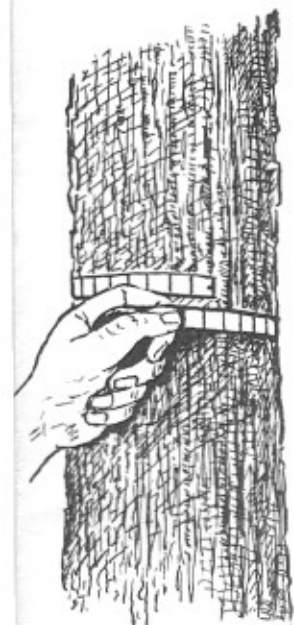
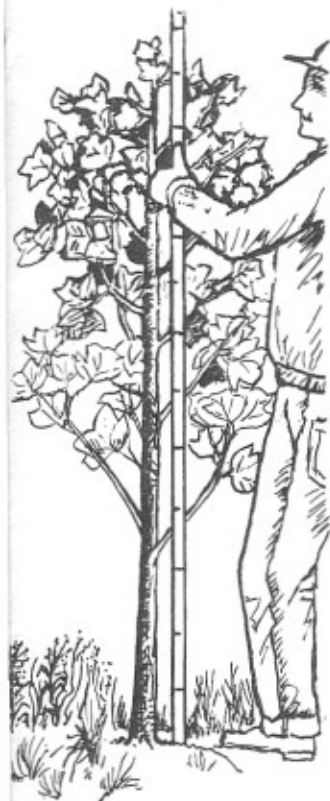


**EFFECT OF INITIAL ROOT COLLAR DIAMETER
ON SURVIVAL AND GROWTH OF
YELLOW POPLAR SEEDLINGS
OVER TWENTY YEARS**



Virginia
Department of Forestry



Effect of Initial Root Collar Diameter On Survival and Growth of Yellow Poplar Seedlings Over Twenty Years

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Nursery Procedure

This study was installed at our Augusta Nursery, in the Shenandoah Valley of Virginia, in the summer of 1971. We wanted to look at the effect of three different treatments on the size and performance of yellow poplar seedlings:

1. Bed densities of 10 and 20 seedlings per square foot
2. Top clipping one time during the growing season vs. no clipping
3. Root pruning one time during the growing season vs. no pruning

The three treatments were applied in all combinations, resulting in a 2x2x2 factorial, yielding eight treatment combinations. These eight treatments were replicated five times, in five adjacent seed beds, for a total of 40 plots. The individual plots were five feet long.

We thinned the plots to the target density of 10 and 20 seedlings per square foot on July 19 and 20. Seedlings were still very small, none of them over six inches tall. Stocking was erratic and sparse, in places, on all plots. We had hoped to leave either 10 or 20 seedlings on each square foot of each five foot long plot, but many individual square feet had fewer than 20 seedlings. Actual densities left after thinning averaged 9.5 and 16.3 seedlings per square foot.

We top pruned to about a 10-inch height on August 23. Many seedlings were not tall enough to be clipped.

We did the root pruning on September 17, attempting to keep the under-cutter at about a 10-inch depth. Soils at the Augusta Nursery are very heavy and contain a lot of small rounded rocks, and the root pruning did not go well at all. We ended up dragging a lot of seedlings, and decided to drop this part of the study, which reduced the eight treatment combinations to just four (those that included just seedbed density and top clipping).

Lifting and Grading

We lifted the seedlings on March 21, 1972. We discarded one of the five seedbed replications because of excessive variation related to soil differences. From the remaining 16 plots (four replications times four treatment combinations), we lifted a 40-seedling sample across the center of each plot.

We separated the seedlings from each sample by root collar diameter into 1/16-inch classes. Seedlings less than 5/32-inch were discarded, and the remaining trees were counted by root collar diameter class. We grouped them into two size classes for planting in the field: the small size class included the 3/16 and 4/16-inch seedlings and the large size class included 5/16-inch and larger.

