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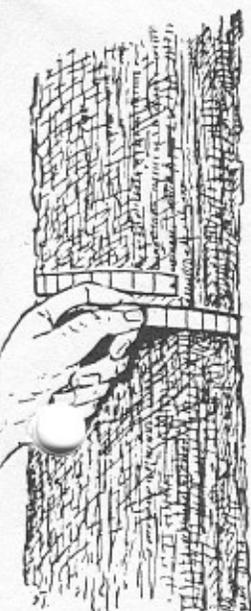
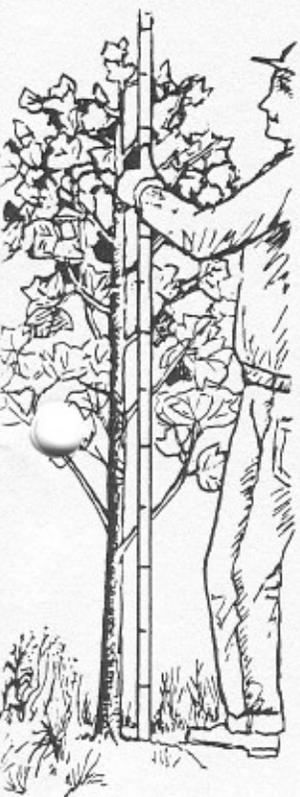
LOBLOLLY PINE RELEASE STUDY

REPORT NUMBER

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LOBLOLLY PINE RELEASE
Report Number 12
by
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ABSTRACT

This study included two treatments: no release, and aerial application of 2 pounds active ingredient of 2,4,5-T per acre during the 6th growing season. Hardwood competition was severe. At age 18, released plots averaged 41% more basal area and 39% more volume in standard cords than check plots, and cordwood yields were related to both a free-to-grow index estimated at age 6 ($r^2 = .852$) and hardwood basal area measured at age 18 ($r^2 = .868$).

INTRODUCTION

This is the twelfth in a series of Occasional Reports concerning release of loblolly pine seedlings from hardwood competition. This particular study was installed on the Lancaster County Poor Farm, in the northeastern corner of the Virginia Coastal Plain, on a nearly level, well-drained soil. The previous stand was a mixture of pine and hardwood. After harvest, the area was drum-chopped and burned, during the summer of 1968, and planted during the spring of 1969. The aerial release was done in June of 1974, during the 6th growing season. Approximately 2 pounds active ingredient of 2,4,5-T, in a total volume of 5 gallons per acre, was applied. Ideally, the release spraying should have been done 2 or 3 years earlier. Hardwood sprouts and brush were very dense, but many pines were already as tall as the hardwood and would have captured a place in the canopy eventually, even without spraying.

Hardwood kill from the aerial release was unusually good, but damage to pine was also unusually high. Many pines were more than 50 percent defoliated and the leaders were badly curled. They had made little recovery by the end of the summer following spraying.

PLOT INSTALLATION

Permanent growth plots were installed in February of 1975, when the plantation was six years old. Four one-tenth acre plots were installed in the check area and four in the released area (Figure 1). Volunteer Virginia pine were cut down when the plots were installed.

There was considerable drift from the spraying, so a 200-foot buffer was left between sprayed plots and check plots. Ordinarily, only a $\frac{1}{2}$ to 1-chain buffer would have been left between check and sprayed plots. Wider buffers allow for more change in site index, hardwood competition, and pine stocking between check and sprayed plots. There does not seem to have been a difference in site index, but there was a difference in initial pine stocking (see discussion on page 11).

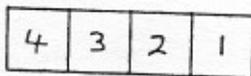
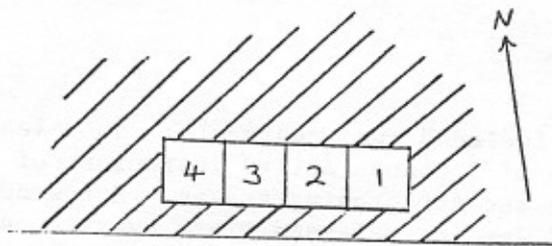


Figure 1. Layout of growth plots.
Aerial-released area is cross-hatched.

