United States
Department of
Agriculture

Forest Service

**Northeastern Forest
Experiment Station**

Research Paper NE-622

Crop-Tree Release Increases Growth of 12-Year-Old Yellow-Poplar and Black Cherry

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Abstract

Precommercial thinning was done in a 12-year-old Appalachian hardwood sapling stand in West Virginia. Two crop-tree release techniques were used—crown touching and crown touching plus 5 feet. Results indicated that both treatments significantly increased 5-year d.b.h. growth for released yellow-poplar and black cherry crop trees. Although there was a major increase in d.b.h. growth, caution is suggested when using the crown-touching plus 5 feet treatment as butt-log quality response was not conclusive. Releasing crop trees with the crown-touching approach seems appropriate in sapling stands when applied to desirable stems on better sites.

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Manuscript received for publication 6 March 1989

Northeastern Forest Experiment Station
370 Reed Road, Broomall, PA 19008
July 1989

Introduction

Crop-tree release is the recommended precommercial treatment for hardwood stands (Smith and Lamson 1986). This paper reports the 5-year growth of released yellow-poplar and black cherry crop trees in a 12-year-old Appalachian hardwood stand in West Virginia.

There are two general methods used to release individual crop-trees—a tree bole to tree bole release and a crown release. For this study, we used a crown release. This method involves the crown-touching concept, that is, cutting any tree in the intermediate, codominant, or dominant crown class whose crown intersects the drip edge of a crop-tree crown (except in the case of another crop tree). This is a practical way to ensure that a particular desirable tree is released.

Study Methods

The study was established in a 12-year-old Appalachian hardwood stand near Parsons, West Virginia. The stand was predominatly yellow-poplar *(Liriodendron tulipifera* L.) and black cherry *(Prunus serotina* Ehrh.), with a northern red oak (*Quercus rubra* L.) site index of 77 feet. Annual precipitation for the local area averages 55 inches and the growing season averages 145 frost-free days. The 12-year-old stand originated after a clearcut in which all trees 1.0 inches and larger in diameter at breast height (d.b.h.) were cut.

Six plots, each one-quarter acre in size, were established in fully stocked portions of the study stand during February 1983. All live trees at least 1.0 inches d.b.h. were permanently identified on the plots. Species, d.b.h., crown class, and tree condition (e.g., dead top, insect damage) were recorded for each tree. During March 1983, 80 yellow-poplar or black cherry crop trees per acre were selected on each plot (20 crop trees on each plot). A crop tree was defined as a condominant stem of a commercial species which had: 1) no main-stem fork in the lower 25 feet of the bole, 2) no evidence of insect or disease damage, and 3) a vigorous, healthy crown, and 4) potential for a butt log grade 1 or 2.

After the crop trees were selected, a crown-release treatment was assigned randomly to each plot—two plots per treatment. The treatments were control, crown-touching release (T), and crown-touching plus 5-foot release (T+5). The T treatment consisted of cutting all trees whose crowns either touched a crop-tree crown or intercepted the drip edge of a crop-tree crown. Depending on the number of selected crop trees, there usually were several noncrop trees left in a precommercial stand after release. The T+5 treatment consisted of cutting all trees whose crowns were within 5 feet of a crop-tree crown. With the T+5 method, there were few to no intermediate, codominant or dominant noncrop trees in the stand after release; only crop trees were present. We realize this latter treatment was a drastic release for young stems. Our purpose was to determine how much is too much. D.b.h. growth and reductions in stem quality should be near maximum for this treatment. After the plots were marked, all trees to be cut were recorded.

Additional crop trees were selected outside the plots to make a total of at least 30 individual crop trees in each treatment for both yellow-poplar and black cherry. The crop trees outside the plots received the same treatments as those on the plots.

In April 1983, the crop trees were released by felling competing trees with a chain saw (Fig. 1). After release, detailed measurements were taken for each crop tree. These included length of clear stem, height to base of live crown, total height, crown width, and crown growing space. Length of clear stem was measured as the height to the first live branch at least 1 foot long. Base of live crown was measured as the height to the first live branch that was not an epicormic branch. Crown width was measured along the four cardinal radii by estimating the point of the drip edge of the crop-tree crown and measuring the distance from the crop-tree bole with a tape. Crown growing space was measured similarly along the four cardinal radii as the distance between the drip edge of the crop tree and the closest adjacent tree. Length of clear stem, height to base of live crown, and total height were measured with a telescopic measuring pole.