Planting in the Field

We planted the seedlings on our Lesesne State Forest, which is in Nelson County, east of and at the foot of Three Ridges Mountain, one of the tall mountains that form the crest of the Blue Ridge in central Virginia. The soil is deep and rocky, developed in colluvium from the mountain above, which is largely composed of granodiorite. These soils are typically good hardwood sites.

Prior to planting, the area supported a stand dominated by black locust and *Ailanthus*, with some dogwoods and scattered apple trees, and a moderate ground cover of honeysuckle. We harvested the stand during the winter of 1970-71, using the locust for posts. We piled the brush and burned the piles in the spring of 1971. Stumps sprouted vigorously and the honeysuckle grew rapidly. In the late summer of 1971 we sprayed the area with 2,4-D and then in the early fall, after the honeysuckle had cured, we burned the area. Even with this intensive site preparation, hardwood sprouts again became a serious problem, especially the locust and *Ailanthus*. Consequently, in the spring of 1974, after the poplar seedlings had been through two growing seasons, all hardwoods were basal sprayed.

The seedlings were planted on March 28, 1972, using a spacing of 6.6 x 6.6 feet. Even though the seedlings were grouped into small and large diameter classes, we noted on a map the diameter of each individual seedling (in other words within the small diameter class, we knew which seedlings were 3/16 and which were 4/16). As seedlings were planted, the top length of each seedling was measured and recorded.

The field planting, therefore, included eight treatments, the four original seedbed treatments each with two size classes. These eight treatments were replicated three times in randomized blocks, with a 20-seedling row of each treatment in each block.

Measurements

Seedling heights were measured at age one and two. At age 9 we measured the DBH of each surviving tree. At age 17 we measured the DBH of each surviving tree and the total height of 60 percent of the surviving trees. Prior to the measurement at age 17, there had been considerable top breakage from at least one severe ice storm. The trees on which we measured heights were, for the most part, trees which had sustained the least breakage. Many of the badly broken trees became suppressed by more fortunate neighbors.

The three replications were installed side by side with the 20 seedling rows running approximately north and south. At age 18 we thinned the northern half of each replication. This left us with two "plots" of equal size, one thinned and one not thinned. The latest measurement was made at age 20, three years after the age 17 measurement and two years after the actual thinning.

Seedbed Results

Seedlings grown at 10 (9.5) per square foot were slightly taller (7 percent) and slightly larger in diameter (13 percent) than seedlings grown at 20 (16.3) per square foot (Table 1). Top clipping reduced top length substantially; seedlings top-clipped were 33 percent shorter. Top-clipping also had a slight effect on diameter; seedlings top-clipped were 8 percent smaller (Table 1).

Table 1. Average root collar diameter (1/16 inch) and top length (inches) when seedlings were lifted, by seedbed treatment.

<u>Treatment</u>	<u>Length¹</u>	<u>Diameter²</u>
Low Density, top-clipped	1.02	4.11
Low Density, not clipped	1.53	4.79
High Density, top-clipped	.97	3.90
High Density, not clipped	1.42	3.96

¹Based on 120 seedlings for each treatment, measured as they were planted.

²Based on 160 seedlings for each treatment, 40 from each of four seedbed plots.

Survival

The seedbed treatments involving bed density and top clipping had no significant effect on survival (Table 2).

Table 2. Average survival at ages 1, 2, 9, and 17 by seedbed treatment.

<u>Treatment</u>	<u>Age</u>			
	<u>1</u>	<u>2</u>	<u>9</u>	<u>17</u>
Low Density, top-clipped	96	92	82	74
Low Density, not clipped	92	92	84	68
High Density, top-clipped	93	92	84	68
High Density, not clipped	94	93	82	71

Root collar diameter, on the other hand, had an important effect on survival that increased with age (Table 3 and Figure 1).¹ After age 2, the slower height growth of smaller diameter seedlings resulted in more of them dying of suppression.

Table 3. Average survival at ages 1, 2, 9, and 17 by initial root collar diameter.