Measurements were made at age 6, when the plots were installed, and again at ages 10, 14, and 18. At age 6, each loblolly pine DBH was measured to the nearest inch and total height to the nearest foot, and classified as to free-to-grow status using a four part classification system.^{1/}

At later measurements, diameter at breast height of each pine was measured to the nearest inch. For a sample of trees in each diameter class, total height to the nearest foot was measured, noting which trees were dominant or codominant. For the final measurement, at age 18, all hardwoods over .5 inches DBH were tallied by species, 1-inch diameter class, and crown class. Total height to the nearest foot was measured on half of the intermediate and all of the codominant and dominant hardwoods.

1/ See Release Report Number 11 (Occasional Report Number 78) for a description and discussion of this classification system.

Table 1. Summary of loblolly data at ages 6, 10, 14, and 18: number of trees per acre, average DBH, basal area per acre, standard cords per acre, and average height of dominant and codominant trees.*

Age	Plot	No.	Check Plots				Released Plots					
			DBH	B.A.	Cds.	Ht.	Plot	No.	DBH	B.A.	Cds.	Ht.
6	1	520	2.30	16.6	-	14.4	1	630	2.04	17.1	-	13.2
	2	450	2.01	11.6	-	13.1	2	620	1.96	15.6	-	13.1
	3	360	1.89	9.6	-	12.4	3	550	1.78	11.8	-	12.1
	4	530	2.61	21.8	-	15.2	4	580	2.11	16.8	-	11.9
Means		465	2.20	14.9	-	13.8		595	1.97	15.3	-	12.6
<hr/>												
10	1	480	4.19	49.3	-	29.5	1	620	3.83	58.9	-	28.6
	2	400	3.83	36.3	-	29.8	2	630	3.67	53.0	-	26.4
	3	260	4.35	29.4	-	30.0	3	520	3.83	47.5	-	27.3
	4	520	4.44	60.4	-	31.7	4	520	4.24	56.5	-	26.6
Means		415	4.20	43.8	-	30.2		572	3.89	54.0	-	27.2
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14	1	440	5.43	76.8	10.4	40.5	1	560	5.38	97.4	13.2	38.7
	2	310	5.61	57.1	7.4	38.6	2	540	5.26	87.0	11.0	38.5
	3	250	5.76	49.9	7.3	40.2	3	490	5.31	84.6	10.7	37.9
	4	500	5.40	85.3	11.7	40.4	4	500	5.74	96.0	11.8	36.9
Means		375	5.55	67.3	9.2	39.9		522	5.42	91.2	11.7	38.0
<hr/>												
18	1	410	6.24	94.1	17.5	46.8	1	510	6.47	125.1	23.8	47.3
	2	300	6.20	67.1	12.0	45.9	2	510	6.00	106.2	18.6	45.4
	3	230	6.70	60.9	11.6	47.6	3	470	6.15	109.2	19.7	45.1
	4	480	6.04	102.4	18.2	47.6	4	490	6.41	118.2	19.9	43.7
Means		355	6.30	81.1	14.8	47.0		495	6.26	114.7	20.5	45.4

* Except at age 6, where heights presented are for all trees.

RESULTS AND DISCUSSION

A summary of loblolly pine data for the four measurements is presented in Table 1. At age 18, released plots averaged 5.7 standard cords per acre more than check plots.^{2/} Differences due to release increased with time (Table 2). Table 3 presents stand tables for loblolly pine at age 18.

Table 2. Average differences between check and released plots at each measurement, for basal area and standard cords per acre.

