United States
Department of
Agriculture

Forest Service

**Northeastern Forest
Experiment Station**

Research
Paper NE-528

1983

Growth of Appalachian Hardwoods Kept Free to Grow from 2 to 12 Years after Clearcutting

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Manuscript received for publication 10 January 1983

Abstract

Free-to-grow sapling-size, yellow-poplars of seedling origin outgrew similar black cherry and red oak in both dbh and total height (especially on good sites). Yellow-poplar consistently grew faster in dbh throughout the study, particularly on the better oak sites. Black cherry had an edge over yellow-poplar in total height during the early years of the study, but yellow-poplar began to outgrow black cherry about 5 and 10 years after clearcutting on the good and fair sites, respectively. Sugar maple did not respond to the annual release treatment. With the annual release techniques used in this study, free-to-grow yellow-poplar grew faster than black cherry in height and dbh, with red oak a distant third during the first 10 to 12 years after clearcutting; however, red oak is more competitive with these intolerants on fairer sites.

Introduction

Silviculturists interested in growing high-quality hardwoods want to increase the number of better quality crop trees in the upper crown canopy. There are at least three approaches to keeping quality trees in the upper crown canopy of young even-aged stands:

1. Thin precommercial stands lightly and often, beginning as soon as the crown closes.
2. Thin precommercial stands once, perhaps 10 to 15 years before the first planned commercial thinning.
3. Do not thin young stands until the first commercial thinning.

The research reported in this paper used option 1, thin lightly and often, to maintain trees in a free-to-grow crown class position where the crowns receive light from all sides. Previous information on growth response of Appalachian hardwoods by crown class positions has been reported by Trimble (1968; 1969; 1975). That information was primarily for commercial-size, second-growth hardwoods. The purpose of this study was to determine the early sapling growth response of young trees maintained in a free-to-grow crown class position.

Study Area and Methods

The study was done on the Fernow Experimental Forest near Parsons, West Virginia. This area has approximately 130 to 145 frost-free days and an average of about 60 inches of precipitation annually. Two study areas were used, one with a northern red oak site index of 75 and the other with a site index of 62. Soils on the better site were DeKalb silt loam, derived largely from sandstone with possibly some limestone influence from adjacent areas. The "fair" site soils were Calvin silt loam derived from acid shale sandstone. Both loams ranged from 2 to 4 feet deep.

Both study areas were clearcut: all trees 1.0 inches dbh and larger were cut. Two years after clear-cutting, stems of four species were selected and released annually thereafter to keep them free to grow. Light reached all sides of the tree crown, although the actual crown class of the study trees in the stand was mainly codominant throughout the study. Annual release was discontinued 12 years after clearcutting on the good site and 11 years after clearcutting on the fair site.

Initially red oak, *Quercus rubra* L.; yellow-poplar, *Liriodendron tulipifera* L.; and black cherry, *Prunus serotina*, Ehrh.; stems of seedling-origin were selected on each site, while sugar maple, *Acer saccharum* Marsh. trees were studied on the good site only. Fifteen study trees of each species were selected and released on each site. Individual study trees were a minimum of 25 feet apart. Annual measurements of total height, length of clear bole, and when possible, dbh at 4.5 feet above the ground were recorded for each individual tree.

Results

Survival

Good site. After 12 years, 14 of the yellow-poplar saplings and all 15 black cherry saplings were living. Seven of 15 red oak saplings were living, as were six of the selected sugar maple study trees.

Fair site. Eleven years after clearcutting, all annually released yellow-poplar trees and 14 of 15 black cherry and red oak trees were alive.

Dbh response

Good site. As indicated in Table 1, the earliest dbh measurements were recorded at the 5-year measurement period when the trees were more than 4.5 feet tall. Among the four measured study species on this site, yellow-poplar consistently had the largest dbh and the fastest dbh growth during the study period. Yellow-poplar averaged 3.0 inches in dbh 12 years after clearcutting while black cherry, red oak, and sugar maple averaged 1.9, 1.1, and 0.2 inches dbh, respectively (Table 1). Most of the living sugar maple study trees were not tall enough to have a dbh measurement. The annual dbh growth during the 12th growing season was 0.54 inch for yellow-poplar, 0.24 for black cherry, and 0.08 for red oak (Fig. 1).

