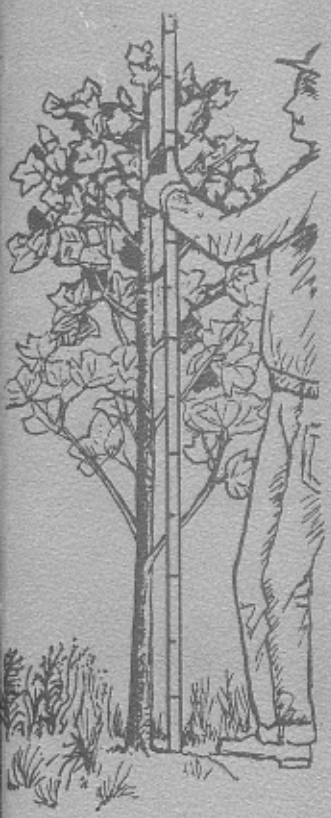

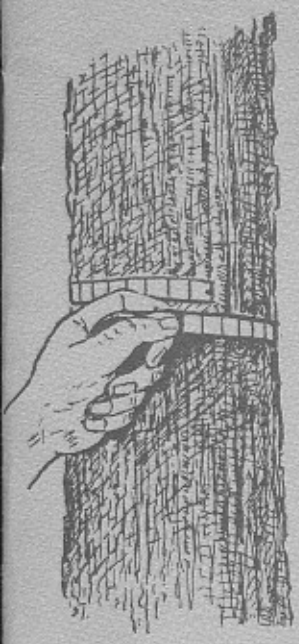

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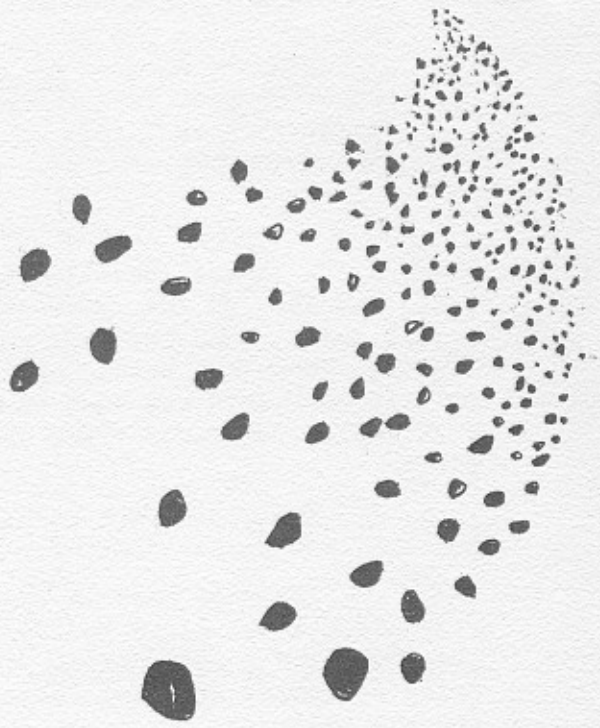
A THREE YEAR LOBLOLLY PINE DIRECT SEEDING STUDY



Virginia Division of Forestry
Department of Conservation and Economic Development

A THREE-YEAR LOBLOLLY PINE DIRECT SEEDING STUDY

by

T. A. Dierauf

ABSTRACT

A 3-year loblolly pine direct seeding study was installed on Coastal Plain soils. One-half and one pound per acre rates were sown during the middle of January, February, March, and April. Dry seed was sown on all 4 dates, and stratified seed was sown in March and April. Permanent transects were installed at the end of the first growing season to obtain information on survival and height growth.

Early sowing produced higher stocking than later sowing, but adequate stocking was obtained from all treatments in all 3 years.

Mortality from the end of the first through the fourth growing season ranged from 6 to 11 percent for the 3 years. The little mortality that occurred was related to seedling height at the end of the first season: the shorter the seedling the greater the mortality.

