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Effects of Herbicide Release on the Growth of 8- to 12-Year-Old Hardwood Crop Trees

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Abstract

In 8- to 12-year-old Appalachian hardwood stands, crop trees were released by stem injecting competing trees with a 20 percent aqueous solution of glyphosate. Species released were black cherry, red oak, and sugar maple. Release treatments were (a) injection of all trees within a 5-foot radius of the crop tree bole and (b) injection of all trees whose crown touched the crop tree. Five-year diameter growth of all species was significantly increased by both release treatments, but height growth was not affected by either treatment. Survival of released crop trees was higher and crown-class retrogression of released trees was less than unreleased trees. Glyphosate was effective in controlling most hardwood species during the 5 years of observation.

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Introduction

Some control of species composition in young hardwood stands can be accomplished by releasing trees of desirable species and form (Erdmann 1983). Theoretically, released trees should grow faster and have a greater chance of attaining and maintaining dominance in the new stand. Major obstacles in regulating species composition in naturally regenerated stands are the variety of species, stem quality, large number of stems, and growth differences among species.

Early work by Trimble (1973, 1974) generally showed that 7-year-old stems of yellow-poplar, *Liriodendron tulipifera* L.; black cherry, *Prunus serotina* Ehrh.; and northern red oak, *Quercus rubra* L., did not respond in diameter or height growth when all competing trees within a 5-foot radius of the bole were cut. In a 9-year-old stand, Lamson and Smith (1978) measured response of released sugar maple, *Acer saccharum* Marsh.; red oak; black cherry; and yellow-poplar crop trees. All trees were cut that were one-half or more as tall as the crop tree and were within a radius of 5 feet of the crop tree. Their general conclusions were (1) that release did not significantly improve height or diameter growth or length of clear stem, and (2) that a large portion exhibited crown-class regression in the 5-year period after release. One factor affecting response of crop trees in these studies, particularly in the 7-year-old stands, was the vigorous sprouting from the cut stems surrounding the crop tree.

In this study, we injected glyphosate, a herbicide, into the base of competing stems and measured crop-tree response in d.b.h. growth, height growth, and changes in crown class. Glyphosate injection is very effective in eliminating or reducing sprouting of most hardwood species (Wendel and Kochenderfer 1982).

The Study

Seedling-origin crop trees in three 8- to 12-year-old naturally and artificially regenerated hardwood stands were selected for release. Species included codominant and intermediate black cherry; codominant, intermediate, and suppressed red oak; and intermediate sugar maple (Table 1). Competing trees were injected with a 20 percent aqueous solution of glyphosate. Injections were spaced at intervals of 1.5 inches edge-to-edge around the base of all stems that had a basal diameter larger than 1.0 inch. Approximately 1.5 ml of solution was injected into each incision. In the 8- and 10-year-old stands, competing trees within a radius of 5 feet of the crop tree bole were injected. In the 12-year-old stand, competing trees whose crowns were touching under or over the crop-tree crown were injected (Table 1). All crop trees were permanently marked. Crop trees were randomly selected, and every other crop tree was released.

D.b.h., total height and crown class of each crop tree were recorded at the time of and 5 years after treatment. Analysis of variance was used to test for differences in d.b.h. and height growth.

Results

Survival

Except for codominant black cherry and intermediate sugar maple, survival was better for released trees than it was for control trees (Table 2).

Table 1.—Species, number of trees, and type of release used in the study

Species	Initial stand age[a]	Origin[b]	Initial crown class[c]	Number of trees		Type of release
				Control	Released	
Black cherry	8	N	2	25	25	5′ radius around bole
Black cherry	8	N	3	22	22	"
Red oak	10	P	2	35	46	"
Red oak	10	P	3	29	29	"
Red oak	10	P	4	22	14	"
Sugar maple	12	N	3	12	13	Crown touching

[a]Planted seedlings were 1-0 bare-rooted stock.
[b]N = natural, P = planted.
[c]2 = codominant, 3 = intermediate, 4 = overtopped.