<u>Root Collar Diameter (16ths)</u>	<u>Number Planted</u>	<u>Age</u>			
		<u>1</u>	<u>2</u>	<u>9</u>	<u>17</u>
3	120	82	81	62	45
4	120	96	94	87	73
5	119	98	98	89	82
6	59	100	98	93	81
7	29	100	100	97	86
8	8	100	100	100	88
9	2	100	100	100	100
Totals	457				

¹An analysis of variance was performed on survival at age 2 by grouping the 6, 7, 8, and 9/16 inch seedlings. This provided 120, 120, 119, and 98 planted seedlings in the 3/16, 4/16, 5/16, and 6/16 and larger diameter classes. Survival percents were first transformed to arc sine percent. The overall F for initial diameter was statistically significant (probability of a larger F=.014). Using Duncan's New Multiple Range Test, the only significant differences (at both .05 and .01) were that both 5/16 and 6/16 and larger seedlings survived better than 3/16 seedlings.

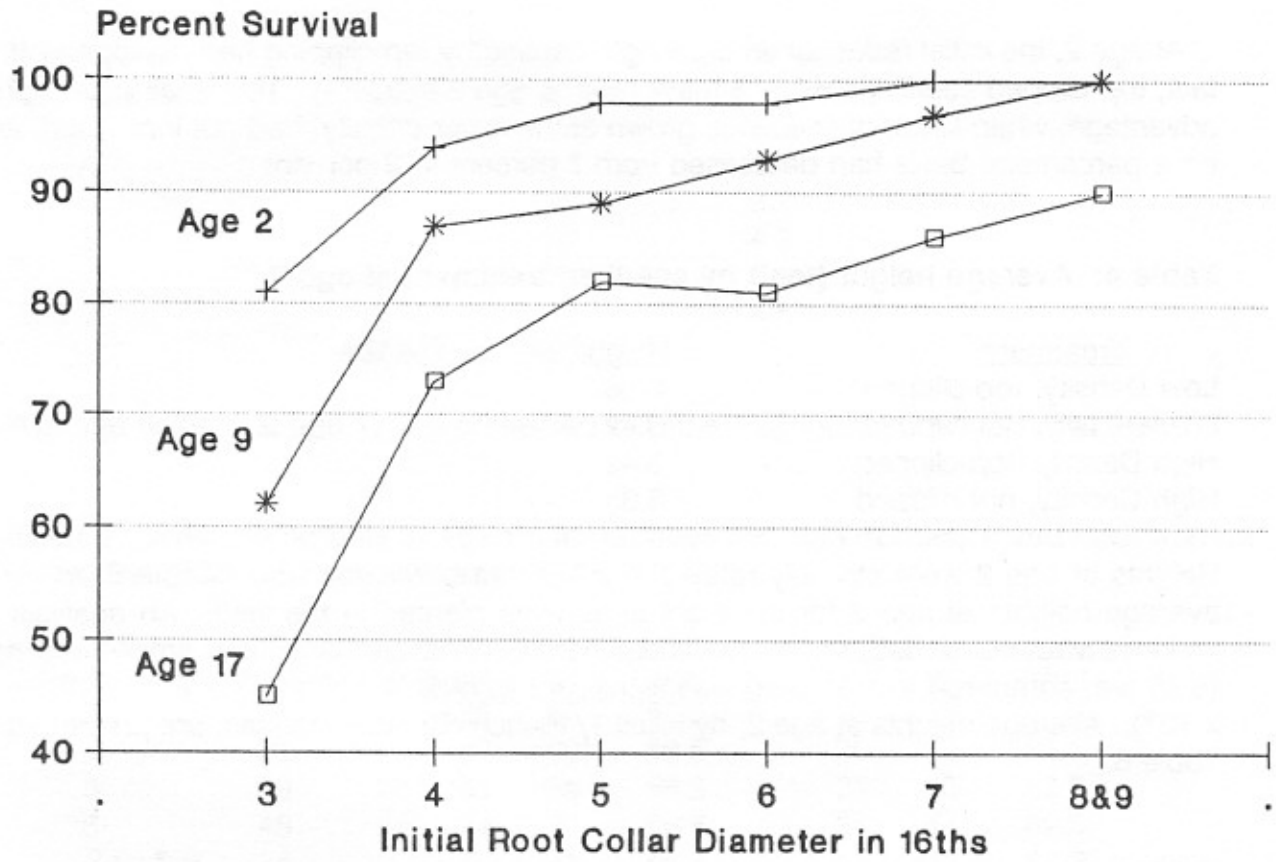


Figure 1. Average survival by initial root collar diameter at ages 2, 9, and 17.

Height Growth

At age 2, the initial reduction in top length caused by top-clipping had disappeared; in fact, top-clipped seedlings were actually taller at age 2 (Table 4). The small initial height advantage, when lifted, of seedlings grown at the lower density, had not increased, and on a percentage basis had decreased from 7 percent to 3 percent.

Table 4. Average height (feet) by seedbed treatment at age 2.

<u>Treatment</u>	<u>Height</u>
Low Density, top-clipped	3.56
Low Density, not clipped	3.42
High Density, top-clipped	3.42
High Density, not clipped	3.35

Heights at age 2 were strongly related to initial root collar diameter. Table 5 presents average heights at age 2 for the eight treatments planted in the field. An analysis of variance was performed, and the overall difference between large and small seedlings (3.96 feet compared to 2.91 feet) was significant (probability of a larger $F = 9.0 \times 10^{-6}$). Average heights at age 2, by initial 1/16-inch diameter classes, are presented in Table 6.

