EFFECTS OF THINNING INTENSITY AND CROWN CLASS ON CHERRYBARK OAK EPICORMIC BRANCHING FIVE YEARS AFTER TREATMENT

Luben D. Dimov, Erika Stelzer, Kristi Wharton, James S. Meadows, Jim L. Chambers, Kenny Ribbeck, and E. Barry Moser[1]

Abstract—Thinning in oak-dominated stands may have many desirable consequences, including increases in tree growth and mast production. One of the potential disadvantages, however, is the proliferation of epicormic branches, which leads to reduction in lumber quality and value. We assessed the effects of thinning intensity and initial crown class on cherrybark oak (*Quercus pagoda* Raf.) epicormic branching in a 35-year old plantation in east central Louisiana. The thinning regimes were light, with residual stocking (Goelz 1995) of 75 percent, heavy, with 50 percent residual stocking, and an uncut control. The crown classes of all residual trees were classified immediately after treatment with a numeric crown class system (Meadows and others 2001). Five years after treatment, the number of epicormic branches increased across all treatments and crown classes. However, trees with higher crown class scores (the more dominant trees) continued to have fewer epicormics than trees with lower crown class scores.

INTRODUCTION

Thinning in oak stands achieves a number of objectives, including providing intermediate return on investments and increasing basal area growth of the residual trees. Such objectives are common for the typical landowner. One negative consequence often associated with thinning in oak stands however, is the proliferation of epicormic branches on the boles of some trees. Epicormic branches arise from adventitious or dormant buds and can cause substantial reduction in both lumber value and log grade. Meadows and Burkhardt (2001) reported a reduction in willow oak (*Quercus phellos* L.) lumber value of 13 percent as a result of epicormic branches. The difference in value of hardwood logs grade 1, 2, and 3, other conditions being equal, can be dramatic; Stubbs (1986) reported value ratios between such logs as 13:7:1. Any stem attribute change that results in such a difference in log value deserves special attention of the forest manager and the landowner. Since fertilization (Michalek and others 2004) and pruning (Dwyer and Lowell 1988, Pelkki and Colvin 2004) are not solutions to the reduction in number and size of epicormic branches and lumber quality, proper silvicultural measures need to be taken in managing oak stands.

Cherrybark oak (*Quercus pagoda* Raf.), often considered to be one of the most commercially valuable bottomland hardwood species in the Southeastern United States (Putnam and others 1960), is believed to have medium susceptibility to epicormic branching (Meadows 1995). Production of new epicormic branches in cherrybark oak, as well as in other hardwood tree species, is sometimes observed after thinning and has often been believed to be caused by the increase in the amount of light reaching the tree bole. Proliferation in epicormics, however, occurs even in stands that have not been thinned. Indications from various studies suggest that tree species and vigor may also have an effect on epicormic sprouting (Meadows 1995), with more dominant trees being less likely to produce new epicormic branches, even after thinning.

In this study, we examined the effects of thinning intensity and crown class on the production of epicormic branches in plantation-grown 35-year-old cherrybark oak trees 5 years after thinning. Crown class was determined using a crown classification system that assigns numeric values to crown attributes and allows the crown condition, and consequently the tree vigor, to be rated in more precise increments.

MATERIALS AND METHODS

The Red River Wildlife Management Area in southern Concordia Parish, LA, served as the study area. The cherrybark oak plantation used in the study is within 0.5 mile west of the Mississippi River levee, but the site is not subject to flooding. The soils are Commerce silt loam (Aeric Fluvaquents), which are deep and somewhat poorly drained, and Bruin silt loam (Fluvaquentic Eutrudepts), a deep and moderately well-drained soil. The site was planted with several oak species between 1969 and 1972 with cherrybark oak representing 43 percent of the area. The average planting density was approximately 412 trees per acre. Between 1982 and 1985, the area was subjected to timber stand improvement using Tordon injection.

During the 1998 growing season, we established 14 treatment plots 3 chains (1 chain = 66 feet) x 6 chains. The measurement plots were nested within the treatment plots and were 1 chain wide x 4 chains long (0.4 acre). Diameter of all trees > 5 inches in diameter at breast height (d.b.h., 4.5 feet above ground) was measured to determine initial stocking according to the Goelz's (1995) stocking guide for southern bottomland hardwoods. Three thinning treatments were randomly assigned

[1] Postdoctoral Researcher, School of Renewable Natural Resources, Louisiana State University AgCenter, Baton Rouge, LA 70803; Biological Technician, IAP World Services, Inc., U.S. Geological Survey National Wetlands Research Center, Lafayette, LA 70506; Forestry Technician, USDA Forest Service, Southern Research Station, Pineville, LA 71360; Principal Silviculturist, USDA Forest Service, Center for Bottomland Hardwood Research, Stoneville, MS 38776; Forestry Program Leader and Weaver Brothers Professor of Forestry, Louisiana State University AgCenter, Baton Rouge, LA 70803; Biologist Programs Manager, Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA 70898; and Department Head and Professor of Experimental Statistics, Louisiana State University AgCenter, Baton Rouge, LA 70803, respectively.