Height growth from the end of the first through the fourth growing season was related to both seedling height and presence of secondary needles at the end of the first season: taller seedlings grew faster, and seedlings with secondary needles grew faster than seedlings of the same first year height that did not have secondary needles.

DESCRIPTION OF STUDY

A 3-year loblolly pine direct seeding study was installed in 1965, 1966, and 1967 on the Pocahontas State Forest in Chesterfield County. Rates of 1/2 and 1 pound per acre were tested. Seed was sown during the middle of January, February, March, and April. Dry seed was sown on all 4 dates, and stratified 1/ seed was sown in March and April. The 12 different treatments were replicated three times each year in randomized blocks, using 1/5 acre plots.

The plots were prepared for seeding by clearcutting, prescribed burning, and double disking. Mineral soil exposure was virtually complete.

The seed used in the study for all 3 years was collected in the Virginia Coastal Plain in the fall of 1964. It had a count of 18,000 seeds per pound and a germination percent of 88 percent. All seed was treated prior to sowing to repel rodents and birds. 2/ A cyclone seeder was used to sow the seed.

1/ *Stratified 60 days in polyethylene bags at 35-40° F.*

2/ *Materials applied at following rates per 100 pounds of seed:*

Arasan 42-S - 2.4 gallons	*Dow Latex 512 sticker - 12 ounces*
Endrin 50-W - 2.5 pounds	*Aluminum flakes - 2 ounces*

The Pocahontas State Forest straddles the fall line, but the study was installed in an area with Coastal Plain soils. Well drained soils of the Norfolk, Kempsville, Marlboro, and Faceville soil series predominate, with a minor amount of the moderately well-drained Goldsboro soil series. The topography is nearly level.

Stocking was evaluated after 3 growing seasons, by tallying seedlings on 49 mil-acre plots systematically distributed over each 1/5 acre plot.

Permanent Transects for Survival and Height Growth.

At the end of the first growing season, a permanent transect was installed in the center of each plot sown at the 1 pound per acre rate (a total of 18 transects each year). The transects were 66 feet long and 6.6 feet wide (10 mil-acres). The locations of all seedlings on each transect were plotted on graph paper, and the height to the nearest inch was recorded. If secondary needles were present (at least one fascicle) this also was recorded. Presence of secondary needles was correlated with height, as shown in Table 1.

The seedlings on the permanent transects were remeasured each year until they were 4 years old.

Table 1. Number of Seedlings Plotted and Percent with Secondary Needles, by Height After the First Season.

Height After First Season, In Inches	1965 Sowing		1966 Sowing		1967 Sowing	
	No. Plotted	% With Secondaries	No. Plotted	% With Secondaries	No. Plotted	% With Secondaries
1	14	0	57	0	38	0
2	71	10	248	7	160	13
3	75	39	268	22	214	44
4	98	59	158	53	207	66
5	101	75	82	82	121	88
6	74	97	47	89	101	92
7	61	95	18	94	60	100
8	48	100	12	92	20	100
9	29	100	4	100	16	100
10	19	100	1	100	5	100
11	10	100	1	100	1	100
12	2	100	-	-	-	-
13	5	100	-	-	1	100
14	2	100	-	-	-	-
15	1	100	-	-	-	-
Totals & Means	610	68	896	34	944	59

RESULTS

Stocking on 1/5 Acre Plots.

Average stocking on the 1/5 acre plots at age 3 is shown in Table 2. 3/ All treatments produced adequately stocked stands; the lowest average stocking obtained was 1,300 seedlings per acre. In general, early sowing produced higher stocking than late sowing:

1. January and February sowing with non-stratified seed and March sowing with stratified seed were equally effective and produced the highest stocking.

2. March sowing with non-stratified seed and April sowing with stratified seed were intermediate.

3. April sowing with non-stratified seed produced the lowest stocking.

Mil-acre stocking percent 4/ was high in all cases. The lowest average stocking percent obtained was 67 percent (for stratified seed sown in April 1965).

