HERBICIDE RELEASE OF 4 YEAR OLD, NATURALLY REGENERATED BOTTOMLAND OAKS – 10 YEAR RESULTS

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Abstract—In 1989 two clearcut, naturally regenerated bottomland hardwood stands near the Congaree River in South Carolina were found to contain nearly 2000 red oak (*Quercus pagoda* Raf. *and Q. shumardii* Buckley) seedlings per acre. By age 4, these oak seedlings were quickly being overtopped by competitive sprouts, vines, and fast growing pioneer species. The number of remaining seedlings had been reduced to 450 per acre. In order to improve the competitive status of these desirable oak seedlings, a number of directed and broadcast pine herbicide release treatments at full and half strength were applied late in the fourth growing season. It was hoped that the overtopping competition would be inhibited or killed, but simultaneously shield the oak seedlings from the herbicides. Two year measurements indicated that oak seedling diameter growth was nearly doubled by some of the herbicides, but there was little difference in the number or canopy position of the oaks. Remeasurements 10 years after applications indicated that at least four of the simulated aerial herbicide broadcasts and one of the directed sprays resulted in 14-year-old oak saplings nearly an inch larger in diameter and three times more numerous in the dominant canopy position than those in the untreated areas. One herbicide and method of application in particular resulted in 4-inch diameter oaks, 36 feet tall with nearly 400 per acre remaining in at least a codominant status.

INTRODUCTION

In the past 30 years, oaks *(Quercus* spp.) have been decreasing in the bottomland hardwood stands of the Southern United States (Johnson 1984). Cherrybark oak *(Quercus pagoda* Raf.) and Shumard oak *(Q. shumardii* Buckl.) are two high quality bottomland oak species (Miller and Lamb 1985) that are not being replaced in these stands. The ecology and biology of bottomland oaks have been investigated to determine why the number of oaks are decreasing in new stands of the bottomland forests (Clatterbuck and Hodges 1988, Guldin and Parks 1989, Hodges and Janzen 1987, Johnson 1979). Because of their slow early growth, newly established oak seedlings cannot compete successfully with sprouts and fast-growing pioneer species. Oak seedlings often grow and die back for 4 to 6 years after germination before they reach a stage of rapid height growth.

The slow growth of oak seedlings after germination is compounded by animal predation and overtopping by briars, sprouts, and early successional trees and brush (Gingrich 1979, Hannah 1987, Nix 1989, Watt 1979). However, if released, oak seedlings can respond and achieve a dominant position in the developing canopy (Nix 1989). Some type of release of oak seedlings after clearcutting is usually needed to have oaks in the dominant canopy in a reasonable period with quality, size, and grade (Beck 1970, Hannah 1987). Release should be accomplished 3 to 5 years after clearcutting to allow the seedling oaks to quickly catch up with the other woody species on the site (Beck 1970). Early release should allow the oaks to be a dominant component of the canopy by the time the stand is 25 years old. Early release may also shorten the normal oak rotation by 10 to 15 years for quality oak products (Clatterbuck and Hodges 1988, Clatterbuck and others 1985).

Release of crop trees with herbicides has been accomplished successfully for many years in the management of pine stands (Bacon and Zedaker 1987, Clason 1978, Nelson and Cantrell 1990, Nelson and others 1985). Therefore, it should be possible to release oak seedlings with careful application of the same herbicide provided the oaks are somehow sheltered from the herbicides. During the winter of 1987 and 1988, two bottomland hardwood stands with a 40-percent oak component (basal area basis) were clearcut along the Congaree River in South Carolina. These stands apparently had a good seed crop prior to harvest, as from 3,000 to 5,000 oak seedlings per acre were established (Nix and Lafaye 1993). When first examined, in the winter of 1989, these oak seedlings were overtopped by a dense canopy of blackberry, herbaceous composites, woody seedlings, and sprouts. This study was implemented to evaluate several herbicides and application methods for releasing overtopped oak seedlings developing in dense young clearcuts.

PROCEDURE

Forty-two plots approximately 18- to 22-feet wide and 25- to 130-feet long were located along 2-foot wide transects cut through the vegetation of 3- and a 4-year-old clearcuts, approximately 1/2-mile apart in the first bottom of the Congaree River near Columbia, SC. The transects were placed where two or three cherrybark or Shumard oak seedlings in each of three height classes were found in an overtopped condition. The plots were placed at least 15 feet apart to reduce the chance of one herbicide treatment influencing any adjoining treatment. Each plot contained six to nine seedlings located along either side of the transect. Seedlings were chosen within approximately 7 to 9 feet of the transect, but at least 2 feet away so that the cut transect did not affect the seedlings' competitive status. The seedlings were selected to be approximately 6+ feet apart to accommodate the directed herbicide treatments. The length of the plot was determined by the distribution of the seedlings and the width of the plot was determined by the overspray width and the spray apparatus boom height. The

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beginning and end of each plot center line was marked by a white, 4-foot, plastic pipe driven into the ground.