<u>Age</u>	<u>Released minus Check</u>	
	<u>Basal Area</u>	<u>Std. Cds.</u>
6	.4	-
10	10.2	-
14	23.9	2.5
18	33.6	5.7

A summary of average hardwood data at the final measurement at age 18 is presented in Tables 4 and 5, and individual plot data is presented in Table 6. There were almost as many hardwoods on the released plots as on the check plots, but they were smaller. Check plots averaged about 1.5 times as much basal area considering all hardwoods over .5 inches. However, considering only hardwoods in the canopy (intermediate crown class and above), check plots averaged about 6 times as much basal area as released plots.

2/ Standard cords at age 18 were subjected to an analysis of variance. Yields on released plots were significantly greater than on check plots (probability of a larger F = .035)

Table 3. Average number of loblolly pines per acre by diameter class at age 18.

<u>DBH</u>	<u>Check Plots</u>	<u>Released Plots</u>
2	5	10
3	18	22
4	38	68
5	52	60
6	85	90
7	72	128
8	48	70
9	32	33
10	5	12
11		
12		2
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Totals	355	495

Table 4. Average numbers of hardwoods per acre by species and diameter class at age 18.

<u>Species</u>	<u>Check Plots</u>							<u>Totals</u>
	<u>DBH</u>							
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	
Yellow poplar	145	15	18	10	8	10	8	214
Red maple	398	75	30	2				505
Black cherry	40	48	40	25	8			161
Red oak	52	60	33	18	2			165
White oak	25	30	8	2	12	2		79
Dogwood	1,082	215	25					1,322
Hornbeam	845	70	2					917
Sweetgum	25	2	10	5	5		2	49
Hickory	205	13						218
Holly	82							82
Beech	8							8
Sassafras	105	30	2					137
Blackgum	58	5	2					65
Miscellaneous	10	2						12
Totals	3,080	565	170	62	35	12	10	3,934

<u>Species</u>	<u>Released Plots</u>						<u>Totals</u>
	<u>DBH</u>						
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	
Yellow Poplar	68	20	10	10		2	110
Red maple	385	120	10				515
Black cherry	32	12	8				52
Red oak	120	63	18	8			209
White oak	85	2					87
Dogwood	1,248	255	12				1,515
Hornbeam	612	33	12				657
Sweetgum	5						5
Hickory	55						55
Holly	105	5					110
Beech	430	48	15				493
Sassafras	10						10
Miscellaneous	5	2					7
Totals	3,160	560	85	18		2	3,825

Table 5. Average numbers of hardwood per acre by diameter class and crown class, and basal area by crown class, at age 18.

Check Plots

<u>DBH</u>	<u>Over-topped</u>	<u>Intermediate</u>	<u>Codominant</u>	<u>Dominant</u>	<u>Totals</u>
1	3,080				3,080
2	565				565
3	130	40			170
4	7	48	7		62
5		15	20		35
6		2	8	2	12
7			2	8	10
<hr/>					
Totals	3,782	105	37	10	3,934
B.A.	36.1	8.6	5.5	2.5	52.7

Released Plots

<u>DBH</u>	<u>Over-topped</u>	<u>Intermediate</u>	<u>Codominant</u>	<u>Dominant</u>	<u>Totals</u>
1	3,160				3,160
2	558	2			560
3	68	17			85
4		18			18
5					
6			2		2
<hr/>					
Total	3,786	37	2		3,825
B.A.	32.8	2.4	.4		35.6

Table 6. Numbers of hardwoods by DBH class and crown class, and basal area by crown class, on each 1/10 acre plot.