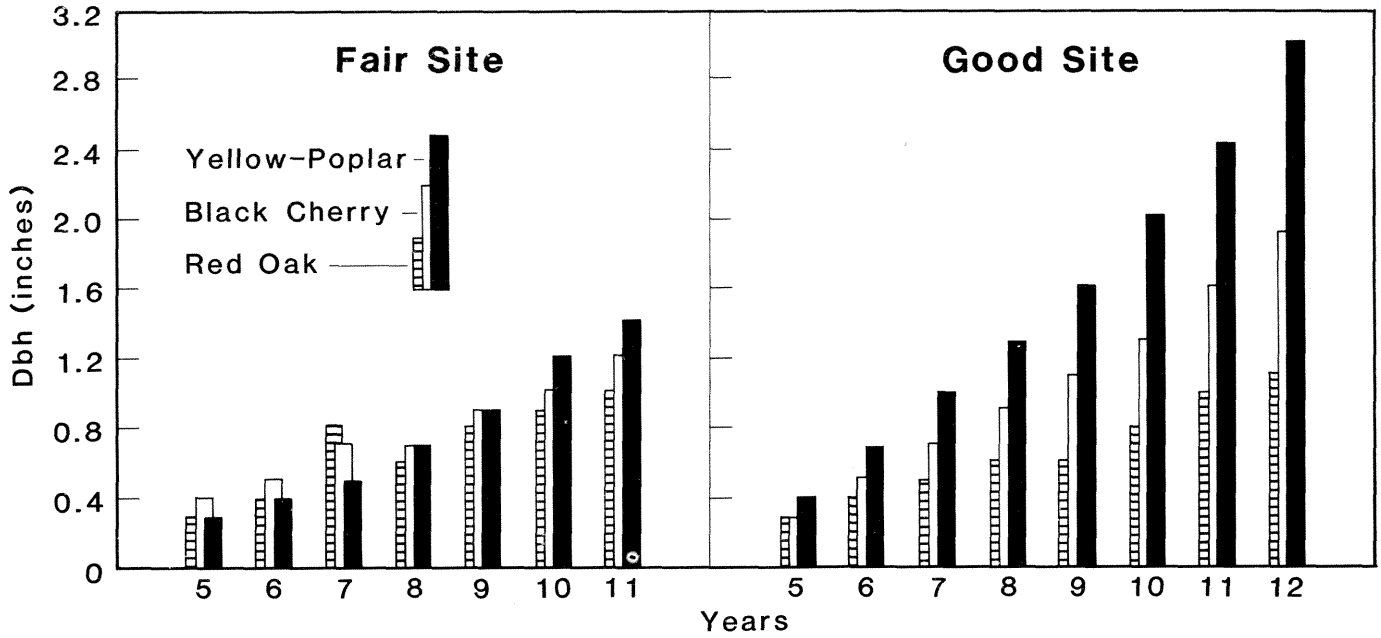
Fair site. Though annually released yellow-poplar maintained a higher dbh growth than the other species, the average difference in dbh among the three species after 11 years was much closer on the fair than the good sites—yellow-poplar 1.4 inches, black cherry 1.2, and red oak 1.0 inches dbh (Table 1). The annual dbh growth for the 11th growing season was about 0.20 inch for both the yellow-poplar and black cherry. Red oak averaged 0.1 inch in annual diameter growth.

During the early years after clearcutting, black cherry was the largest of the three species (in dbh), but during the 9th year, yellow-poplar surpassed the cherry in dbh, and remained larger throughout the rest of the study period (Table 1).

Table 1.—Average annual dbh, total heights, and clear bole lengths for hardwood species released annually to a free-to-grow crown class position on two oak sites

