by G. R. Trimble, Jr.
and Donald W. Seegrist

EPICORMIC BRANCHING

On Hardwood Trees Bordering Forest Openings

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WARREN T. DOOLITTLE, DIRECTOR

The Authors

G. R. TRIMBLE, JR., is timber-management project leader for the USDA Forest Service's Northeastern Forest Experiment Station at its Timber and Watershed Laboratory at Parsons, West Virginia. He received his forestry training at the University of Maine. He worked for a number of years in watershed management problems throughout much of the northeastern United States.

DONALD W. SEEGRIST is a biological statistician at the Northeastern Forest Experiment Station, Upper Darby, Pa. He graduated from George Washington University, Washington, D. C., in 1953 with a bachelor of science degree in zoology. He received his master's degree in 1959 and his Ph.D. degree in zoology in 1965 at the University of California, Berkeley. In 1963, he joined the U. S. Forest Service as a biological statistician at the Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif. In 1968 he joined the biometrics staff at the Northeastern Forest Experiment Station.

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Abstract

Epicormic branching in hardwoods can degrade logs and reduce the dollar returns from growing trees. A study made around clear-cut openings of various sizes showed that the following variables were related to the degree of epicormic branching on trees bordering the openings: size of opening, species, tree dominance class, exposure of tree bole, and position on tree bole.

Common and scientific names of species referred to in this study:

Basswood	*Tilia* L.
Beech, American	*Fagus grandifolia* Ehrh.
Birch, sweet	*Betula lenta* L.
Cherry, black	*Prunus serotina* Ehrh.
Gum, black	*Nyssa sylvatica* Marsh.
Hickory	*Carya* Nutt.
Maple, red	*Acer rubrum* L.
Maple, sugar	*Acer saccharum* Marsh.
Oak, chestnut	*Quercus prinus* L.
Oak, northern red	*Quercus rubra* L.
Oak, white	*Quercus alba* L.
Sassafras	*Sassafras albidum* (Nutt.) Nees.
Sourwood	*Oxydendrum arboreum* (L.) DC
Yellow-poplar	*Liriodendron tulipifera* L.

INTRODUCTION

EPICORMIC BRANCHING in hardwoods can degrade logs and reduce the dollar returns from growing trees. A study was made to investigate the effect of opening size on epicormic branching. This information is needed because group selection cutting and patch cutting with area control — both of which create small openings in the forest— are important methods of regeneration. And the creation of such openings in hardwood stands triggers epicormic branching on border trees.

In addition to studying the effects of opening size on epicormic branching, we also examined variables that previous research had shown to affect epicormic branching.

DESCRIPTION OF AREA

The study was made in the Central Appalachians on the Fernow Experimental Forest near Parsons, West Virginia. Elevation of the study areas is about 2,500 feet. Plot slopes vary from gentle to very steep. Soils are medium-textured, well-drained, and derived from sandstone and shale. The Experimental Forest has a rainy and cool climate with a well-distributed annual rainfall of about 57 inches.

The study was made in areas that fell into two site-quality groups: one is a very good site in terms of the oak site scale *(Schnur 1937)*—site index about 75: and the other is a fair site—site index about 60. The dominating species on the better sites were sugar maple, yellow-poplar, northern red oak, black cherry, basswood, hickory, beech, and sweet birch. On the area of lower site quality, the most numerous species were chestnut, white, and red oaks; red maple; sweet birch; black gum; sassafras; and sourwood.

The stands were second growth about 60 years old; the better sites contained an admixture of old-growth stems residual from the original cutting. At study inception, all stands were unmanaged and well-stocked.

STUDY METHODS

Plot Layout and Measurements

Circular plots of different diameters were clearcut to specific dimensions. The smallest plots—50 feet in diameter—approximated the kind of openings that would be created by selection cutting if a couple of large trees were removed; the largest plots—250 feet in diameter — were expected to provide the kind of border environment created by large clearcuts.

The following tabulation shows the number and sizes of openings studied:

Opening diameter (feet)	*Area (acres)*	*Number of openings*	
		Good site (s.i. 75)	*Fair site (s.i. 60)*
50	0.045	9	9
100	.180	9	0
150	.406	9	9
200	.721	9	0
250	1.127	9	9
	Total	45	27

We were able to cut the plots, as measured from tree bole to tree bole, fairly close to intended size. The canopy openings were smaller than the plots measured on the ground between tree boles because of branch overhang. After cutting, some of the canopy openings for 50-foot plots were less than 20 feet across.

