem with ground level measurements was that planting holes were not completely refilled. These holes exhibited siltation problems affecting height and GLD measurements as well as survival.

Negative or negligible height growth of some species and sites is thought to be attributable to siltation, dieback, and herbivory (table 2). The better sites are easily identified as Sites 3, 4, and 6. These were excellent bottomland hardwood sites, whereas Sites 1, 2, and 7 were lower-quality hardwood sites and had less growth. Since oaks generally do not grow much in the first growing season, these measurements are not outside ordinary expectations for sites of this quality.

Protocol Problems

While post-plant, pre-bud break Oust® applications were performed properly, the post-emergent directed glyphosate applications were not. The timing of these applications was left to the discretion of WMA personnel who may not have had sufficient training or instructions to properly implement such applications. Application timings should probably have been at 2- to 3-week intervals. However, sites received between zero and three sprayings for the entire growing season. Another deviation from recommended protocol was the mowing, which was completed only at some locations. These problems, while foreseeable to foresters, may not have been anticipated by WMA personnel who were not acquainted with this type of work.

CONCLUSIONS

Dr. Kormanik has proven "enhanced" oak seedlings are capable of acorn production in periods of time much shorter than that expected when oak seedlings are normally planted.

However, his protocol is a two-part process. The first part is production of "enhanced" seedlings capable of capitalizing on the second portion of the protocol. The second portion is a series of steps that include proper planting, fertilization, and complete weed control. If implemented properly, the second half of the protocol is effective in its design. Problems arise when protocol breaches are encountered. When utilizing Dr. Kormanik's protocol, all steps must be properly performed. Even the healthiest, most vigorous seedlings will die if improperly handled or if proper planting technique is overlooked. Proper handling and planting technique is critical to growth and survival of hardwood regeneration.

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Table 2—Average height growth in feet for hardwood planting sites

Site	WAO	WIO	NO	PO	SRO	SHO	SCO	CBO	WO
1	a	c	-0.200	c	c	c	c	c	c
2	a	c	c	0.013	0.027	-0.140	c	c	c
3	a	a	0.192	c	c	c	0.592	c	c
4	0.217	c	c	c	c	c	0.634	c	c
5	ad	cd	d	cd	cd	cd	d	d	d
6	a	a	0.100	c	c	0.114	0.406	c	c
7	-0.020	c	-0.061	c	c	c	c	c	c

^a Shipped on separate truck and left on site for 3 weeks, all died.

^b Sites 4 and 7 shipped separate from other WAO and WIO seedlings.

^c Species not planted at site.

^d Site 5 seedlings were destroyed before evaluations could be made.

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