Table 5. Average height (feet) by treatment at age 2.

<u>Treatment</u>	<u>Height</u>
Low Density, top-clipped, small	3.12
Low Density, top-clipped, large	4.00
Low Density, not clipped, small	2.87
Low Density, not clipped, large	3.96
High Density, top-clipped, small	2.96
High Density, top-clipped, large	3.88
High Density, not clipped, small	2.70
High Density, not clipped, large	4.00

Table 6. Average height (feet) at age 2 by initial root collar diameter.

Root Collar Diameter (16ths)	# of Trees		Average Height
	Planted	Measured	
3	120	97	2.5
4	120	113	3.3
5	119	116	3.7
6	59	58	4.3
7	29	29	4.4
8 & 9	<u>10</u>	<u>10</u>	4.5
	457	423	

Average heights at age 17 are presented in Table 7 by initial root collar diameter.

Table 7. Average heights at age 17, for all trees and just dominant and codominant trees, by initial root collar diameter.

Initial Root Collar Diameter	Number Surviving	All Trees Measured for Height			D&CD Trees Measured		
		Number	% ¹	Height	Number	% ¹	Height
3	54	35	65	52.0	18	33	62.2
4	88	53	60	56.5	28	32	61.1
5	98	55	56	55.8	25	26	62.5
6	48	34	71	56.5	21	44	62.5
7, 8, & 9	<u>34</u>	<u>16</u>	<u>41</u>	<u>58.7</u>	<u>11</u>	<u>32</u>	<u>62.3</u>
	322	193	60	55.7	103	32	62.0

¹Number measured as a percent of number surviving.

Diameter Growth

Average diameters at ages 9 and 17, by initial root collar diameter class, are presented in Table 8 and Figure 2. DBH increased with increasing initial root collar diameter, reaching a maximum for 6/16 and 7/16-inch seedlings, and then fell off for 8/16 and 9/16-inch seedlings. We have no idea why DBH decreased for the largest seedlings, but the sample size was only 10 and 9 seedlings (at ages 9 and 17), so the difference may be a random effect.

Table 8. Average DBH by initial root collar diameter at ages 9 and 17.