In the dormant season immediately before the openings were logged, the border-tree samples were designated and numbered. After logging, the sample-tree bole was divided into an exposed and an unexposed half (the exposed half faced into the opening); and this division was indicated by paint lines on the lower trunk.

The following measurements were taken for each sample tree: species, d.b.h., dominance class (taken before logging), number of half

logs, and the number of existing established branches by half-log positions on both the exposed and unexposed faces. Only trees over 5.0 inches d.b.h. were taken as samples, and most of the trees were 10 inches d.b.h and larger. Total log height was based on estimates of potential log height—that is, length of clear stem to crown.

In the dormant season after the five growing seasons, we repeated a count of branches by half logs, eliminating those branches that had existed at the first count. We based our analyses of epicormic branches on the residual number.

We terminated the study at the end of 5 years and examined the study results.

Analysis

Because previous research has shown that epicormic branching is affected by these variables, we stratified the data on the sample trees by species, tree dominance class (dominant and codominant, 1 and 2; intermediate and suppressed, 3 and 4), and site quality (site index 75 and 60). We also stratified the data by the numbers of half logs in the tree and by opening size—the variable of primary interest.

By dividing the sample trees into so many strata, we greatly reduced the number of trees in each stratum. The less common species were not represented in many strata. Also, the smaller the opening was, the shorter the total length of border was; therefore there were fewer sample trees in the small plots.

For each stratum, we computed the number of sample trees and the mean and the variance of the number of epicormic branches on the exposed and unexposed faces for each half-log position.

The data showed that the variance was a function of the mean—the higher the mean, the higher the variance. Because the variance was not constant and some strata had no or few trees, we decided not to use analysis of variance techniques to test hypotheses about the strata means. Instead we examined the means for expected relationships. When the pattern of particular subsets of means were as expected, we took this as evidence of factor effects.

RESULTS

Effect of Opening Size

The effect of opening size on the occurrence of epicormic branching was measured, using means of epicormics for the exposed faces of border trees.

Because epicormic branching on the tree bole was previously known to increase with height above the ground, and because all trees did not have the same log height (they varied from 1½ to 3½ logs), it was necessary to make comparisons for similar sections of the tree bole. We therefore counted the branches in the top 16 feet of the bole. We justified this on two bases: (1) Because the upper bole branches more freely, it is a more sensitive indicator of factors that cause epicormic branching; and (2) the frequency of branching on the upper log seemed similar for trees of different total log height (table 1).

We first compared the epicormic branch means of similar tree groups in the smallest (50-foot) versus the largest (250-foot) openings (table 2). The comparisons we made were as follows: chestnut oak, site index 60, groups 1, 2 (table 2) had a mean of 2.16 epicormic branches for 12 trees bordering 50-foot openings and a mean of 4.16 sprouts for the 41 trees bordering the 250-foot opening. Of the 19 groups with sample trees in both sizes of openings, 17 had higher means for the 250-foot opening. The 10 groups of heavily sprouting species (red, white, and chestnut oak; black cherry; and basswood) all showed more sprouting in the 250-foot

Table 1. — *Average number of epicormic branches in the upper two 8-foot sections of chestnut oak trees of different log height (site index 60). Number of sample trees in parentheses.*

1½-log trees	2-log trees	2½-log trees
DOMINANT AND CODOMINANT		
(5)	(16)	(19)
0.6	1.6	1.3
3.0	2.8	2.6
INTERMEDIATE AND OVERTOPPED		
(7)	(13)	
1.2	0.7	—
2.0	1.9	—

Table 2. — *Average number of epicormic branches on the exposed face of the upper log for openings of different sizes*