The treatment plots were blocked for replication according to preliminary estimates of total competition based on a height/distance index (Daniels 1976) on the plots (high, medium or low). Three replications of the treatments were arranged with each treatment plot randomly placed in each of the three blocks. The oak seedlings chosen for measurement were statistically similar in height on all plots. The preferred condition of the seedlings for release was overtopped, but at least 12 inches in height. Each plot contained at least two seedlings and, if possible, three seedlings in each of the three following height classes: 1-Foot Class (1 to 1.9 feet), 2-Foot Class (2 to 2.9 feet), 3-Foot Class (3 feet and taller). Each seedling chosen was marked by a wire flag and metal tag bearing an embossed coded number.

Preliminary treatments with a quick-browning herbicide in 20 percent increments of the recommended release rates for pines were applied to plots adjacent to the study area after full foliage development (midsummer) to refine the rates that were used in the treatments. The methods of treatment, herbicides, and rates which were applied in late July to early August were as follows:

1. Control—no treatment.
2. Directed (Streamline)—Application of 20 percent Garlon 4 (a triclopyr herbicide), 10 percent Cide-Kick II surfactant (JLB 1984), and 70 percent diesel fuel applied to the lower portion of all competing stems in a 3+ foot radius around the oak seedlings (Dow 1988, McLemore and Cain 1988, Yeiser and others 1989). This application was accomplished with a Solo piston backpack sprayer equipped with a D2 orifice disc tip for stream application.
3. Directed (Spot gun)—Application of Velpar L (a hexazinone herbicide) or Escort (a metsulfuron benzoate herbicide) applied in a grid pattern of six 1 mL spots placed approximately 3.5 feet from the oak seedlings to be released. The spots of Velpar L consisted of a mixture of Velpar L and water that was 50 percent of the manufacturer's product strength. The application mixture of Escort consisted of 1 ounce of Escort mixed in 2 gallons of water. Due to the fine texture of the soils on the study site, the manufacturer's rate of application for use on this texture of soil indicated that there would be a 1.5- to 2-foot non-toxic zone around the treated oak seedlings (Du Pont 1987, 1988; Rachal and others 1988). These applications were accomplished with a standard spot gun applicator calibrated at 1 mL per spot application.
4. Broadcast (Overspray)—Simulated aerial broadcast, an overspray applied with a boom apparatus, applied at 1/2 and full label-recommended application rate of commercial herbicides for releasing pines with 3.2 ounces per acre of TimberSurf 90 surfactant (0.25 percent v/v — commonly recommended rate in release of pines) (Timberland ca.1989) at 10 gallons total mix per acre (Dow 1988) for each of the herbicides in table 1. The simulated aerial broadcast spray was applied with a carbon dioxide pressurized backpack apparatus with a boom extended well above the vegetation (16 feet above ground) and equipped with a single horizontally aligned flood jet nozzle. The actual area treated was calculated by using the length of the plot, the boom height, and the nominal spray width within which competing vegetation would be uniformly treated (18 to 22 feet).

Table 1—Simulated aerial broadcast applications (oversprays) that were used at 100 and 50 percent of standard pine release rates for oak release in 3-and 4-year-old clearcut bottomland hardwood stands in South Carolina

Herbicide	Standard pine release rate
Garlon 4	1.5[a]
Escort	1[b]
Accord	1.5[a]
Velpar L	3[a]
Arsenal AC/Escort	8 / 0.25[b c]

[a] Quarts per acre.

[b] Ounces per acre.

[c] The rate of 0.25 ounces per acre of Escort remains the same for both the 100 and the 50 percent rate plots.

The spray time, spray pressure, boom height, and amount of herbicide to be used were predetermined. Measurements of the spray time and pressure were recorded for each plot so the actual rate of application could be calculated. To determine effectiveness of the release treatments after two years, herbaceous competition, woody competition, total competition, seedling height, and ground line diameter (GLD) were measured before and after treatment. Data were analyzed using a complete random block design and PC-SAS, Anova procedure. Means were tested at the 0.01 level of probability. The results of the initial reduction of competition in this study were reported in an earlier paper (Thompson and Nix 1993). For the purpose of this paper which reports 10 year response to the herbicide treatments only diameter at 4.5 feet, total height, and total number of at least codominant red oaks per plot and acre were measured. Water and willow oaks (*Q. nigra* and *Q. phellos)* were included as desirable oak crop trees along with the cherrybark and Shumard oaks previously measured.

