TWO-YEAR RESULTS OF HERBICIDE RELEASED, NATURALLY-REGENERATED BOTTOMLAND CHERRYBARK AND SHUMARD OAK SEEDLINGS

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Abstract: After clearcuting in bottomlands, oak seedlings that naturally regenerate are often overtopped by woody pioneer species, sprouts and herbaceous material. To improve the competitive status of three- to four-year-old oak seedlings in two bottomland stands in South Carolina, several herbicides and methods of application were used to kill and/or stunt the overtopping competition. Oak seedling diameter growth two years after treatment was nearly doubled by four of the late summer herbicide oversprays and by two of the directed applications. Height growth two years after treatment was increased by 1.9 to 2.7 feet by two of the oversprays and by one of the directed soil applications. Timing the oversprays so that competing vegetation shielded the oak seedlings from herbicide damage appeared to aid in improving the oak seedling's competitive position in the rapidly developing dominant canopy.

INTRODUCTION

In the past thirty years oak (*Quercus* sp.) has been decreasing in the bottomland hardwood stands of the Southern United States (Johnson 1984). Cherrybark oak (*Quercus pagoda* Raf.) and Shumard oak (*Quercus shumardii* Buckl.) are two high quality bottomland oak species (Miller and Lamb 1985) that are not being replaced in the bottomland hardwood forest. 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 (Johnson 1979, Guldin and Parks 1989, Clatterbuck and Hodges 1988, Hodges and Janzen 1987). 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, Watt 1979, Hannah 1987, Nix 1989). 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 et al. 1985, Clatterbuck and Hodges 1988). Release of crop trees with herbicides has been accomplished successfully for many years in the management of pine stands (Clason 1978, Nelson et al. 1985, Bacon and Zedaker 1987, Nelson and Cantrell 1990). Therefore, it should be possible to release oak seedlings with careful application of the same herbicide.

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- to 5-thousand 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, and 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.

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PROCEDURE

Forty-two plots approximately 18- to 22-feet wide and 25- to 130-feet long were located along two-foot wide transects cut through the vegetation of a three- and a four-year-old clearcut, approximately one-half mile apart in the first bottom of the Congaree River near Columbia, South Carolina. 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 6 to 9 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 such 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 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 was 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 a coded number.

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

Control - no treatment.

Directed (Streamline) - Application of 20% Garlon 4 (a triclopyr herbicide), 10% Cide-Kick II surfactant (JLB 1984) and 70% 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 et al. 1989). This application was accomplished with a Solo piston backpack sprayer equipped with a D2 orifice disc tip for stream application.

Directed (Spot gun) - Application of Velpar L (a hexazinone herbicide) or Escort (a metsulfuron benzoate herbicide) applied in a grid pattern of 6 - 1 milliliter 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% of the manufacturer's product strength. The application mixture of Escort consisted of 1 oz. 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 indicates that there will be a 1.5- to 2-foot non-toxic zone around the treated oak seedlings (Du Pont 1987, Rachal et al. 1988, Du Pont 1988). These applications were accomplished with a standard spot gun applicator calibrated at 1 milliliter per spot application.

Broadcast (Overspray) - Simulated aerial broadcast, an overspray applied with a boom apparatus, applied at one half and full label-recommended application rate of commercial herbicides for releasing pines with 3.2 oz. per acre of TimberSurf 90 surfactant (0.25% 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 accomplished with a CO^2-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). 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. Spray width ranged from 18 to 22 feet depending on height of competing vegetation and number of boom sections installed, but within which competition was uniformly treated.

Table 1. Simulated aerial broadcast applications (oversprays) that were used at 100% and 50% 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 qt/ac
Escort	1 oz/ac
Accord	1.5 qt/ac
Velpar L	3 qt/ac
Arsenal AC/Escort	8 oz - 0.25 oz/ac[1]

[1]The rate of 0.25 oz/ac of Escort remains the same for both the 100% and the 50% rate plots.

To determine effectiveness of the release treatments, herbaceous competition, woody competition, total competition, seedling height, and GLD (ground line diameter), were measured before and after treatment. The results of the initial reduction of competition in this study were reported in an earlier paper (Thompson and Nix 1993). Seedling height (± 0.1 foot) and GLD (± 0.1 inch) were measured after two years of growth. Data were analyzed using a complete random block design and PC-SAS (1992), Anova procedure. Means were tested at the 0.01 level of probability.

RESULTS AND CONCLUSIONS

The effectiveness of any crop tree release treatment can be judged early by the subsequent tree height and diameter growth. In this study, oak seedling height and diameter growth two years after treatment are the major criteria for evaluating the effectiveness of the herbicide release treatments. Two treatments resulted in a significant increase in height growth of released oak seedlings after two full growing seasons (Table 2). Seedlings released by the low rate, broadcast application of Escort and the high rate, broadcast application of Arsenal/Escort grew 1.5 and 0.9 feet, respectively, more than the untreated seedlings (all height classes combined). Velpar L, soil-applied by spot gun, apparently increased seedling height growth (1.2 feet more then the control); however, no difference could be statistically detected because of high variance. Nine of the thirteen treatments significantly increased oak seedling ground line diameter (GLD) as compared to the untreated seedlings (Table 2).