Groups[a]	Diameter of the opening, in feet				
	50	100	150	200	250
Chestnut oak — 60 — 1,2	2.16 (12)[b]	— (0)	2.16 (57)	— (0)	4.16 (41)
Chestnut oak — 60 — 3,4	2.42 (14)	— (0)	3.43 (21)	— (0)	2.81 (21)
White oak — 60 — 1,2	— (0)	— (0)	2.33 (9)	— (0)	5.00 (15)
White oak — 60 — 3,4	5.67 (3)	— (0)	7.50 (2)	— (0)	6.78 (9)
Red oak — 60 — 1,2	3.78 (9)	— (0)	6.07 (16)	— (0)	5.42 (33)
Red oak — 60 — 3,4	3.40 (5)	— (0)	10.00 (7)	— (0)	6.11 (9)
Red oak — 75 — 1,2	5.50 (2)	2.80 (5)	2.00 (10)	6.23 (22)	6.05 (21)
Red oak — 75 — 3,4	4.00 (4)	1.00 (1)	4.80 (5)	6.00 (8)	7.71 (7)
Black cherry — 75 — 1,2	.00 (9)	.50 (10)	3.69 (13)	.83 (6)	2.39 (18)
Black cherry — 75 — 3,4	— (0)	1.00 (2)	2.00 (1)	.50 (2)	3.00 (3)
Basswood — 75 — 1,2	1.50 (6)	1.91 (11)	5.37 (24)	10.50 (2)	3.82 (35)
Basswood — 75 — 3,4	2.86 (7)	4.67 (12)	4.00 (16)	— (0)	6.18 (27)
Yellow-poplar — 75 — 1,2	1.45 (11)	1.00 (25)	1.22 (33)	1.57 (21)	1.21 (33)
Yellow-poplar — 75 — 3,4	1.00 (2)	1.67 (6)	2.78 (9)	1.67 (6)	1.44 (9)
Sweet birch — 75 — 1,2	— (0)	1.14 (7)	.00 (2)	.00 (2)	.33 (6)
Sweet birch — 75 — 3,4	.60 (5)	.67 (3)	.36 (14)	1.92 (12)	.94 (17)
Beech — 75 — 1,2	.80 (5)	.75 (4)	1.12 (17)	1.11 (9)	.82 (22)
Beech — 75 — 3,4	1.00 (1)	.33 (3)	3.90 (10)	1.00 (2)	2.87 (15)
Sugar maple — 75 — 1,2	.18 (11)	.28 (18)	.19 (21)	.50 (2)	.32 (31)
Sugar maple — 75 — 3,4	4.50 (2)	1.56 (9)	2.42 (12)	1.80 (5)	2.46 (30)
Red maple — 60 — 1,2	.33 (3)	— (0)	.33 (3)	— (0)	1.80 (10)
Red maple — 60 — 3,4	2.08 (12)	— (0)	3.66 (24)	— (0)	3.31 (32)

[a] Species — site index — crown class (1 and 2 are dominant and codominant, and 3 and 4 are intermediate and overtopped).
[b] Number of sample trees in parentheses.

openings than in the 50-foot openings. This is strong evidence that epicormic branching is affected by opening size.

We then established, for openings of all size classes, the proportion of instances where the larger opening produced more branches (table 3). We used only the heavily sprouting species groups from table 2. One expects the proportion to be close to 1.0 if the effect of opening size is large. If there is no effect of opening size, the proportion should average 0.5. The proportions in table 3 indicate that there is little or no difference among 150-, 200-, and 250-foot openings. The effects of 50- and 100-foot openings are likewise somewhat alike. The largest increase in epicormic branches is apparently between 100- and 150-foot openings.

Table 3. — *Proportion of instances where larger openings produced a greater mean number of epicormic branches. Comparison based on means (table 1) of heavy branching species*

Smaller opening size, in feet	Larger opening size, in feet			
	100	150	200	250
50	0.60[a]	0.80	1.00	1.00
100	—	.67	.80	1.00
150	—	—	.60	.50
200	—	—	—	.50

[a] In the 5 comparisons involved, means were greater for the 100-foot opening in 3 of the cases, thus ⅗ = 0.60.

Effect of Species

It has long been recognized that tree species differ in their potential to produce epicormic branches. In a previous study of border-tree sprouting, Smith *(1966)* rated nine species of Appalachian hardwoods for this characterstic. Our study supports Smith's ratings and expands the list to 12 species.

To measure species differences, we compared the average number of epicormic branches on the exposed face of the upper log (table 2). We used the available means from trees bordering the 150-, 200-, and 250-foot plots. As a result of this evaluation, we came up with a ranking in which the species were rated in descending order of potential for branching.

