EVALUATING DIFFERENT PLANTING STOCKS FOR OAK REGENERATION ON HURRICANE KATRINA DISTURBED LANDS

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ABSTRACT

Three oak planting stocks were evaluated to determine their influence on survival and initial growth. Planting stocks utilized included conventional containerized seedlings in 240 centimeter^3 (cm^3) containers, 1-0, bareroot seedlings, and Root Production Method (RPM™) seedlings in 11.4 liter (L) containers. Initial height, groundline diameter (GLD), and survival were assessed after planting and at the conclusion of the first growing season. Species planted were swamp chestnut oak (*Quercus michauxii* Nutt.) and Nuttall oak (*Q. texana* Palmer). Study sites were located in southern Mississippi on lands disturbed by Hurricane Katrina. Statistical comparisons of growth and survival among species and planting stocks were performed. RPM™ and bareroot seedlings exhibited similar growth and survival, and both were greater than conventional containerized seedlings. Bareroot seedlings could be the most economically feasible planting stock to utilize for artificial oak regeneration.

INTRODUCTION

Oaks are valuable to southern forests for timber production and wildlife habitat (Moree and others 2010, Ezell and others 1999). However, the oak component of many bottomland hardwood stands in the southern United States has been decreasing for many years (Nix and Barry 1992, Nix 1988, Chambers and others 1986, Johnson 1984,), and oaks are often lacking following harvest (Loftis 1988, Beck and Hooper 1986). Successfully regenerating a stand following harvest is one of the challenges of hardwood silviculture (Belli 1999). Many hardwood regeneration managers utilize natural regeneration to adhere to landowner objectives (Coder 1994). However, natural regeneration alone is not always practical in situations where oak regeneration is desired (Dey and others 2008). Naturally regenerated oaks are often unable to compete with faster-growing competitors (Kellison 1993) because oak seedlings are poor competitors with herbaceous vegetation which grows rapidly in bottomland systems throughout the South.

Planting poor quality seedlings can also complicate artificial oak regeneration (Duryea 1985). Dey and Parker (1997) reported that planting high quality seedlings is an essential element of any artificial regeneration prescription. Seedlings with larger initial diameters and more fully developed root systems have shown greater survival and growth rates (Kormanick and others 1998, 1995). Larger seedlings also tend to perform better against competing vegetation (Dey and others 2008).

Proper planting is fundamental to ensure seedling survival. Both hand planting and machine planting can be effective if experienced, conscientious personnel oversee the planting job (Gardiner and others 2002). Improper planting such as J-rooting or shallow planting, increases the chance of mortality for a seedling. Thus, using high quality seedlings provides no advantage if a poor planting job is implemented.

Numerous research projects have been conducted to address the previously mentioned regeneration problems, but little research has been conducted comparing the survival and growth of various oak planting stocks. Also, Hurricane Katrina created a need for hardwood regeneration on thousands of acres. Therefore, this research project had the potential to provide valuable information to land managers considering planting hardwoods.

MATERIALS AND METHODS

Two study areas were utilized in this project. The first area, the Gordon Tract, is located approximately 26 kilometers (km) southwest of Poplarville, MS in the floodplain of the Pearl River. The study area encompasses approximately 1.6 hectares (ha) within an area that received a salvage harvest due to damage from Hurricane Katrina. The soil series is Latonia fine sandy loam (coarse-loamy, siliceous, semiactive, thermic Typic Hapludults) with 0 – 2 percent slopes. Average annual precipitation is 152 cm, average temperature in winter is 12°C, and average temperature in summer is 27°C. The second study area, the Brooke Tract, is located approximately 21 km northeast of Picayune, MS and also encompasses approximately 1.6 ha. This

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site also received a salvage harvest due to damage from Hurricane Katrina. The soil series is Harleston (coarse-loamy, siliceous, semiactive, thermic Aquic Paleudults) with slopes 0 – 2 percent. Average annual precipitation is 145 cm, average winter temperature is 11°C, and average summer temperature is 27°C.