The six plots were reinventoried five growing seasons after treatment. Crown class and d.b.h. were recorded for each permanently identified tree and ingrowth trees (1.0-inch d.b.h. threshold). Crop-tree measurements of length of clear stem, base of live crown, total height, crown width, and crown growing space were repeated. Data from the quarter-acre plots were used to compute per-acre growth. Data from all of the crop trees, both on and off the plots, were summarized to compute average individual crop-tree growth. Analysis of variance and Tukey's multiple range test were used to test differences between treatments at the 1 percent level.

Results

Before treatment, basal area averaged about 75 ft^2 per acre in 2,840 stems per acre (1.0+ inch d.b.h.). The T treatment reduced basal area from 75.6 to 43.1 ft^2 per acre, while the T+5 treatment reduced basal area from 66.4 to 19.7 ft^2 per acre (Table 1). Five-year net basal-area growth averaged 36.3, 42.4, and 36.1 ft^2 per acre for the control, T, and T+5 treatments, respectively.

Figure 1.—Releasing 12-year-old yellow-poplar and black cherry crop trees by the crown-touching technique: before release (top) and after release.

D.b.h. growth of individual crop trees was significantly increased by both release treatments (Table 2). For yellow-poplar, 5-year d.b.h. growth was 2.1, 2.8, and 3.6 inches for control, T, and T+5, respectively. The T treatment increased d.b.h. growth by 33 percent, while T+5 increased d.b.h. growth by 72 percent over control. For black cherry, 5-year d.b.h. growth was 1.3, 2.1, and 2.4 inches for control, T, and T+5, respectively. D.b.h. growth was increased 62 and 85 percent by the T and T+5 treatments, respectively.

Table 1.—Stand data before, immediately after, and 5 years after crop-tree release

	Control				Crown-touching release				Crown-touching +5 release			
Item	**1.0-2.9**	**3.0-4.9**	**5.0+**	**Total**	**1.0-2.9**	**3.0-4.9**	**5.0+**	**Total**	**1.0-2.9**	**3.0-4.9**	**5.0+**	**Total**
Before Treatment												
Trees/acre (no.)	2774	398	44	3216	2224	390	60	2674	2248	352	28	2628
BA/acre (ft^2)	44.5	29.1	8.6	82.2	36.4	28.8	10.4	75.6	35.1	26.4	5.0	66.5
Cut for Treatment												
Trees/acre (no.)	0	0	0	0	888	186	24	1098	1664	224	20	1908
BA/acre (ft^2)	0	0	0	0	14.5	13.8	4.1	32.4	26.8	16.2	3.7	46.7
Residual												
Trees/acre (no.)	2774	398	44	3216	1336	204	36	1576	584	128	8	720
BA/acre (ft^2)	44.5	29.1	8.6	82.2	21.9	15.0	6.2	43.1	8.3	10.1	1.3	19.7
5 Years Later												
Trees/acre (no.)	1560	702	170	2432	1168	478	134	1780	1304	186	112	1602
BA/acre (ft^2)	28.6	53.8	36.0	118.4	16.7	37.7	31.1	85.5	16.3	14.2	25.2	55.7
5-year Net Growth												
BA/acre (ft^2)				36.2				42.4				36.0

Table 2.—Crop tree growth by treatment

	Yellow-poplar			Black cherry		
Item	**Control**	**Crown-touching release**	**Crown-touching +5 release**	**Control**	**Crown-touching release**	**Crown-touching +5 release**
No. of Trees	31	30	32	29	34	34
Initial D.b.h. (inches)	3.9	3.6	3.8	3.9	3.8	3.6
D.b.h. 5 years later	6.0	6.4	7.4	5.2	5.9	6.0
5-year growth	2.1a	2.8b	3.6c	1.3a	2.1b	2.4c
Initial Clear Stem (ft)	17.0	16.9	17.3	17.0	16.2	15.4
Clear stem 5 years later	25.2	19.8	16.6	24.5	18.7	17.0
5-year change	8.2a	2.9b	−0.7c	7.5a	2.5b	1.6b
Initial Base Live Crown (ft)	19.6	19.2	18.8	20.6	19.9	17.7
Base live crown 5 years later	25.3	20.8	17.7	24.5	20.3	17.7
5-year change	5.7a	1.6b	−1.1c	3.9a	0.4b	0.0b
Initial Total Height (ft)	35.1	32.9	33.5	35.8	35.1	32.8
Total height 5 years later	49.3	46.7	44.2	46.8	44.0	40.8
5-year growth	14.2a	13.8a	10.7b	11.0a	8.9b	8.0b
Initial Crown Diameter (ft)	9.4	8.0	9.0	10.6	9.8	10.4
Crown diameter 5 years later	13.4	17.0	20.4	12.6	18.6	19.6
5-year change	4.0a	9.0b	11.4c	2.0a	8.8b	9.2b
Initial Growing Space (ft)	0.0	4.4	9.8	0.0	4.9	9.5
Growing space 5 years later	0.0	1.0	5.3	0.0	1.0	5.5
5-year change	0.0a	−3.4b	−4.5c	0.0a	−3.9b	−4.0c