Shown below by broad species groups is our list, together with Smith's list and a subjective combination of the two. Susceptibility to branching differs less within each group than it does between groups:

Number of branches	*Our study*	*Smith's list*	*Combination*
Very many	Red oak White oak	White oak	White oak Red oak
Many	Basswood Black cherry Chestnut oak	Black cherry Red oak Chestnut oak	Basswood Black cherry Chestnut oak
Few	Beech Yellow-poplar Red maple Sugar maple Sweet birch	Hickory Yellow-poplar Red maple Sugar maple	Beech Hickory Yellow-poplar Red maple Sugar maple Sweet birch
Very few	—	White ash	White ash

Effect of Tree Dominance

Previous studies on the Fernow Experimental Forest have shown that after release, more epicormic branching occurred on intermediate and overtopped trees than on dominant and codominant trees *(Wahlenberg 1950, Smith 1965)*.

We compared dominant and codominant trees to intermediate and overtopped trees (table 2). We compared trees bordering 150-, 200- and 250-foot openings. In 22 of 28 comparisons, the intermediate and overtopped trees had more epicormic branches on the exposed face of the upper log than the dominant and codominant trees.

For example, yellow-poplar and sugar maple on sites with an index of 75 had higher epicormic branch means in the sub-dominant group (3 and 4) than in the dominant group (1 and 2), for the 150-, 200-, and 250-foot openings.

Effect of Site Quality

Smith *(1966)* found more epicormic branching on chestnut oak, red oak, and white oak growing on site-index 60 areas than on site-index 75 areas. In our study, red oak was the only species common to the two sites. Only four comparisons were possible among the means in the 150-foot and larger openings (table 2). The data on the effect of site on bole sprouting were contradictory. In two of the comparisons (shown below), bole sprouting was greater on the higher site; but for the other two, it was greater on the lower site. The number of epicormic branches on the exposed faces of upper logs by opening size was:

Group	*150-foot openings*	*250-foot openings*
Red oak — *60* — 1,2	6.07	5.42
Red oak — *75* — 1,2	2.00	6.05
Red oak — *60* — 3,4	10.00	6.11
Red oak — *75* — 3,4	4.80	7.71

Effect of Exposure of Tree Bole

Several studies have shown that on trees bordering openings, more epicormic branches appear on the side of the bole facing the opening than on the side facing into the uncut stand *(Smith 1965, Trimble and Smith 1970)*. Results of our study support these findings.

We compared the epicormic branch means of the entire length of the bole on the exposed and unexposed faces for trees bordering the 200- and 250-foot openings. The sample trees were grouped by species, site quality, crown class, and number of logs in the tree. There were 54 of these groups, and 45 of them had more epicormic branches on the exposed face than on the unexposed face.

Effect of Position on Tree Bole

Our study results showed that epicormic branching increased with height above ground. This confirmed the results of past

work *(Jemison and Schumacher 1948, Wahlenberg 1950, Smith 1965 and 1966)*.

The exposed faces of the lower half-logs were compared to the exposed faces of the upper half-logs on border trees around the 150-, 200-, and 250-foot plots. We compared only the half-logs rather than the lower and upper full logs in order to use the data on 1½ log trees. Fifty-five out of 57 groups (table 4) averaged more epicormic branches on the upper half-log than on the lower half-log.

DISCUSSION

The concern with epicormic branching on border trees centers on the extent to which it causes a monetary loss by degrading lumber. Unfortunately, the situation cannot be summed up simply. We can say that bole sprouting appears to be more damaging than it actually is because: (1) the heaviest sprouting is on the upper stem, but the greatest volume and value of the tree are usually in the lower log; (2) the intermediate and overtopped trees sprout the most, but the most valuable trees and those most favored for final crop trees in even-aged systems are the dominants and codominants; and (3) many small epicormic branches are short-lived and therefore unlikely to have much degrading effect.

In spite of this, where we cut openings larger than 100 feet in diameter—and unless we cut them larger than this, reproduction of intolerant species is unlikely to develop satisfactorily—we will get low-quality logs in the more susceptible bole sprouters. For example, the means of epicormic branches on the butt 16-foot log for red oak (exposed and unexposed faces combined) for the three larger openings was 6.0 for dominant and codominant trees and 8.0 for intermediate and overtopped trees. These were not the short-lived type of epicormics, but had persisted for years; and many appeared to be vigorous and permanent. Therefore, in stands composed heavily of oaks, basswood, and black cherry, it is important to maintain a low border-to-cut-acreage ratio: that is, to make clearcuts as large as possible consistent with other considerations, to reduce degrade from bole sprouting.