Two species, Nuttall oak and swamp chestnut oak with three planting stocks: 11.4 L RPM™ seedlings, conventional containerized seedlings with a 240 cm^3 container, and high-quality 1-0, bare-root seedlings, for a total of six species/planting stock combinations were utilized in this study. A randomized complete block design, with three replicates was employed in this study. A total of 3,600 seedlings were planted. Each site had a total of 1800 seedlings planted consisting of: 300 bare-root swamp chestnut oak, 300 bare-root Nuttall oak, 300 RPM™ swamp chestnut oak, 300 RPM™ Nuttall oak, 300 containerized swamp chestnut oak, and 300 containerized Nuttall oak. Each replicate consisted of 100 seedlings per species/planting stock combination. Each six species/planting stock combinations was randomly assigned within each replicate. Seedlings were planted on 3.05 meter (m) x 3.05 m spacing. All seedlings were hand planted with planting shovels in February 2009. Bare-root and conventional containerized seedlings were planted by Mississippi State University personnel and RPM™ seedlings were planted by a crew hired by the Forrest Keeling Nursery in Elsberry, MO.

Both mechanical and chemical techniques were utilized during site preparation. The Gordon Tract received mechanical site preparation only. The landowner was responsible for having all woody harvest debris pushed out of planting areas following the salvage harvest using a bulldozer. Both chemical and mechanical site preparation techniques were utilized on the Brooke Tract. A broadcast application of Accord XRT® (9.3 L per ha) and Garlon 4® (2.3 L per ha) was applied during the first week of November 2008. Chemical site preparation was deemed necessary due to the presence of undesirable woody species. The landowner was responsible for site preparation which was completed using a sprayer affixed to an agricultural tractor. The planting site was burned three weeks after herbicide application. After burning, the landowner pushed residual brush out of the planting site with a bulldozer.

All bare-root seedlings received a post-plant, pre-bud break herbicide treatment of Oust XP® (140.0 grams (g) per sprayed ha) February 29, 2009 applied as a 1.5 m band over the top of the seedlings. The herbicide was applied with 11.4 L backpack sprayers. Caution was taken to only apply the herbicide when there was little to no wind to avoid drift. A Solo® backpack sprayer was used for herbicide application at a rate of 93.5 L per sprayed hectare.

Measurements were recorded after planting and at the conclusion of the first growing season. Height was measured to the nearest centimeter on bare-root and conventional container seedlings using height sticks. Height of RPM™ seedlings was measured to the nearest tenth of a foot using height poles and converted into centimeters. GLD was measured to the nearest tenth of a millimeter (mm) using digital calipers. Seedling survival was based on visual inspection.

Statistical Analysis System (SAS) software version 9.2® was used for statistical analyses. Statistical analyses were performed using PROC SORT, PROC MEANS, and PROC GLM. Least square means was used to perform means separation among treatments. Arcsine transformation was used to normalize survival data. Actual means are presented for purpose of interpretation. Differences were considered significant at $\alpha = 0.05$.

RESULTS

RPM™ swamp chestnut oak seedlings (13.4 cm) had the most height growth, while conventional containerized Nuttall oak seedlings (-16.8 cm) had the least on the Gordon Tract (Table 1). Both species of RPM™ seedlings had the most height growth on the Brooke Tract (Table 2). RPM™ seedlings (11.0 cm) had the most height growth, while bare-root seedlings (-0.2 cm) were significantly greater than conventional containerized seedlings (-11.8 cm) on the Gordon Tract (Table 3). Again, RPM™ seedlings (13.5 cm) exhibited the most height growth, while bare-root seedlings (7.1 cm) were significantly greater compared to conventional containerized (-4.4 cm) seedlings on the Brooke Tract (Table 4).

Nuttall oak seedlings of all planting stocks had significantly more GLD growth compared to swamp chestnut oak seedlings (Table 1) resulting in no significant differences among the planting stocks on the Gordon Tract (Table 3). While Nuttall oak had the most GLD growth for all planting stocks, it was only significantly greater than conventional containerized seedlings on the Brooke Tract (Table 2). RPM™ seedlings had significantly greater GLD growth compared to conventional containerized and bare-root seedlings on the Brooke Tract (Table 4). Conventional containerized seedlings had significantly less GLD growth compared to bare-root seedlings.