DBH	Plot - Check #1				Totals	DBH	Plot - Check #2				Totals
	O	I	CD	D			O	I	CD	D	
1	291				291	1	360				360
2	50				50	2	63				63
3	8	5			13	3	17	9			26
4	2	4	1		7	4		5	2		7
5		3	3		6	5			3		3
6			1		1	6				1	1
Totals	351	12	5		368	Totals	440	14	5	1	460
BA	3.24	1.00	.69		4.94	BA	4.17	.88	.58	.20	5.83

DBH	Plot - Check #3				Totals	DBH	Plot - Check #4				Totals
	O	I	CD	D			O	I	CD	D	
1	268				268	1	313				313
2	50				50	2	63				63
3	16	1			17	3	11	1			12
4	1	5			6	4		5			5
5		2	2		4	5		1			1
6		1	2		3	6					
7			1	3	4	7					
Totals	335	9	5	3	352	Totals	387	7			394
BA	3.42	.95	.93	.80	6.11	BA	3.62	.62			4.24

DBH	Plot - Released #1				Totals	DBH	Plot - Released #2				Totals
	O	I	CD	D			O	I	CD	D	
1	292				292	1	248				248
2	49				49	2	50	1			51
3	5	1			6	3	6	3			9
4						4		3			3
5						5					
6						6			1		1
Totals	346	1			347	Totals	304	7	1		312
BA	2.91	.05			2.96	BA	2.74	.43	.20		3.36

DBH	Plot - Released #3				Totals	DBH	Plot - Released #4				Totals
	O	I	CD	D			O	I	CD	D	
1	342				342	1	382				382
2	68				68	2	56				56
3	13	2			15	3	3	1			4
4		3			3	4		1			1
Totals	423	5			428	Totals	441	2			443
BA	3.99	.36			4.35	BA	3.45	.14			3.59

A six inch yellow-poplar, which was 45 feet tall, was the only codominant hardwood on the four released plots (equivalent to 2 per acre). On the four check plots, there were a total of 15 codominant and 4 dominant hardwoods (37 and 10 per acre), and these trees ranged from 35 to 52 feet in height and averaged 43 feet. Some of these trees, particularly the yellow poplars, will continue to grow rapidly enough to maintain a position in the canopy.

Cordwood yields of loblolly pine were related to the amount of hardwood present. Figure 2 shows pine cordwood yields relative to total hardwood basal area at age 18, for the 8 plots. A simple linear regression fitted to these data accounted for 87% of the variation in cordwood yields. 3/ A regression of yields over hardwood basal area in just intermediate, codominant, and dominant trees accounted for 79% of the variation in yields.

Cordwood yields also correlated well with the average free-to-grow index for each plot at age 6; in fact, the correlation was just as good as with hardwood basal area at age 18. Table 7 shows the percent of trees in each free-to-grow class for each plot, at age 6. In Figure 3, pine cordwood yields for each plot at age 18 are plotted over average free-to-grow index at age 6. A simple linear regression fitted to these data accounted for 85% of the variation in cordwood yields. 4/

Table 7. Percent of trees by free-to-grow class for each plot, at age 6.

	<u>Plot</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>Means</u>
Check	1	6	71	17	6	2.23
	2	2	64	16	18	2.49
	3	3	54	11	31	2.71
	4	18	68	8	6	2.02
	Means	7	64	13	15	2.36
Released	1	50	27	17	7	1.80
	2	45	34	16	5	1.81
	3	39	41	10	10	1.90
	4	27	60	4	9	1.95
	Means	40	40	12	8	1.86

3/ Estimated standard cords = $32.43 - .3339$ (hardwood basal area), $r^2 = .868$, probability of a larger F = .0008.

4/ Estimated standard cords = $41.50 - 11.279$ (free-to-grow index at age 6), $r^2 = .852$, probability of a larger F = .0011.

Figure 2. Pine cordwood yields at age 18 relative to total hardwood basal area.