Initial Root Collar Diameter (16ths)	Age 9		Age 17	
	Number	DBH	Number	DBH
3	74	2.44	54	5.13
4	104	3.26	88	5.98
5	106	3.50	98	5.78
6	55	3.98	48	7.04
7	28	3.90	25	6.80
8 & 9	10	3.34	9	5.78
	377	3.32	322	5.99

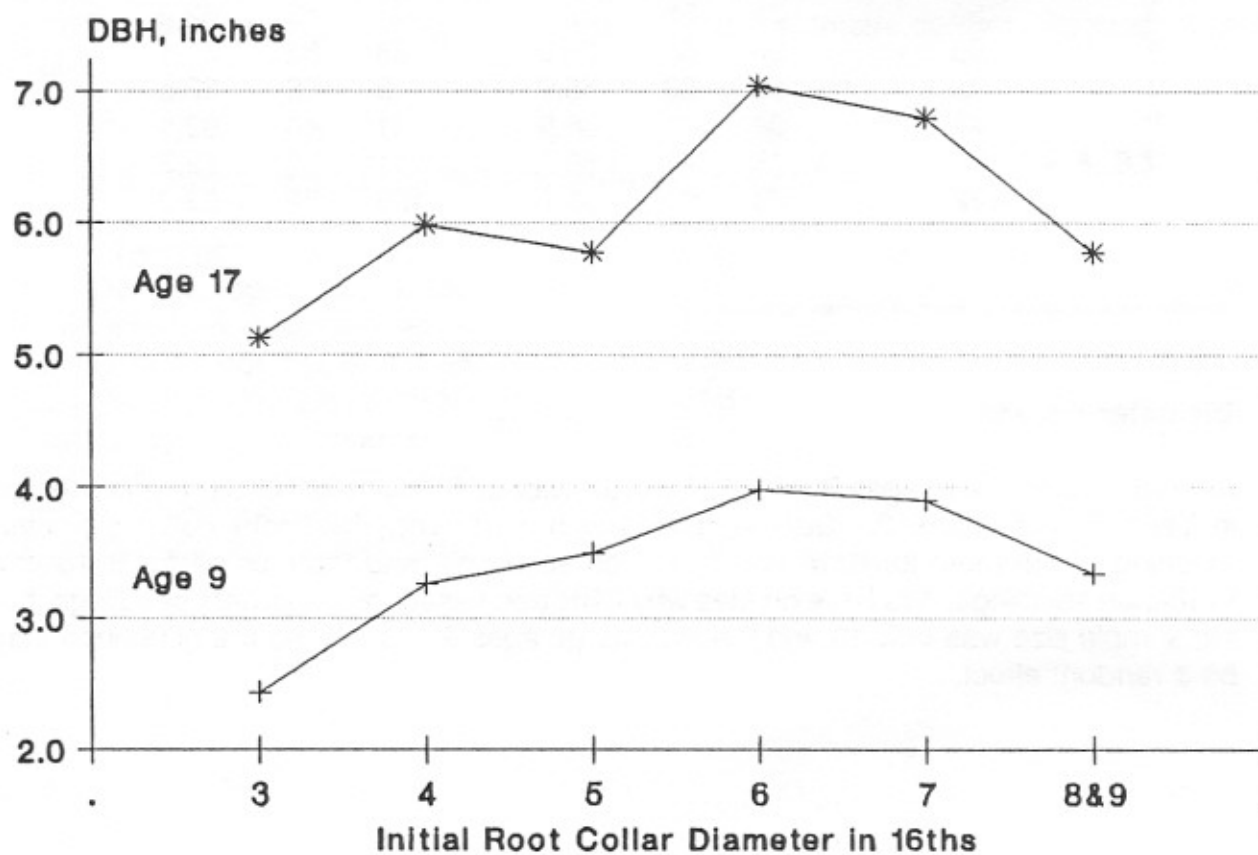


Figure 2. Average DBH by initial root collar diameter at ages 9 and 17.

An average stand table at age 17, combining all initial root collar diameter classes, is presented in Table 9 and illustrated in Figure 3.