Years since clearcutting	Good site (SI 75)				Fair site (SI 62)		
	Yellow-poplar	Black cherry	Red oak	Sugar maple	Yellow-poplar	Black cherry	Red oak
	Dbh (inches)						
5	0.4	0.3	0.3	—	0.3	0.4	0.3
6	0.7	0.5	0.4	—	0.4	0.5	0.4
7	1.0	0.7	0.5	—	0.5	0.7	0.8
8	1.3	0.9	0.6	0.1	0.7	0.7	0.6
9	1.6	1.1	0.6	0.2	0.9	0.9	0.8
10	2.0	1.3	0.8	0.2	1.2	1.0	0.9
11	2.4	1.6	1.0	0.2	1.4	1.2	1.0
12	3.0	1.9	1.1	0.2			
	Total Height (feet)						
2	1.5	1.8	1.3	0.8	1.2	3.0	1.6
3	3.1	3.8	2.3	1.4	2.4	4.3	2.8
4	4.9	5.6	3.6	2.3	3.4	5.3	3.6
5	6.4	6.8	4.8	2.6	5.1	6.6	5.1
6	9.1	8.8	6.6	3.4	5.9	8.2	6.8
7	11.6	11.1	8.2	3.7	7.1	10.0	7.8
8	14.7	13.6	9.5	4.4	8.8	11.4	9.3
9	17.4	15.3	10.4	4.9	11.5	12.9	10.8
10	21.4	17.7	12.1	5.3	13.7	14.6	12.2
11	23.7	19.8	14.0	5.7	16.5	15.4	13.7
12	28.4	21.5	15.6	5.8			
	Length of Clear Bole (feet)						
5	3.2	2.7	2.3	1.1	2.3	2.6	2.4
6	3.9	4.1	3.0	1.5	3.3	3.4	3.2
7	4.6	4.5	3.6	1.6	3.2	3.8	3.4
8	6.2	6.0	5.3	1.6	4.0	4.4	3.8
9	7.3	6.7	5.4	1.9	4.1	5.3	4.9
10	8.3	8.1	6.2	2.1	5.2	6.1	5.9
11	9.9	8.0	5.4	1.8	5.7	6.6	6.2
12	9.8	8.2	5.5	2.0			

Figure 1.—Periodic dbh response of free-to-grow yellow-poplar, black cherry, and red oak stems on two oak sites.

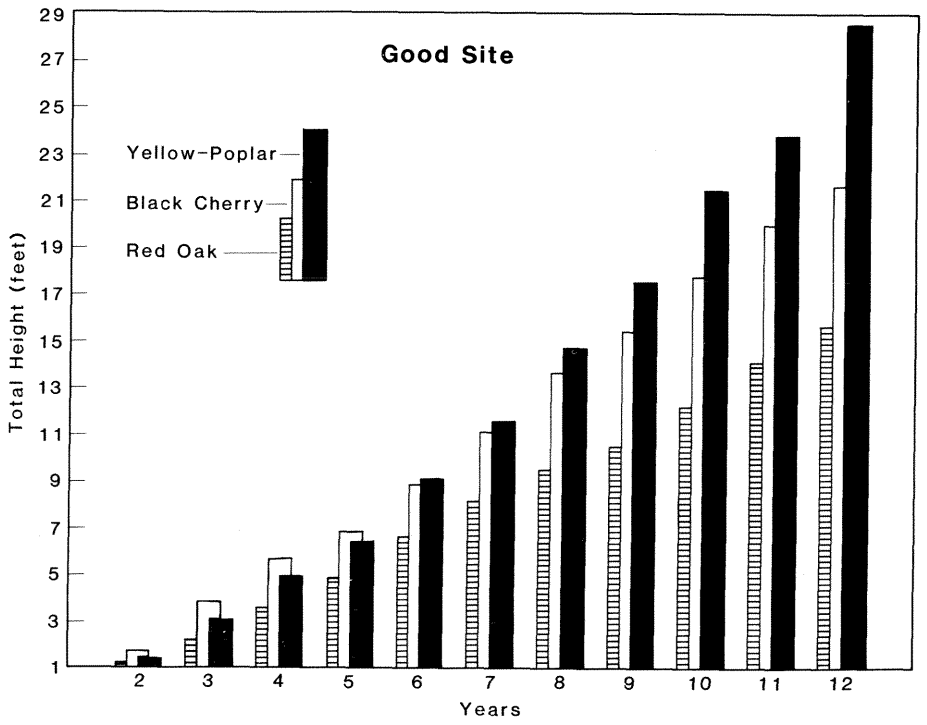


Total Height

Good site. Yellow-poplar was also the tallest of the four study species, averaging 28.4 feet 12 years after clearcutting, when black cherry averaged about 21.5 feet, red oak 15.5 feet, and sugar maple about 6.0 feet (Table 1). The annual height growth at the 12th year after clearcutting averaged about 4.7 feet for yellow-poplar, 1.7 feet for black cherry, and 1.5 feet for red oak (Table 1). Annual height growth for maple saplings was less than 0.5 feet. This was attributed to seedling mortality and shoot dieback (Fig. 2).