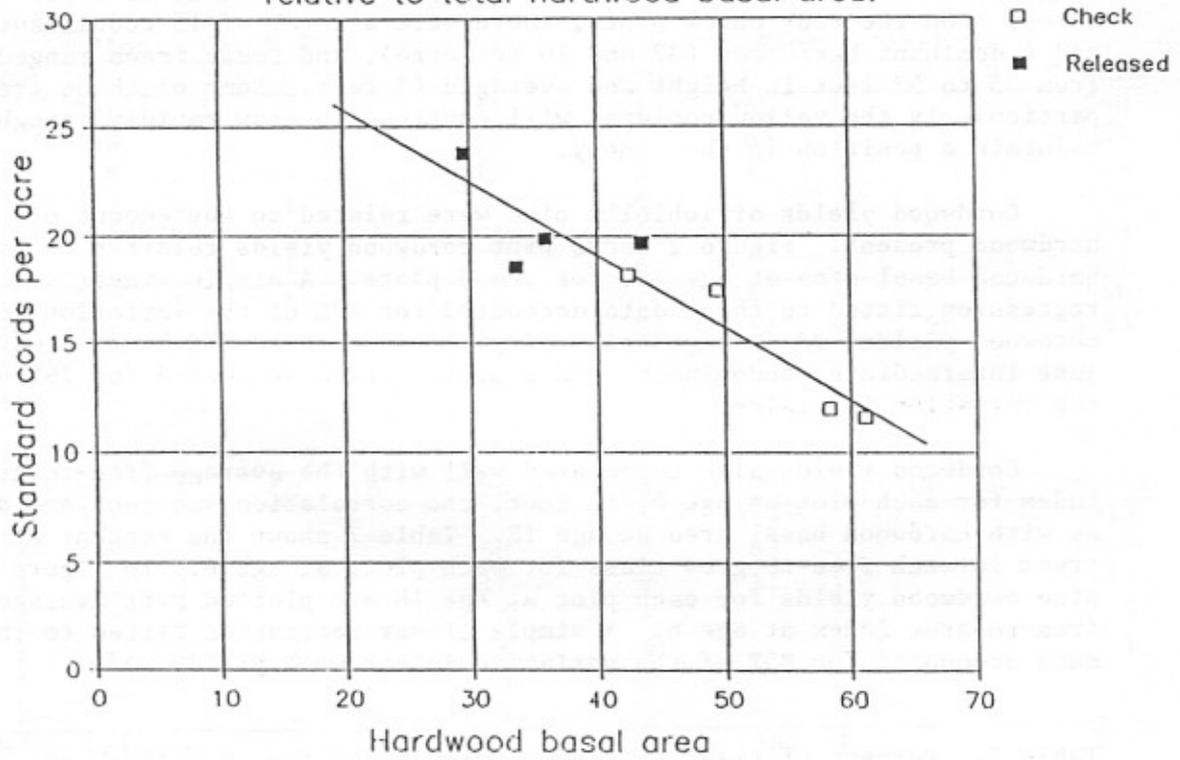
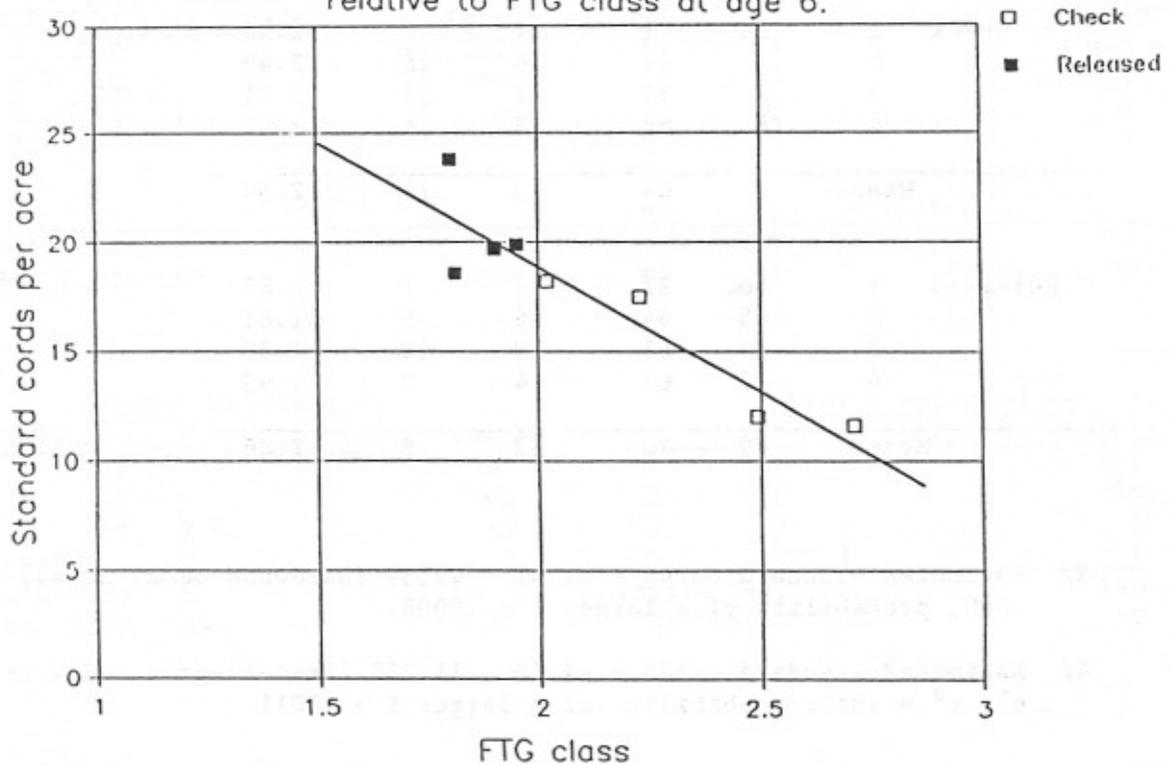