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to the plots within each block: light thin, where stocking was reduced to 75 percent, heavy thin, with stocking reduced to 50 percent, and uncut control (table 1). The thinning method was "from below", where trees with low crown class, vigor, and small d.b.h. were preferentially removed until the desired stocking level was achieved. Thinning intensity was assigned randomly to the plots within each block and was applied between September 30, 1998, and February 3, 1999.

Crown class of each residual tree was determined immediately after treatment using the classification system of Meadows and others (2001). This system assigns numeric values to tree crown according to the criteria: (1) proportion of the crown exposed to direct sunlight from above - values from 0 to 10, (2) proportion of the upper half of the crown exposed to direct sunlight from the sides - values from 0 to 10, (3) crown balance - values from 1 to 4 according to the number of quadrants occupied by 20 percent or more of the total crown volume, and (4) relative crown size - values from 1 to 4 assigned for appropriate crown size and density as related to a tree of that diameter and species: One point is assigned if the crown size and density are considered to be severely limiting to growth, two points if limiting to growth, three points if somewhat limiting to growth, and four points if not limiting to growth. All points are then summed up and crown class is assigned in the following manner: 24 to 28 points = dominant, 17 to 23 points = codominant, 10 to 16 points = intermediate, and 2 to 9 points = suppressed.

Epicormic branches were counted immediately after treatment in February, 1999, and then 5 growing seasons later, in March, 2004. We counted all epicormic branches on the first 16-foot log of the cherrybark oak trees larger than 5 inches d.b.h.

We utilized a split-plot model with thinning treatment in the whole plot and crown class in the sub-plot and the MIXED procedure (software SAS v.9) to analyze the 5-year change in number of cherrybark oak epicormic branches. Effects with p-value < 0.05 were considered significant.

Table 1—Differences in initial stocking necessitated assignment of plots into one of five blocks

Block number	Plot number	Initial stocking	Thinning intensity
		- -% - -	
1	12	75	Control
	1	76	Light
	2	77	Heavy
2	11	80	Heavy
	6	81	Light
3	14	85	Heavy
	4	87	Light
	7	90	Control
4	8	92	Heavy
	3	95	Control
	10	96	Light
5	18	102	Light
	15	103	Heavy
	5	107	Control

RESULTS

The overall effects of thinning intensity, initial crown class, and their interaction term were not significant. Therefore, the change in number of epicormic branches did not appear to be influenced by the residual stocking level and by the degree of crown release. The average 5-year increase in number of epicormic branches was 6.5 branches per tree, and the 95 percent confidence interval was from 4.0 to 9.1 branches.

However, the average number of epicormic branches per tree at the end of the fifth growing season was significantly greater than the number of epicormic branches at the beginning of the study in three of the four crown classes (fig. 1) and in each of the individual treatments (fig. 2, table 2). The average increase in number of epicormic branches per tree on the different treatments ranged from 6.0 to 6.8 branches. Trees from more dominant crown classes experienced smaller increase in number of epicormic branches than did trees that were codominant or intermediate. These differences, however, were not significant (table 2). Although the suppressed trees did not experience a very large increase in the number of epicormic branches, at the end of the period they still had more epicormic branches than the trees from the other three crown classes (fig. 1).

With the exception of the trees from the dominant crown class in the Control plots, the increase in epicormic branches

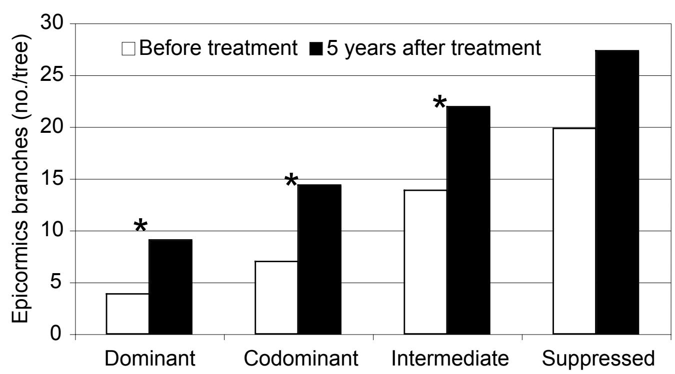

Figure 1—Average number of epicormic branches per crown class before and 5 years after thinning. Asterisks indicate that the increase in number of epicormic branches is significant at the 0.05 level.