NOTE: For each species, means in the same row followed by the same letter are not significantly different, $P > 0.01$; Analyses done using Tukey's multiple range test.

Crop-tree release significantly slowed the rate of increase of length of clear stem (Table 2). For the controls, length of clear stem increased by 8.2 and 7.5 feet in 5 years for yellow-poplar and black cherry, respectively. For the T treatment, length of clear stem increased by only 1.6 feet for yellow-poplar and 0.4 feet for black cherry; for the T+5 treatment, length of clear stem decreased by 0.7 foot in 5 years for yellow-poplar and by only 1.6 feet for black cherry. Five years after treatment, length of clear stem for both species averaged 24.8 feet for controls, 19.3 feet for T, and 16.8 feet for T+5.

Five-year height growth was decreased 2 to 3 feet by crop-tree release. For yellow-poplar, height growth averaged 14.2, 13.8, and 10.7 feet for control, T, and T+5, respectively. The T+5 release resulted in significantly less height growth than the other treatments. For black cherry, 5-year height growth was 11.0, 8.9, and 8.0 feet, for control, T, and T+5, respectively. However, in this instance, both the T and T+5 treatments produced significantly lower 5-year height growth in black cherry compared to control trees.

Crown diameter was significantly increased by crop-tree release. During the 5 years after treatment, crown diameter of yellow-poplar increased by 4.0, 9.0, and 11.4 feet for control, T, and T+5, respectively. During the same period, crown diameter of black cherry increased by 2.0, 8.8, and 9.2 feet, for control, T, and T+5 treatments, respectively (Table 2). The released crop trees of both species showed an increase in crown diameter of about 2 feet per year.

Crown growing space immediately after release of both species combined averaged about 4.6 and 9.6 feet for the T and T+5 treatments, respectively. Five years later, the T-released crop trees had an average of 1.0 foot of crown growing space, while the T+5 crop trees had an average of 5.4 feet of crown growing space. Crown growing space around all released trees decreased by about 4 feet in 5 years.

Discussion

Net stand basal-area growth was not decreased by either of the crop-tree release treatments. Even though basal area in the T+5 treatment was reduced from 66.4 to 19.7 ft^2 per acre, the 5-year net basal area growth was 36.1 ft^2 per acre, or only 0.2 foot less than the control. It appears that this heavy thinning was not severe enough to reduce the stand below its biological potential.

Stand growth was shifted onto fewer more desirable stems, which is a major objective of intermediate stand treatments. Stand basal-area growth was not reduced by thinning even though there were more than 3 times as many stems on the control plots as on the T+5 plots. For stems more than 3.0 inches d.b.h., the control plots averaged 442 stems per acre, while the T and the T+5 plots had 240 and 136 stems per acre, respectively.

Crop-tree release studies in 7- and 9-year-old stands in West Virginia, with height of codominant stems averaging less than 25 feet, showed that yellow-poplar and black cherry crop trees did not respond to a 5-foot radius bole release (Smith 1977). Wendel and Lamson (1987) showed that 8-year-old black cherry crop trees responded to a 5-foot bole release when the competition was killed by injecting herbicide. It is possible that rapid resprouting of cut stems negated the effects of a crop-tree release reported by Smith (1977). In this study, the crop trees were 12 years old and about 35 feet tall. The T treatment resulted in a 6.5-foot radius bole release, while the T+5 treatment resulted in a 11.1-foot-radius bole release. This study supports Smith and Lamson's (1986) recommendation that when using a crown-touching release, wait until the codominants are at least 25 feet tall before releasing crop trees. However, we are not aware that a T+5 treatment has been used to release codominant crop trees that are less than 25 feet tall.