Figure 3. Pine cordwood yields at age 18 relative to FTG class at age 6.



At age 18, dominant and codominant loblolly pines on the check plots averaged 1.6 feet taller than on the released plots (Table 2), but we doubt that this indicates a difference in site index. Pine damage from the aerial release was severe. When the plots were installed at the end of the 6th season, after being released during June of the 6th season, loblolly pine averaged 1.2 feet taller on the check plots than on the released plots (Table 2). Four years later, at age 10, this difference had increased to 3.0 feet. By age 14 the difference had decreased to 1.9 feet and by age 18 to 1.6 feet. These differences in height may simply be a consequence of the damage from the release spraying, with the released trees falling behind between the age 6 and 10 measurements and then gradually catching up over the next 8 years.

At age 6, when plots were installed, the four check plots averaged 465 loblolly pine per acre and the four released plots averaged 595. The relationship between standard cords at age 18 and number of loblolly at age 6 suggests that much of the difference in yield may be due to this initial difference in stocking (Figure 4), rather than release effects. At the final measurement, we estimated the proportion of each plot that would eventually be dominated by loblolly pine, with the remaining area dominated by hardwoods. On all four released plots, the canopy was already completely dominated by loblolly pine at age 18. On the check plots, however, we estimated that on plots 1 through 4 respectively, 85, 80, 65 and 95 percent of the canopy eventually would be dominated by loblolly pine. These percentage estimates correlate well with both hardwood basal area at age 18 and free-to-grow index at age 6, reinforcing our belief that hardwood competition has had a significant effect on pine yields, despite the relationship shown in Figure 4. Numbers of loblolly pine on each plot at age 6 are inversely related to average free-to-grow index at age 6 (and also to hardwood basal area at age 18). This may be just a coincidence, or it may suggest that hardwood competition caused greater seedling mortality on the check plots prior to age 6. In addition, the check plots are close to the edge of the tract (the released plots well within the tract) and the burn may not have been as hot on the check plots. If so, hardwood control sit cleanup, and planting quality may have been poorer on the check plots, which could have contributed to lower stocking at age 6. None of this explains the relationship shown in Figure 4, however. Normally, where release has significantly increased yields, we would expect similar slopes for check and released plots, but with the regression line for released plots at a higher level (see our Release Reports 5 and 7).

Figure 4. Pine cordwood yields at age 18 relative to number of loblolly at age 6.