Table 2. Two year height and diameter growth (all seedling height classes combined) of cherrybark and Shumard oak seedlings after herbicide release in three and four year-old clearcut bottomland hardwood stands on the Congaree River in South Carolina.[1]

Herbicide Treatment	Height Growth	Diameter Growth	Damaged[3]
	-- ft --	-- inches --	-- % --
BROADCAST[2]			
ACCORD HIGH	5.6	0.68**	9
ACCORD LOW	5.9	0.68**	4
ESCORT HIGH	5.5	0.78***	9
ESCORT LOW	7.0**	0.70***	0
VELPAR L HIGH	6.1	0.72***	4
VELPAR L LOW	5.9	0.51	0
GARLON 4 HIGH	4.8	0.84***	17
GARLON 4 LOW	5.4	0.73**	14
ARSENAL/ESCORT HIGH	6.4*	0.67	0
ARSENAL/ESCORT LOW	4.0	0.39	14
SPOT GUN			
ESCORT	6.2	0.56	0
VELPAR L	6.7	0.85***	8
STREAMLINE			
GARLON 4	4.8	0.99***	29
CONTROL	5.5	0.48	0

[1]Numbers with *, **, and *** adjacent, differ only from the control at the 0.10, 0.05, and 0.01 level of probability, respectively.
[2]High indicates 100% pine release rates. Low indicates 50% pine release rates.
[3]Damaged indicates the percent of the seedlings that were either killed down to the rootstock and are resprouting or have died.

The lack of significant increase in height or GLD in the 1-foot height class, except in the most drastic treatment (Tables 3 and 4), indicates that seedlings less than two feet in height at this age would not respond to the release treatments. The 2- and 3-foot height class oak seedlings, however, would respond as indicated by the number of treatments that significantly increased seedling GLD (Table 3). Nine treatments and seven treatments of the 2- and 3-foot height class seedlings, respectively, significantly increased the GLD as compared to the untreated seedlings. However, in only four treatments in the 2- and 3-foot height class were seedlings significantly taller than the untreated seedlings.

One possible reason for the lack of significant height growth response is that the released oak seedlings appear, by casual observation, to have larger and fuller crowns than the control seedlings or oak seedlings that had less reduction in competition (Thompson and Nix 1993). Another reason for less height growth by released seedlings may be the lack of close trainer seedlings/trees. Again, from casual observation the oak seedlings that were released enough to obtain some direct sunlight, but that have close (within 3 feet), taller seedlings/trees seemed to achieve more height growth than other oak seedlings.

Table 3. Two year diameter growth (according to initial height class) of cherrybark and Shumard oak seedlings after herbicide release in three and four year old clearcut bottomland hardwood stands on the Congaree River in South Carolina.[1]

Herbicide Treatment	Diameter Growth/Height Class		
	1-Foot	2-Foot	3-Foot
	--inches--		
BROADCAST[2]			
ACCORD HIGH	0.29	0.69	0.95**
ACCORD LOW	0.39	0.90**	0.78
ESCORT HIGH	0.45	0.81**	1.12**
ESCORT LOW	0.47	0.71*	0.89**
VELPAR L HIGH	0.45	0.80**	0.87*
VELPAR L LOW	0.40	0.41	0.74
GARLON 4 HIGH	0.47	0.82**	1.08**
GARLON 4 LOW	0.40	0.90***	0.80
ARSENAL/ESCORT HIGH	0.49	0.76*	0.83
ARSENAL/ESCORT LOW	0.22	0.28	0.70
SPOT GUN			
ESCORT	0.47	0.51	0.72
VELPAR L	0.38	0.92**	1.15*
STREAMLINE			
GARLON 4	0.88**	1.10***	0.97**
CONTROL	0.42	0.47	0.58

[1]Numbers with *, **, and *** adjacent, differ only from the control at the 0.10, 0.05, and 0.01 level of probability, respectively.
[2]High indicates 100% pine release rates. Low indicates 50% pine release rates.

CONCLUSIONS

It is possible to release oak seedlings in young (3 to 4 year old) clearcuts without serious losses with careful application of selected herbicides, especially if the oak seedlings are in an overtopped condition. This overtopping, which is very common in such clearcuts, seems to protect (shield) the seedlings from lethal amounts of the herbicides. Although only two treatments induced a significant increase in seedling height growth at present (2 years after treatment), nine of the thirteen treatments caused a significant increase in diameter growth; one, the streamline application caused more than double the diameter growth of the control. It may be too early to ascertain the full effect of this release on height growth as the oak seedlings appear at present to be gaining biomass from the increased sunlight, as indicated by the increased GLD. 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.

These are two-year results; and because of the oak developmental pattern, the seedlings need several more growing seasons before the full treatment effects can be determined. Evaluation of the treatments in the future and an economic analysis will better assess the full practicality of such herbicide release of young overtopped oaks in recently clearcut bottomland hardwood stands.

Table 4. Two year height growth (according to height class) of cherrybark and Shumard oak after herbicide release in three and four-year old clearcut bottomland hardwood stands on the Congaree River in South Carolina.[1]

Herbicide Treatment	Height Growth/Height Class		
	1-Foot	2-Foot	3-Foot
		--feet--	
BROADCAST[2]			
ACCORD HIGH	3.6	5.5	7.1
ACCORD LOW	4.0	7.6*	6.5
ESCORT HIGH	5.4	5.9	5.3
ESCORT LOW	6.0	6.9	7.8**
VELPAR L HIGH	5.5	6.4	6.4
VELPAR L LOW	5.3	5.6	7.0
GARLON 4 HIGH	2.9	5.2	5.7
GARLON 4 LOW	3.4	6.8	5.1
ARSENAL/ESCORT HIGH	6.1	6.7	6.5
ARSENAL/ESCORT LOW	2.3	3.4	6.5
SPOT GUN			
ESCORT	5.9	6.4	6.4
VELPAR L	3.4	7.8**	8.2**
STREAMLINE			
GARLON 4	4.8	5.8	3.7
CONTROL	5.2	5.7	5.5

[1]Numbers with * and ** adjacent, differ only from the control at the 0.10 and 0.05 level of probability, respectively.
[2]High indicates 100% pine release rates. Low indicates 50% pine release rates.

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