Fair site. As on the good site, yellow-poplar saplings were taller than the black cherry and red oak 11 years after clearcutting—averaging 16.5 feet compared to 15.4 feet for black cherry and 13.7 feet for red oak (Table 1). Annual height growth for yellow-poplar was 2.8 feet for the 11th growing season. This was about 0.5 feet more than similar growth on the good site. Growth for the 11th

Figure 2.—Periodic total height response of free-to-grow yellow-poplar, black cherry, and red oak stems on a site with oak site index 75.



year after clearcutting was 1.5 feet for red oak while black cherry averaged 0.8 feet. Also, during this 11th year, the yellow-poplar passed the black cherry in average total height on this site (Fig. 3).

On the good site, the average initial heights of the black cherry, yellow-poplar, and red oak seedlings differed by only 0.5 foot (1.5, 1.8, and 1.3, respectively). On the fair site, the difference in average height between species was 1.8 feet, with yellow-poplar having an average initial height of 1.2, red oak 1.6, and black cherry 3.0 feet.

Clear Bole Length

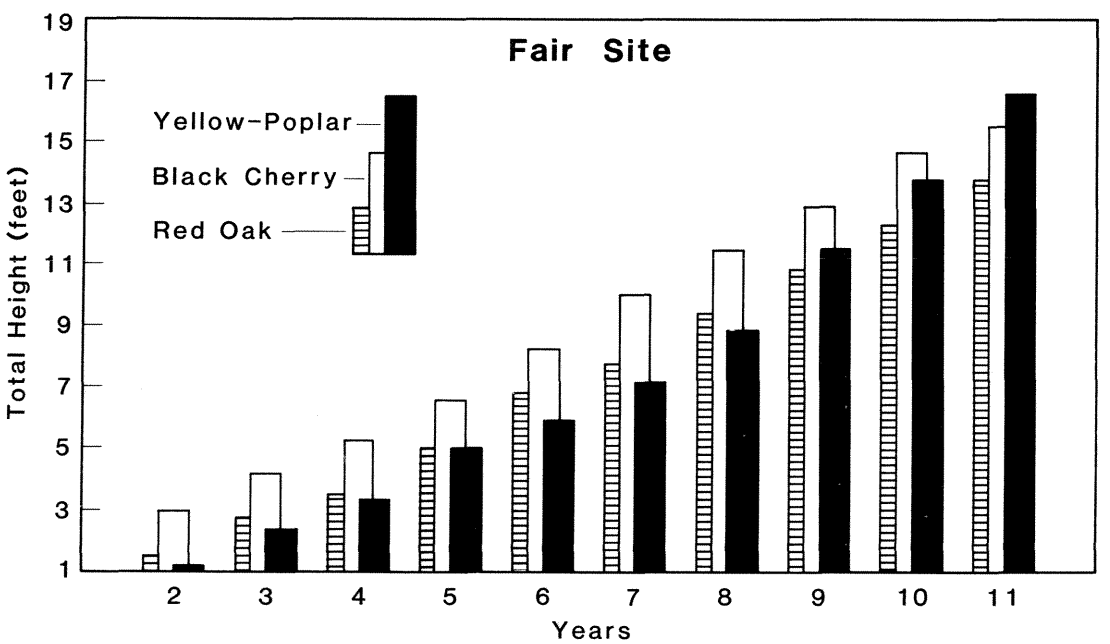
Good site. The initial length of clear bole was recorded 5 years after clearcutting. At that time, yellow-poplar and black cherry had a clear bole length of about 3.0 feet (to the first branch 1.0 inch in length or larger) while red oak averaged about 2.0 feet and sugar maple 1.0 foot. Twelve years after clearcutting, the clear bole length for yellow-poplar and black cherry was about 9.5 and 8.0 feet, respectively, while red oak was about 5.5 feet and sugar maple about 2.0 feet (Table 1). Thus, the yellow-poplar and black cherry were beginning to develop a clear bole, even though the study trees were continually released to a free-to-grow crown class. About 40 percent of the tree was in clear bole for yellow-poplar, black cherry, and red oak. For sugar maple it was 32 percent.

Fair site. The three species had a clear bole length of about 2.5 feet at the 5-year measurement period. After 11 years, the black cherry averaged 6.6 feet, red oak 6.2 feet, and yellow-poplar 5.7 feet of clear bole length (Table 1). Clear bole for red oak and black cherry averaged 45 and 43 percent of the total tree height, while for yellow-poplar, it averaged 35 percent. Yellow-poplar did not produce as high a percentage of clear bole length on the fair site as on the good site, but red oak increased its percentage of clear bole slightly on the fair site.