Figure 2 shows the effect of crop-tree release on total height and crown development. During the 5-year period, the control trees grew about 13 feet taller and the height to base of live crown increased by about 5 feet. Although height growth was decreased by both release treatments, the released trees clearly have more crown area than the control trees. This increase in crown area translated into an increase in d.b.h. growth. It is likely that released crop trees will experience increased d.b.h. growth for 5 to 10 more years because of their crown area.

Epicormic branching was not serious even in the T+5 crop trees. The only crop trees that decreased in length of clear stem or height to base of live crown were T+5 yellow-poplar. Only 5 of 32 T+5 yellow-poplar produced epicormic branches below the base of the live crown and most of these will not persist.

Length of clear stem of the T crop trees was about 5 feet less than that of the controls; for T+5 crop trees, it was 7 to 8 feet less than that of control crop trees. Yellow-poplar T+5 crop trees had the shortest length of clear stem, 16.6 feet. There is little doubt that these crop trees will have a clear stem of at least 25 feet after the stand begins to close in another 5 to 10 years.

The growing space around released crop-tree crowns decreased at about the same rate (4 feet in 5 years) for both the T and T+5 treatments. At this rate, crown closure around crop trees should occur in another 1 or 2 years for T crop trees, and in another 4 to 5 years for T+5 crop trees. Assuming that the released trees will continue to have a slight increased d.b.h. growth rate for a few years after closure, it is possible that the d.b.h. of T crop trees will be about 1.5 inches larger than that of the controls. The d.b.h. of T+5 crop trees will be about 2 to 3 inches larger than that of the controls.