Table 9. Average number of trees per acre at age 17 by diameter class.

<u>DBH</u>	<u>Number</u>
1	25
2	38
3	58
4	88
5	71
6	73
7	135
8	73
9	56
10	38
11	10
12	6
Totals	671

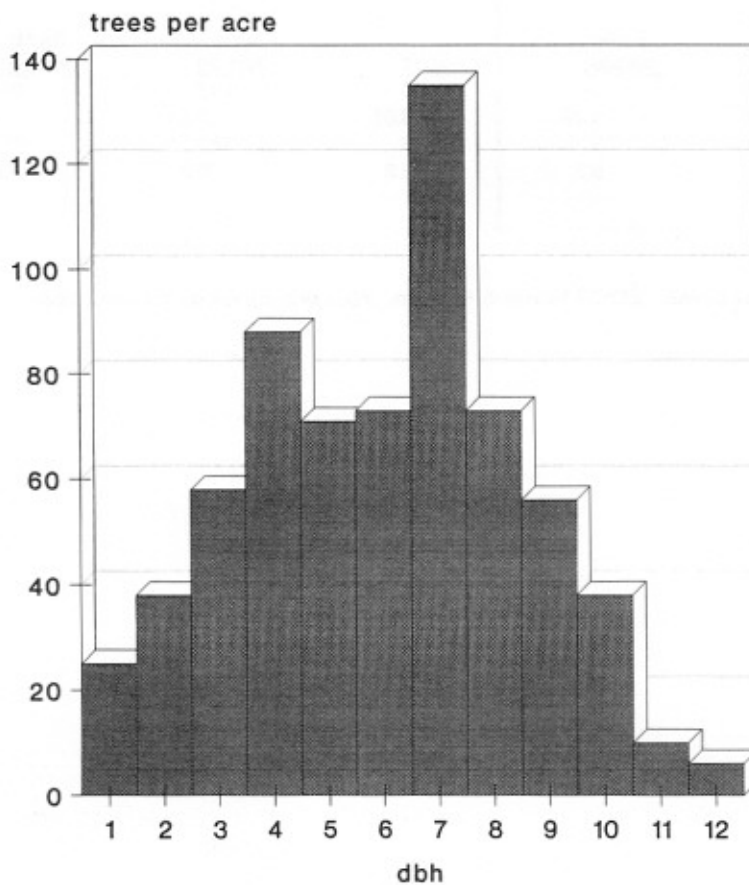


Figure 3. Average number of trees per acre by DBH class at age 17.

Thinning and Subsequent Growth

After the age 17 measurement, the north half of all three blocks was marked for a thinning. The actual cutting was not done until a year later, at age 18. A measurement was made at age 20. Table 10 compares the thinned and unthinned areas at age 17 prior to thinning, describes the leave stand on the thinned area (at age 17), and summarizes the changes that occurred during the three-year period. Growth has been impressive, especially on the thinned area, where DBH growth has averaged .46 inches per year and basal area growth almost 11 square feet per year. The estimated site index¹, based on the age 20 measurements, is above 110 on both areas. We wonder if black locust, which fixes large amounts of atmospheric nitrogen and dominated the previous stand, might be partly responsible for the outstanding growth for these first 20 years.

Table 10. Comparison of thinned and unthinned areas at age 17, prior to thinning, and at age 20 (two years after the actual thinning), on a per acre basis.

Thinned Area					Unthinned Area		
	Age 17		Age 20	3-year change	Age 17	Age 20	3-year change
	All Trees	Leave Trees					
Number	692	225	225	0	650	617	33
Mean DBH	5.98	8.17	9.56	1.39	6.01	6.73	.72
Basal Area	156	85	117	32	153	183	30
D&CD	61.4		68.1	6.7	62.6	70.6	8.0
Height							

¹From Donald E. Beck, 1962, Yellow-Poplar Site Index Curves. SEFES Research Note No. 180, using curves for the mountains.