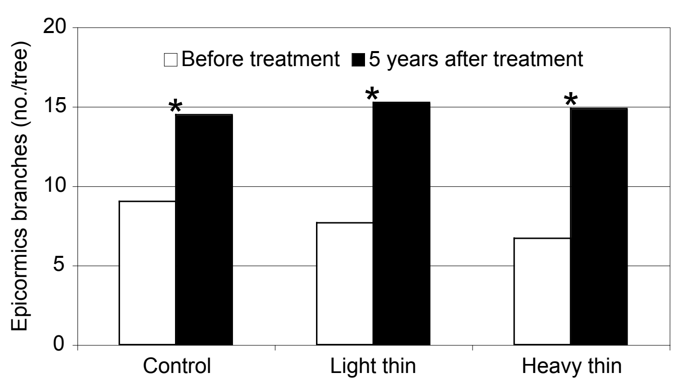

Figure 2—Average number of epicormic branches per treatment before and 5 years after thinning. Asterisks indicate that the increase in number of epicormic branches is significant at the 0.05 level.

was significant for trees within all crown classes in each treatment (table 3; figs. 3 and 4). It should be noted that due to the very small number of suppressed trees in the heavy and light thin plots (as a result of their preferential removal during the thinning operations), they were not included in table 3.

Table 2—Five-year mean (least squares means) change in numbers of epicormic branches for each of the three levels of thinning (control-C, light-L, and heavy-H) and four crown classes (dominant-D, codominant-CD, intermediate-I, and suppressed-S). Significant t tests indicate an increase in the number of epicormic branches

Effect	Thinning (C,L,H)	Crown class (D,CD,I,S)	Estimate	Standard error	DF	t-value	P-value
thinning	C		6.830	1.842	11.1	3.71	0.003
	L		6.782	2.126	29.4	3.19	0.003
	H		5.951	2.425	47.1	2.45	0.018
crown class		D	5.594	1.281	29.8	4.37	<0.001
		CD	7.361	1.137	19.1	6.48	<0.001
		I	8.654	1.630	67.6	5.31	<0.001
		S	4.476	3.200	289.0	1.40	0.163

Table 3—Five-year mean (least squares means) change in numbers of epicormics for the cell-mean combinations of the three levels of thinning (control-C, light-L, and heavy-H) and four levels of crown class (dominant-D, codominant-CD, intermediate-I, suppressed-S). Significant t tests indicate an increase in the number of epicormic branches

Effect	Thinning (C,L,H)	Crown class (D,CD,I,S)	Estimate	Standard error	DF	t-value	P-value
thinning by crown class	C	D	3.944	2.307	26.3	1.71	0.099
	C	CD	5.298	2.010	15.6	2.64	0.018
	C	I	7.278	2.328	27.6	3.13	0.004
	C	S	10.801	3.112	78.8	3.47	<0.001
thinning by crown class	L	D	5.163	2.208	34.8	2.34	0.025
	L	CD	7.623	1.831	16.9	4.16	<0.001
	L	I	11.392	2.570	56.9	4.43	<0.001
thinning by crown class	H	D	7.674	2.136	29.7	3.59	0.001
	H	CD	9.162	2.058	26.5	4.45	<0.001
	H	I	7.294	3.449	131	2.11	0.036

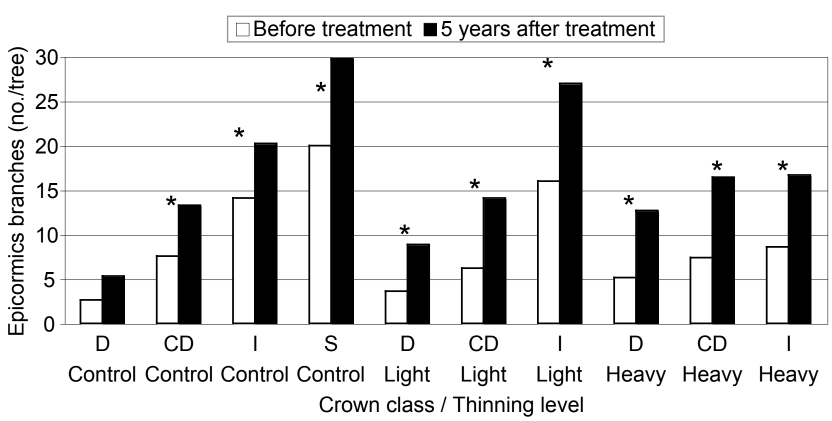

Figure 3—Number of epicormic branches before and 5 years after treatment per crown class (dominant-D, codominant-CD, intermediate-I, suppressed-S) by treatment and ordered by the treatment level. Asterisks indicate that the increase in number of epicormic branches is significant at the 0.05 level.