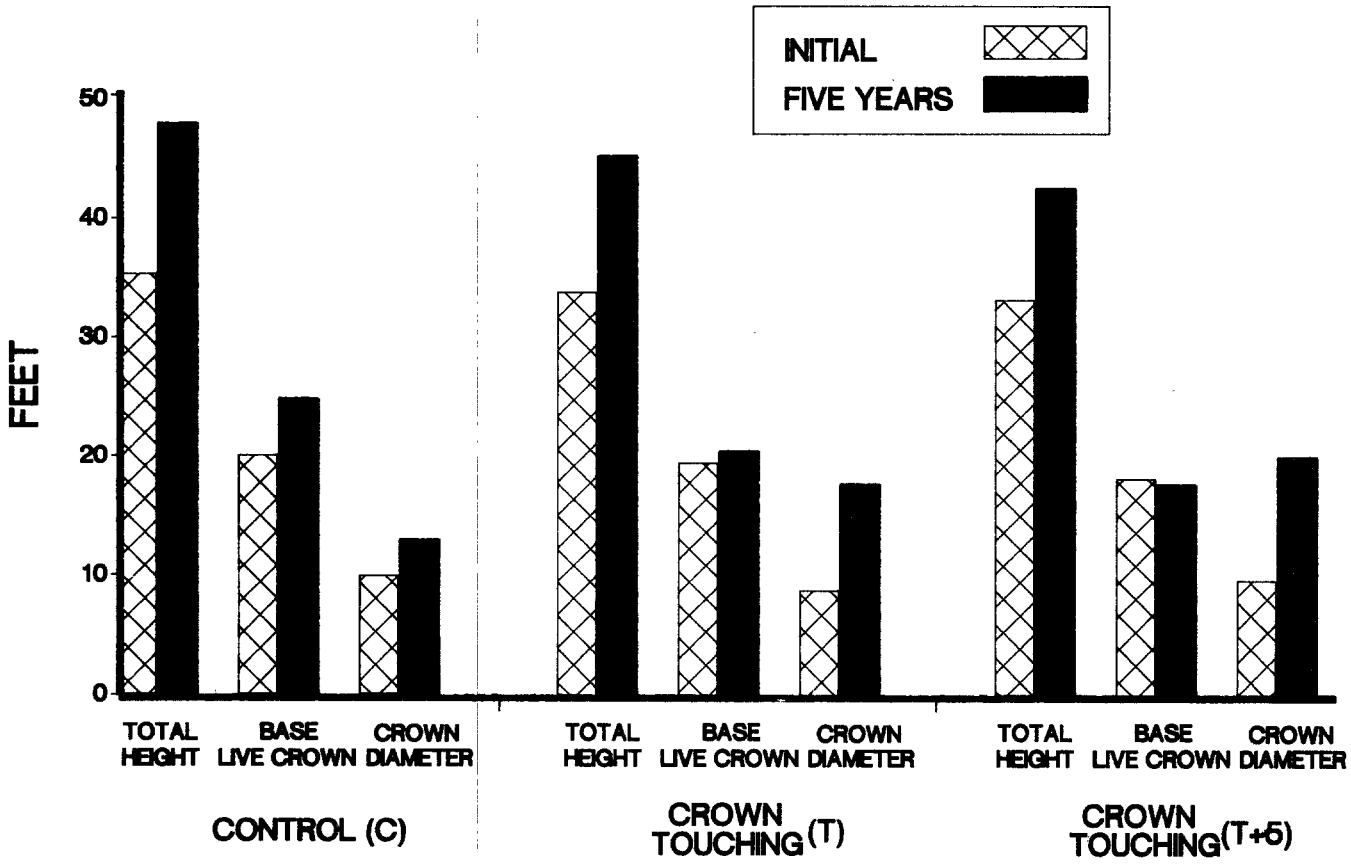

Figure 2.—Effect of a crop-tree release on total height, crown width, and height to base of live crown.

The cost of the T treatment was about $0.42 per tree, or $33.60 per acre (Miller 1984). Miller (1986) estimated that for an investment period of 70 years and a current real stumpage price of $100 per 1,000 board feet, it would take an increase in d.b.h. of 1.75 inches on 60 crop trees per acre to return 4 percent on an investment of $33.60. It appears that the T treatment will return nearly 4 percent on the investment, even if invested for 70 years. Of course, releasing fewer crop trees per acre would be a means of ensuring a high rate of return.

Comparable cost information published by Miller (1984) was not determined for the T+5 treatment. However, an average of 29 trees were cut to release each crop tree when using the T+5 treatment, while an average of 14 trees were cut for the T release treatment. Thus, a reasonable estimate of cost for the T+5 treatment would be nearly twice that of the T release.

In general, height growth of nonreleased crop trees is significantly greater than that of released crop trees, though, total height growth is not a concern at this stage of stand development. Quality merchantable height has been established and the remainder of the merchantable stem will be primarily of low quality due to log diameter. No additional precommercial thinning treatments are planned for the study areas. These stands will have at least two more commercial thinnings before the final harvest cut. These managed stands could be reduced from the present 80 crop trees per acre to about 30 crop trees per acre 15 to 20 years before the final harvest cut.

Summary

Both a T and a T+5 crop-tree release increased d.b.h. growth of 12-year-old yellow-poplar and black cherry during the first 5 years after treatment. D.b.h. growth increased by as much as 66 percent for the T release and 85 percent for the T+5 release. Height growth was slowed by both treatments, as was the rate of increase of length of clear stem. However, it is expected that even the most heavily released crop trees eventually will develop a length of clear stem of at least 25 feet.

The T crop-tree release may increase the d.b.h. of released trees by about 1.5 inches, while the T+5 crop tree release will likely increase d.b.h. by as much as 3 inches. Although there was a major increase in d.b.h. growth with the T+5 treatment, at this time we urge caution in recommending this treatment. It is too early to evaluate butt-log quality response as these results are not conclusive. After 5 years, understory growth has responded rapidly as several of the butt logs already are receiving protection and shade from the understory stems. Also, because of the intensity of the overstory removal, the new understory, largely of sprout origin, will rapidly develop into a fourth-growth stand. In hardwood trees, a significant portion of the tree volume-value is in the butt log. If management goals are to grow one quality 16-foot butt sawlog per tree in a short period, this technique may be practical.

Thus, a crown-touching crop-tree release (T) seems appropriate in 12-year-old Appalachian hardwood stands when applied to desirable species on better sites.

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Precommercial thinning was done in a 12-year-old Appalachian hardwood sapling stand in West Vriginia. Two crop-tree release techniques were used—crown touching and crown touching plus 5 feet. Results indicated that both treatments significantly increased 5-year d.b.h. growth for released yellow-poplar and black cherry crop trees. Although there was a major increase in d.b.h. growth, caution is suggested when using the crown-touching plus 5 feet treatment as butt-log quality response was not conclusive. Releasing crop trees with the crown-touching approach seems appropriate in sapling stands when applied to desirable stems on better sites.

ODC 242:236.1:176.1

Keywords: Appalachian hardwoods, saplings, crown touching, yellow-poplar, black cherry.

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