There were no significant differences in survival between species for RPM™ and bare-root seedlings on the Gordon Tract (Table 1). Nuttall oak had significantly higher survival than swamp chestnut oak for only conventional containerized seedlings on the Brooke Tract (Table 2). RPM™ and bare-root seedlings did not differ significantly but both had significantly higher survival than conventional containerized seedlings on both tracts (Tables 3 and 4).

DISCUSSION

Previous research comparing RPM™ seedlings and bare-root seedlings has been variable. Several previous studies have documented RPM™ seedlings to have greater height growth than other planting stocks. Shaw and others (2003) reported RPM™ pin oak (*Quercus palustris* Münchh.) and swamp white oak (*Quercus bicolor* Willd.) seedlings to have greater first-year height growth compared to bare-root seedlings in Missouri. Dey and others (2003), as well as, Kabrick and others (2005) also reported RPM™ pin oak and swamp white oak seedlings had greater first-year height growth compared to bare-root seedlings in Missouri. However, several Missouri studies have reported RPM™ hardwood seedlings to have less third-year height growth than bare-root seedlings (Dey and others 2003, 2006, Kabrick and others 2005).

Previous studies have shown containerized oak seedlings to have greater height growth compared to other planting stocks. Teclaw and Isebrands (1993) reported northern red oak containerized seedlings had greater height growth than bare-root seedlings after two and three growing seasons. Burkett and Williams (1998) reported small containerized Nuttall oak seedlings had greater first-year height growth compared to bare-root seedlings in Mississippi, Louisiana, and Texas. Williams and Stroupe (2002) reported small containerized water oak (*Quercus nigra* L.) and willow oak (*Quercus phellos* L.) seedlings had greater first-year height growth compared to bare-root seedlings in Texas. However, Kormanik and others (1976) reported bare-root cherrybark oak (*Quercus pagoda* Raf.) seedlings had greater height growth compared to small containerized seedlings for the first four years after outplanting in Georgia.

GLD growth results were not surprising as Nuttall oak is known to exhibit excellent early growth (Miwa and others 1992, Williams and others 1992). However, the lack of significant difference in GLD growth among planting stocks on the Gordon Tract was surprising (Table 3). Larger planting stocks have been shown to exhibit more early growth than smaller planting stocks as discussed previously. GLD results on the Brooke Tract might be more typical for the three planting stocks observed in this study as the largest planting stock had the most GLD growth and the smallest planting stock had the least.

The application of Oust XP® is a possible explanation for bare-root seedling survival compared to conventional containerized seedlings. Herbaceous weed control has been proven to be effective at increasing early survival of bare-root oak seedlings (Ezell and Hodges 2002, Ezell and Catchot 1998) due to reduced competition for soil moisture. Containerized oak seedlings have been shown in previous studies to have excellent early survival without herbaceous weed control (Miller 1999). Though survival of conventional containerized seedlings was significantly less than RPM™ or bare-root seedlings, 71-85 percent survival is considered acceptable for most land managers.

With the smallest and shallowest root system of the three planting stocks used in this study, conventional containerized seedlings were possibly not able to compete with herbaceous competition for soil moisture as well as the bare-root and RPM™ seedlings. Previous studies have shown that water deficit can be a primary contributor to early mortality of newly planted seedlings (Kramer 1986, Kozlowski and Davies 1975). Russell and others (1997) concluded that competing vegetation is the primary cause of oak seedling mortality due to competing vegetation can capture much of the available soil moisture (Newton and Comeau 1990). Though no rain gauges were installed on the sites, monthly precipitation data from the nearest weather station were noted. The weather station was located approximately 25.7 km from both the tracts, and recorded precipitation levels 6.4 cm below average for April, 8.9 cm below average for July, and no precipitation recorded for the months of June and September. It is possible that the lack of rainfall combined with the associated lack of soil moisture was a major contributor to first-year seedling mortality in this study. With the documented lack of rainfall during first growing season, the results of this study indicate that small containerized seedlings may be susceptible to a lack of soil moisture combined with herbaceous competition. Previous studies have shown conventional containerized oak seedlings to exhibit greater survival than bare-root seedlings without herbaceous weed control. Williams and Craft (1997) reported first-year survival of Nuttall oak seedlings to be greater for containerized seedlings (84%) as compared to bare-root seedlings (38%) in Mississippi without weed control. Miller (1999) reported containerized oak seedlings to exhibit greater survival than 1-0 bare-root seedlings without application of herbaceous weed control. Burkett and Williams (1998) reported 96 percent first-year survival of containerized Nuttall oak seedlings, whereas 1-0, bare-root seedlings averaged 45 percent survival without weed control. In the same study Burkett and others (2005) reported third-year survival of 1-0, bare-root seedlings (45%) to be greater than containerized seedlings (39%). Williams and Stroupe (2002) reported 81 percent first-year survival of bare-root seedlings and 83 percent for containerized seedlings of water and willow oaks in Texas.