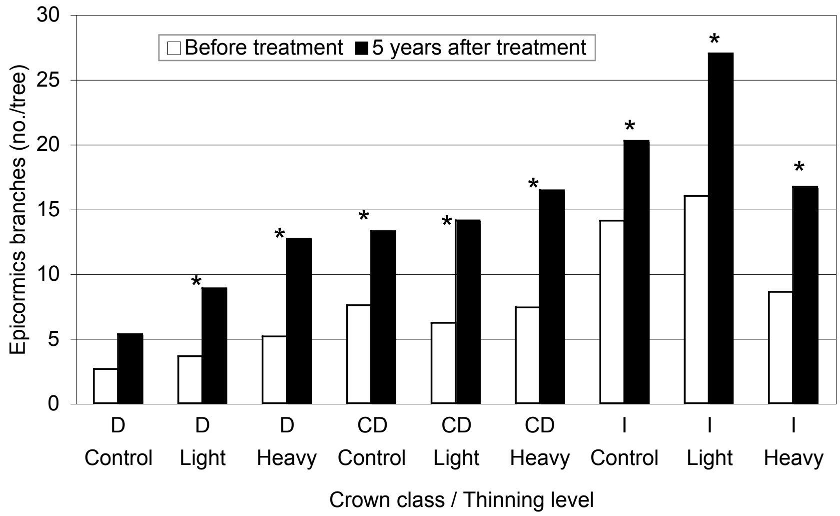

Figure 4—Number of epicormic branches before and 5 years after treatment per crown class (dominant-D, codominant-CD, intermediate-I, suppressed-S) by treatment and ordered by crown class. Asterisks indicate that the increase in number of epicormic branches is significant at the 0.05 level.

DISCUSSION AND CONCLUSIONS

The observed increase in overall number of epicormic branches on the boles of all trees, regardless of their crown class immediately after thinning and regardless of the thinning intensity, indicates that other factors beyond those examined in the study may also be having an impact on this increase. Tree vigor is one of the factors influencing epicormic branching that forest management can manipulate the easiest. This is carried out through timely release of selected crop trees from the crowding effects of inferior neighbors. If such a release is not provided in a timely manner, even the more competitive trees may have already been subjected to enough competition for resources to experience a decrease in vigor and an increase in propensity to produce epicormic branches. This is certainly a possibility for the plantation described in this study, because stocking was high on most of the plots. Additionally, providing sufficient aboveground growing space may not always be a sufficient measure for improving tree vigor. Environmental factors, including droughts and insect infestations, may reduce tree vigor regardless of the amount of growing space available to the tree. Two of the years (1999 and 2000) during the study period were indeed classified as drier than average and may therefore have contributed to increased tree stress and the overall increase in number of epicormic branches. It appears that the combined effect of delayed thinning and lower-than-average rainfall for part of the study period might have been so strong as to mask the effect of thinning intensity and initial crown class, both of which were not significant effects for the 5-year change in number of epicormic branches. In cases where stands have not yet stagnated and there are no climatic events that cause unusual stress on the residual trees, epicormic branches are generally expected to be less of a problem in red oak species. Meadows and Goelz (2002), for example, report little effect of thinning on the production of new epicormic branches in red oaks in a mixed red oak-sweetgum stand 4 years after thinning.

The lack of significance of the overall increase in epicormic branches in the suppressed trees likely results from the limited number of suppressed trees in the heavy and light thinned plots, which makes the estimate for this effect less reliable. When the suppressed trees are examined in regard to the individual treatments, then they do follow the general trend of significant increase in number of epicormic branches by the end of the fifth growing season.

It seems possible that the lack of significance in the increase in number of epicormic branches on the dominant trees from the control plots might be caused by the likely much higher average initial vigor of these trees. That is, dominant trees on controls plot quite possibly experienced less competition and reduction in vigor in the past than trees with comparable crown class score that are in the light or heavy thinned plots. This is because the trees on the thinned plot had such scores after the thinning, while on the average, prior to thinning, their scores would have generally been lower than that, i.e., they would have been growing in a more competitive environment.

Despite the overall increase in the number of epicormic branches on the boles of all trees after thinning, such average increase was also present on trees in the unthinned plots, indicating that factors other than thinning also play a crucial role in the process. Although the number of epicormic branches increased on trees from all crown classes, the high-vigor dominant and co-dominant trees still had fewer epicormic branches at the end of the 5-year period than trees from lower crown classes. Therefore, unless the most vigorous trees are favored during thinning, the residual stand is likely to suffer from substantial reduction in average tree quality and value. A typical diameter limit cut, which often amounts to "high-grading", would certainly result in degrading the stand value and its future potential and should therefore be discouraged and avoided. It is also important to time the thinning operations before the trees in the plantation have gotten so crowded as to jeopardize their future quality.

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