Table 2.—Five-year height growth and survival of control and released trees

Species	Initial age	Initial crown class[a]	Survival		Initial height		Height-growth of survivors		
			Control	Released	Control	Released	Control	Released	Significance[b]
			---Percent---		*----------Feet----------*				
Black cherry	8	2	100	92	16.6	16.6	10.8	10.7	NS
Black cherry	8	3	87	100	14.1	14.3	7.6	7.7	NS
Red oak	10	2	80	98	14.4	14.8	8.8	8.7	NS
Red oak	10	3	65	86	13.0	12.3	5.0	6.5	NS
Red oak	10	4	9	57	10.1	10.9	2.9	3.0	NS
Sugar maple	12	3	100	100	22.7	24.3	6.5	7.0	NS

[a]2 = codominant, 3 = intermediate, 4 = overtopped.
[b]NS = not significantly different. Analysis of variance.

Height growth

For all species and crown classes, 5-year average height growth did not differ significantly between control and release trees (Table 2).

D.b.h. Growth

Five-year average d.b.h. growth was significantly greater for all released trees except 10-year-old overtopped red oak (Table 3). However, in all instances 5-year d.b.h. growth was nominally greater for released trees than control trees. Regardless of crown class, the difference in 5-year d.b.h. growth between control and released trees averaged 0.4 inch for black cherry, 0.3 inch for red oak, and 0.7 inch for sugar maple. Also, the 5-year d.b.h. growth for released 12-year-old intermediate sugar maples was similar to the response for codominant 8-year-old black cherry trees.

Crown-class Changes

A higher percentage of released than control trees remained the same or improved in crown class during the 5 years (Table 4). A large proportion of black cherry in the codominant crown class in both control and released treatments retained their original crown class during the 5 years. However, of the intermediate black cherry, 57 percent of the control trees retrogressed to the overtopped crown class or died. Twenty-four percent of the released intermediates became codominants compared to only 4 percent for the controls.

A higher percentage of released than control red oaks retained their original crown class, regardless of crown class. In contrast, there was higher mortality and retrogression to lower crown classes among the control red oak.

For sugar maples that were initially intermediate, 69 percent of the released trees were codominant 5 years after treatment, while none of the control trees moved into the codominant class.

Discussion and Conclusions

The results of this study have shown that tree injection with a 20 percent solution of glyphosate is an effective way to eliminate competition around selected crop trees. Earlier work by Wendel and Kochenderfer (1982) showed that most of the common Appalachian hardwoods were killed and did not resprout after 2 years following injection with glyphosate. After 5 years in this study, the effects of release are still evident.

In previous early release studies in West Virginia where a 5-foot release radius was used, 7- and 9-year-old black cherry and red oak crop trees did not respond in height or diameter growth (Smith 1977). Vigorous sprouts from the cut stems were suggested as a possible reason for the poor response on the crop trees. In our study, using the same release criteria, we found that treated 8-year-old black cherry and 10-year-old red oak responded in d.b.h. growth and had less crown-class retrogression when a herbicide was used to kill competitors. The herbicide application reduced sprouting by killing the competing trees, thus leaving the crop trees competition-free for a longer period of time.

Smith (1977) also noted that crop trees in young stands were often severely damaged by grapevines that flourished following release.

Table 3.—Five-year d.b.h. growth of control and released crop trees

Species	Initial age	Initial crown class[a]	Initial d.b.h.		D.b.h. growth of survivors	
			Control	Released	Control	Released[b]
			Inches			
Black cherry	8	2	1.5	1.6	1.2	1.6**
Black cherry	8	3	0.9	0.8	0.6	1.0*
Red oak	10	2	1.1	1.2	0.8	1.1*
Red oak	10	3	0.8	0.8	0.3	0.6*
Red oak	10	4	0.8	0.6	0.2	0.4NS
Sugar maple	12	3	1.9	1.9	0.7	1.4**

[a]2 = codominant, 3 = intermediate, 4 = overtopped.
[b]NS = not significantly different; * = P<0.05; ** = P<0.01; analysis of variance.