Table 4. — *Comparison of epicormic branches by position on tree bole. Average number of epicormic branches on the open face*

Groups[a]	150-foot opening		200-foot opening		250-foot opening	
	Lower half log	Upper half log	Lower half log	Upper half log	Lower half log	Upper half log
Chestnut oak — 60 — 1,2	0.05 (57)[b]	2.16 (57)	—	—	0.05 (41)	4.16 (41)
Chestnut oak — 60 — 3,4	.05 (21)	3.43 (21)	—	—	.19 (21)	2.81 (21)
White oak — 60 — 1,2	.00 (9)	2.33 (9)	—	—	.73 (15)	5.00 (15)
White oak — 60 — 3,4	4.50 (2)	7.50 (2)	—	—	.89 (9)	6.78 (9)
Red oak — 60 — 1,2	1.88 (16)	6.07 (16)	—	—	1.64 (33)	5.42 (33)
Red oak — 60 — 3,4	3.29 (7)	10.00 (7)	—	—	1.33 (9)	6.11 (9)
Red oak — 75 — 1,2	.00 (10)	2.00 (10)	1.36 (22)	6.23 (22)	.62 (21)	6.05 (21)
Red oak — 75 — 3,4	2.00 (5)	4.80 (5)	2.88 (8)	6.00 (8)	1.57 (7)	7.71 (7)
Black cherry — 75 — 1,2	.54 (13)	3.69 (13)	.17 (6)	.83 (6)	1.17 (18)	2.39 (18)
Black cherry — 75 — 3,4	1.00 (1)	2.00 (1)	.00 (2)	.50 (2)	1.00 (3)	3.00 (3)
Basswood — 75 — 1,2	.67 (24)	5.37 (24)	3.00 (2)	10.50 (2)	.91 (35)	3.82 (35)
Basswood — 75 — 3,4	.88 (16)	4.00 (16)	—	—	1.56 (27)	6.18 (27)
Yellow-poplar — 75 — 1,2	.12 (33)	1.22 (33)	.14 (21)	1.57 (21)	.18 (33)	1.21 (33)
Yellow-poplar — 75 — 3,4	.22 (9)	2.78 (9)	.17 (6)	1.67 (6)	.11 (9)	1.44 (9)
Sweet birch — 75 — 1,2	.00 (2)	.00 (2)	.00 (3)	.00 (3)	.00 (6)	.33 (6)
Sweet birch — 75 — 3,4	.07 (14)	.36 (14)	.33 (12)	1.92 (12)	.00 (17)	.94 (17)
Beech — 75 — 1,2	.06 (17)	1.12 (17)	.00 (9)	1.11 (9)	.00 (22)	.82 (22)
Beech — 75 — 3,4	.40 (10)	3.90 (10)	.00 (2)	1.00 (2)	.47 (15)	2.87 (15)
Sugar maple — 75 — 1,2	.00 (21)	.19 (21)	.00 (2)	.50 (2)	.00 (31)	.32 (31)
Sugar maple — 75 — 3,4	.25 (12)	2.42 (12)	.40 (5)	1.80 (5)	1.13 (30)	2.46 (30)
Red maple — 60 — 1,2	.00 (3)	.33 (3)	—	—	.10 (10)	1.80 (10)
Red maple — 60 — 3,4	.71 (24)	3.66 (24)	—	—	.81 (32)	3.31 (32)

[a] Species — site index — crown class (1 and 2 are dominants and codominants; 3 and 4 are intermediate and overtopped).
[b] Number of sample trees in parentheses.

For the other species, sprouting on the lower stem of border trees is lighter. For instance, yellow-poplar averages only 0.4 branch on the butt log for dominant and codominant trees and 0.6 branch for intermediate and overtopped trees. In stands of yellow-poplar and other lightly sprouting species, the threat of epicormic branching would be appreciably less of a consideration in deciding on size of area to clearcut.

SUMMARY

From a study of epicormic branching on 10 hardwood tree species bordering forest openings of different sizes, we determined that:

- Five years after cutting, epicormic branching was about the same for 50-foot and 100-foot openings, but was appreciably less than for openings 150 feet in diameter and larger. Branching seemed about as heavy on trees bordering the 150-foot plots as on trees bordering larger plots.
- There were large differences between species in the amount of epicormic branching.
- More epicormic branching occurred on intermediate and overtopped trees than on dominant and codominant trees.
- We had too few data to demonstrate site effect, with only red oak common to our two sites (60 and 75 site index).
- More epicormic branches appeared on the exposed faces of the border trees than on the section facing into the uncut stand.
- Epicormic branching increased with height above ground.

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