Discussion and Conclusions

This study suggests that free-to-grow yellow-poplars of seedling origin on a good site will be taller and larger in dbh than black cherry after 12 years of annual release. At this age, both species were taller and larger in dbh than red oak and sugar maple; the latter was shortest and had the smallest dbh of all species evaluated. From the time the trees were large enough to be measured at breast height, yellow-poplar had the largest diameter, followed by black cherry, and red oak (Fig. 1). Height growth showed a somewhat different pattern: For the

Figure 3.—Periodic total height response of free-to-grow yellow-poplar, black cherry, and red oak stems on a site with oak site index 62.



first 4 years, black cherry grew faster than the other species, but at 6 years the yellow-poplar trees were taller (Fig. 2). Height growth of red oak and sugar maple was less, with sugar maple growing the slowest.

The growth in dbh of the three species (yellow-poplar, black cherry, and red oak) studied on the fair site was about the same through the first 9 years. Yellow-poplar trees grew faster in diameter than black cherry, which outgrew the red oak. In height growth, the superiority of black cherry over yellow-poplar persisted through about the 8th year after clearcutting, with the yellow-poplar attaining a greater height by the 11th year (Fig. 3).

The data indicate that free-to-grow red oak seedlings are more competitive with the intolerant species on fair sites. This result was expected. The lack of response to release and the low survival rate of sugar maple seedlings on the good site indicates that small free-to-grow sugar maple stems on the ground when the stand is clearcut will not be competitive with other free-to-grow species (yellow-poplar, black cherry, red oak). A higher percentage of free-to-grow yellow-poplar and black cherry than of red oak will survive on the good sites. The survival rate of the free-to-grow red oak seedlings on the good site was disappointing.

For comparison with the annually released free-to-grow sapling stems, 9- and 12-year-old unreleased yellow-poplar and black cherry crop trees of seedling origin on a good red oak site were used (Trimble 1973). These data were the best available, but the unreleased trees were crop trees on a different site, selected from a population of faster growing trees.

For yellow-poplar, the growth response of the annually released trees was considerably higher than that of the unreleased dominant and codominant trees (Table 2). It appears that during the later years of the annual release study, the yellow-poplar trees were beginning to respond more rapidly to the release treatment. Annually released black cherry trees outgrew unreleased codominant black cherry trees but not the unreleased dominant black cherry.

Numerous local studies show that as hardwood stands develop into middle age, there will be some changes in the relative dbh growth rate of the different species (Trimble 1969; 1975). Red oak will become the fastest growing tree species, followed by yellow-poplar and black cherry. Little information is available on the relative height growth patterns of older trees of these species.

Free-to-grow yellow-poplars grew more in dbh and height on the good site than on the fair site. In general, the height growth of black cherry was better on the good site, but its dbh growth was only slightly better at best on the good site. Free-to-grow yellow-poplars were more sensitive to site differences at this early age than black cherry. However, height and dbh growth rates of red oak were about the same for the good and fair sites during the study period, suggesting that free-to-grow red oaks were too young to express site differences at this early age. Wendel (1975) reported that site quality did not affect the growth of 10-year-old red oak sprouts in West Virginia. Sprouts on a fair oak site grew in height at about the same rate as those on an excellent site. In another West Virginia study, height data for the tallest seedling and sprouts in 10-year-old clearcuts of different diameters indicated that at this early age, trees on the fair site were taller, on the average, than those on the better sites (Smith 1977).

The information in this paper can be used to evaluate early growth response of free-to-grow trees. Managers need information on other species and for longer times to understand the growth and development patterns of individual species.

Table 2.—Growth in dbh and total height of annually released, unreleased dominant, and unreleased codominant trees 9 and 12 years after clearcutting[1]

Species	9-Year		12-Year	
	Dbh	Total height	Dbh	Total height
	in	*ft*	*in*	*ft*
Yellow-poplar				
Released annually	1.6	17.4	3.0	28.4
Unreleased dominant	1.5	15.3	2.5	24.0
Unreleased codominant	1.1	13.6	1.8	20.5
Black cherry				
Released annually	1.1	15.3	1.8	21.5
Unreleased dominant	1.8	18.1	2.7	25.6
Unreleased codominant	1.1	14.3	1.4	19.2

[1]Data on unreleased trees from Trimble (1975); annual release data from Table 1.

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☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—605-024/06

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Free-to-grow sapling-size yellow-poplars of seedling origin in young stands outgrew similar black cherry and red oak in both dbh and total height. Sugar maple did not respond to the free-to-grow treatment.

ODC 231.31:181.65:176.1

Keywords: Free-to-grow, Appalachian hardwoods, immature stands

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