Table 4.—Distribution of control and released trees by crown class, at the end of five growing seasons

Species	Initial age	Initial crown class[a]	Crown class remained same or improved		Dead	
			Control	Released	Control	Released
			Percent			
Black cherry	8	2	68	88	0	8
Black cherry	8	3	43	76	13	0
Red oak	10	2	14	22	20	2
Red oak	10	3	3	48	62	14
Red oak	10	4	9	50	91	43
Sugar maple	12	3	42	100	0	0

[a]2 = codominant, 3 = intermediate, 4 = overtopped

Since codominant 8-year-old black cherry and 10-year-old red oak responded to release, we would recommend releasing these. The results of this study also showed that some of the intermediate black cherry, sugar maple, and red oak responded significantly in diameter growth to release. However, 5 years after release only 3 percent of intermediate red oak and 24 percent of intermediate black cherry were codominant stems. How many of these codominant trees will retain this position until final harvest is not known. We would recommend releasing some intermediate black cherry where there is a need to improve species composition. We would not recommend releasing 10-year-old intermediate red oak trees. Also, we would recommend releasing 12-year-old intermediate sugar maple.

A major advantage of tree injection with glyphosate is that sprouting of most hardwood species is reduced, thereby providing a longer release period for the crop tree. Injection is also a safe and clean method of applying herbicides and environmental effects are minimized because the herbicide is applied directly to the target species. Cutting of competing trees on the other hand may provide immediate release, but sprouting may be a problem later on. For release of stump sprout crop trees, however, cutting may be the only method that can be used. Also, because cut trees are readily visible it may be easier to achieve a desired degree of release by cutting.

Miller (1984) showed that in 12-year-old stands, chain saw release cost 42 cents per crop tree, injection with a 20

percent glyphosate solution cost 61 cents per crop tree, and basal spraying with a 4 percent mixture of 2, 4–D and fuel oil cost 80 cents per crop tree. However, Miller's study did not evaluate the long-term effectiveness of the three release methods. In younger hardwood stands, where slower growing, desired species may not survive without early release, injection of competing stems with herbicide might be an effective method for maintaining and increasing growth of selected crop trees. Failure to release certain species early may negate future release growth response.

Our study demonstrated that glyphosate will control many hardwood species but that the longer term cost/effectiveness compared to other methods has not been determined. If species composition is not a concern, we suggest a cutting release when trees are more than 25 feet tall (Smith 1977). Unless circumstances dictate otherwise, crop trees of desired species are best picked from the pool of dominant and codominant trees.

For those who might be interested in using glyphosate to release crop trees, we recommend the following:

- Use a 20 percent aqueous solution of glyphosate.
- Inject about 1.5 ml of solution per incision, space incisions at about 1.5 inches edge-to-edge. One incision is sufficient for a 1.0-inch d.b.h. tree.
- Inject trees when they are dormant or approaching dormancy, but before sap begins to flow in the spring. When the sap is flowing, much of the herbicide solution can be forced out of the incision.
- To eliminate a sprout clump, make injections in the stump close to the ground. Thus, treatment of individual sprouts can usually be avoided. Do not release sprout origin crop trees by injecting competing sprouts on the same stump.

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Caution

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers—out of reach of children and pets—and away from foodstuff.

Apply pesticides selectively and carefully. Do not apply a pesticide when there is a danger of drift to other areas. Avoid prolonged inhalation of a pesticide spray or dust. When applying a pesticide, it is advisable that you be fully clothed.

After handling a pesticide, do not eat, drink, or smoke until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If the pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Dispose of empty pesticide containers by wrapping them in several layers of newspaper and placing them in your trash can.

It is difficult to remove all traces of a herbicide (weed killer) from equipment. Therefore, to prevent injury to desirable plants do not use the same equipment for insecticides and fungicides that you use for a herbicide.

NOTE: Registrations of pesticides are under constant review by the U.S. Department of Agriculture. Use only pesticides that bear the USDA registration number and carry directions for home and garden use.

Wendel, G. W.; Lamson, Neil I. 1987. **Effects of herbicide release on the growth of 8- to 12-year-old hardwood trees.** NE-RP-598. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 4 p.

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