CONCLUSIONS

This study found that high quality 1-0, bare-root seedlings that are properly handled can perform as well or better than more expensive containerized planting stocks. Further research is needed to determine if current growth patterns will continue for several growing seasons in order to assess the full potential of these three planting stocks. Several years of growth and survival observations would be helpful in determining which of these planting stocks will perform the best. Although economics of each planting stock were not evaluated in this study, bare-root was the least expensive ($0.25/seedling) planting stock, followed by conventional containerized ($1.50/seedling), with RPM™ seedlings ($15.00/seedling) being the most expensive. Given that the bare-root seedlings performed as well or better than either RPM™ or conventional containerized seedlings, this study indicates that bare-root seedlings could possibly be the most feasible choice when deciding which planting stock to utilize for optimizing early growth and survival.

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Table 1—Average first year height growth, groundline diameter growth, and survival by planting stock and species on the Gordon Tract

Planting Stock/Species	Height Growth	GLD Growth	Survival
	-----cm-----	-----mm-----	-----%-----
RPM™[1]			
NUO[2]	8.5b[3]	3.96a	98.7a
SCO	13.4a	3.18b	96.7ab
BR			
NUO	-1.4c	4.38a	93.3ab
SCO	1.0c	2.41c	91.7ab
CC			
NUO	-16.8e	3.91a	81.9bc
SCO	-6.7d	2.49c	71.3c

[1]RPM™ = root production method, BR = bare-root, CC = conventional containerized
[2]NUO = Nuttall oak, SCO = swamp chestnut oak
[3]Values in a column followed by same letter do not differ at α = 0.05

Table 2—Average first year height growth, groundline diameter growth, and survival by planting stock and species on the Brooke Tract

Planting Stock/Species		Height Growth	GLD Growth	Survival
		-----cm-----	-----mm-----	-----%-----
RPM™[1]				
	NUO[2]	12.7a[3]	4.13a	95.7a
	SCO	14.3a	3.94ab	98.7a
BR				
	NUO	4.7c	3.70ab	97.0a
	SCO	9.5b	3.60b	96.0a
CC				
	NUO	-1.8d	1.89c	85.3b
	SCO	-7.0e	1.01d	73.2c

[1]RPM™ = root production method, BR = bare-root, CC = conventional containerized
[2]NUO = Nuttall oak, SCO = swamp chestnut oak
[3]Values in a column followed by same letter do not differ at α = 0.05

Table 3—Average first year height growth, groundline diameter growth, and survival by planting stock on the Gordon Tract

Planting Stock	Height Growth	GLD Growth	Survival
	-----cm-----	-----mm-----	-----%-----
RPM™[1]	11.0a[2]	3.57a	97.7a
BR	-0.2b	3.40a	92.5a
CC	-11.8c	3.20a	76.6b

[1]RPM™ = root production method, BR = bare-root, CC = conventional containerized
[2]Values in a column followed by same letter do not differ at α = 0.05

Table 4—Average first year height growth, groundline diameter growth, and survival by planting stock on the Brooke Tract

Planting Stock	Height Growth	GLD Growth	Survival
	-----cm-----	-----mm-----	-----%-----
RPM™[1]	13.5a[2]	4.04a	97.2a
BR	7.1b	3.65b	96.5a
CC	-4.4c	1.45c	79.3b

[1]RPM™ = root production method, BR = bare-root, CC = conventional containerized
[2]Values in a column followed by same letter do not differ at α = 0.05