RESULTS AND DISCUSSION

The effectiveness of any crop tree release treatment can be judged early by the subsequent tree height, diameter growth, and presence of sufficient numbers of future crop stems in the dominant canopy. In this study, oak seedling numbers, height and diameter growth 2 and 10 years after treatment were the major criteria for evaluating the effectiveness of the herbicide release treatments. After 10 full growing seasons, 4 herbicide treatments resulted in a significant increase in diameter growth of released oak seedlings (table 2). Overtopped seedlings released by the

Table 2—Ten year response of 4-year-old red oak seedlings to herbicide release in two clearcuts in Red River bottomland hardwoods in South Carolina

Treatment method	Tree per plot	Tree per acre	TPA std. dev.	D.b.h.	D.b.h. std. dev.
	- - - -number- - - -			*inch*	
AVL	4.0	170	118	3.04	0.49
AVH	8.3	365	130	3.54	0.24
AArEL	5.0	219	46	3.92	0.27[a]
AArEH	8.0	321	138	3.55	0.84
AAcH	11.7	537	223	2.86	0.29
AAcL	8.7	356	278	3.75	0.74
Control	4.7	221	171	2.45	0.04
SE	6.0	220	32	2.93	0.17
AEL	6.3	272	173	2.81	0.16
AEH	5.7	242	89	4.05	0.51[a]
AGL	7.0	266	56	4.23	0.62[a]
AGH	8.7	363	361	3.98	0.12[a]
SV	7.7	336	45	3.74	1.50
SG	9.3	391	198	3.87	1.17

TPA = tree per acre; A = at the beginning denotes aerial application; V = Velpar; Ar = Arsenal; E = Escort; Ac = Accord; G = Garlon 4; H = standard pine release rates; L = one-half rates; SE = spot applied Escort; SV = spot applied Velpar; SG = streamlined applied Garlon 4.

[a] Treatments that are significantly different from the control at the 0.01 level of *p*.

aerial broadcast application of the low rate of Garlon, the high rate of Garlon, the high rate of Escort, and the low rate of Arsenal plus Escort were significantly larger in diameter than the untreated seedlings. Numbers of at least codominant saplings, although satisfactory for future stocking at 250 per acre, did not differ from those of the control, 221 per acre. Height of released oak saplings averaged 35 feet but did not differ statistically from the 28 feet height of the control saplings.

One possible reason for the lack of significant height growth response is that the released oak saplings appeared, by casual observation, to have larger and fuller crowns than the control saplings or oak saplings that had less reduction in competition (Thompson and Nix 1993). Another reason for less height growth by released seedlings may be the vine entanglement or lack of close trainer trees in the more extreme directed treatments. The directed treatments, Velpar and Escort spot gun and Garlon streamline application were very effective where splash or flashback did not kill the released oak saplings. However, such treatments were totally impractical in the dense tangled young clearcuts. Again, from casual observation, the oak seedlings that were released enough by the directed herbicide sprays to obtain full sunlight, but that had close (within 3 feet), taller saplings, seemed to achieve more height growth than other oak seedlings.

Vines, particularly the grape (*Vitus* spp.), and honeysuckle (*Japonicum* spp.), were especially onerous; they suppressed many of the released seedlings which eventually died or lost dominance as saplings. In addition wherever vigorous loblolly pine (*Pinus taeda*) saplings and sweetgum (*Liquidambar styraciflua*) sprouts occurred in any of the treatment plots they totally dominated the canopy and suppressed even the released oak seedlings. Furthermore, it is suspected that as many as 20 percent of the taller oak seedlings, greater than 4 to 6 feet, were killed or inhibited by the herbicide overspray treatments as they projected through the sheltering main canopy at 4 years of age (Thompson and Nix 1993).

CONCLUSIONS

It is possible to release oak seedlings with careful application of selected herbicides in young (3- to 4-year-old) clearcuts without serious losses, especially if the oak seedlings are at least several feet tall and in an overtopped, sheltered condition. This overtopping, which is very common in such clearcuts, seems to shield the seedlings from a lethal amount of the broadcast herbicides. Although only 4 treatments induced a significant increase in seedling diameter 10 years after treatment, most of the 13 treatments appeared to increase diameter growth and the presence of desirable oaks in the dominant canopy. It may be too early to ascertain the full effect of this release at 14 years of age, but some of these treatments appear to have potential for establishing more oaks in the main canopy at an earlier age, thereby increasing the oak component and basal area of the young stand. It is apparent that vines must be controlled on these better bottomland sites at some time during this critical developmental period, or many of the released oak seedlings will succumb to suppression.

These are 10 year results and because of the oak developmental pattern, the codominant oak saplings need perhaps 10 more growing seasons before the full treatment effects

can be evaluated. Economic analysis of the treatments will better assess the full practicality of such herbicide release of young overtopped oaks in recently clearcut bottomland hardwood stands.

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