The effect of stratification varied. In 1965 stratification had no significant effect on stocking; in 1966 it significantly improved stocking in March but not in April; and in 1967 it significantly improved stocking in both March and April. 5/

3/ Separate analyses of variance were made for each year of average number of seedlings per acre at age 3. Differences between treatments were tested using Duncan's New Multiple Range Test. Significant differences at the .05 level are shown in Table 2. Treatments not bracketed in Table 2 are different at the .05 level of significance.

4/ Mil-acre stocking percent is the percent of sample mil-acre plots containing one or more seedlings.

5/ Additional analyses of variance were made of average number of seedlings per acre for March and April sowings only. Orthogonal comparisons were made and the results are given in the table below. None of the interactions between month, stratification, and rate were significant with the single exception shown in the table below:

Comparison	1965	1966	1967
	Level of Significance		
March vs. April	.05	.005	.05
Stratification	NS	.005	.005
March vs. April x stratification	NS	.005	NS

Note: NS means not significant.

Table 2. Average Number of Seedlings Per Acre at Age 3, by Year and Sowing Rate (treatments listed in order from most to least effective).

1965 Sowing

1/2 Pound		1 Pound	
Treatment	No./Ac.	Treatment	No./Ac.
February, NS	2,110	February, NS	3,930
March, NS	2,050	January, NS	3,810
March, S	2,030	March, S	3,580
January, NS	1,870	April, S	3,080
April, S	1,480	March, NS	2,760
April, NS	1,300	April, NS	2,340

1966 Sowing

1/2 Pound		1 Pound	
Treatment	No./Ac.	Treatment	No./Ac.
March, S	3,270	March, S	5,690
February, NS	2,650	January, NS	5,340
January, NS	2,520	February, NS	4,310
March, NS	2,230	March, NS	3,260
April, S	1,880	April, NS	2,900
April, NS	1,710	April, S	2,820

1967 Sowing

1/2 Pound		1 Pound	
Treatment	No./Ac.	Treatment	No./Ac.
March, S	3,560	February, NS	5,560
April, S	3,350	March, S	5,020
February, NS	3,300	April, S	4,810
January, NS	2,990	March, NS	4,670
March, NS	2,730	January, NS	4,480
April, NS	2,090	April, NS	2,970

Permanent Transects.

Mortality

Very little mortality occurred after the permanent transects were installed (in the fall at the end of the first growing season). At age 4, survival was 94, 89, and 92 percent for the 1965, 1966, and 1967 sowings respectively. The limited mortality that did occur was strongly related to height at the end of the first growing season, as shown in Table 3. Also, comparing seedlings of equal height after the first season, seedlings with secondary needles survived slightly better than seedlings without secondary needles.

Height Growth

Height growth on the permanent transects during the second, third, and fourth growing seasons was strongly related to height at the end of the first season, as shown in Figure 1. 6/ Taller seedlings increased each year their initial height advantage over shorter seedlings, as shown by the increasing steepness of the curves from age 2 to age 4 in Figure 1. Table 4 shows the average 3 year height growth between the first and fourth growing seasons, and was constructed by subtracting heights at the end of the first season from the average heights at age 4 shown in Figure 1.

Seedlings with secondary needles at the end of the first growing season grew faster than seedlings of the same height that had only primary needles, as shown in Figure 2. 7/

6/ The curves in Figure 1 were derived by applying the method of least squares to individual seedling heights. The regression equations and multiple correlation coefficients are given below (X is seedling height at the end of the first season).

1965 Sowing

$$\text{Height at age } 2 = 4.119 + 2.495X - .066X^2,\ R^2 = .518$$
$$3 = 9.448 + 6.002X - .200X^2,\ R^2 = .434$$
$$4 = 22.492 + 9.374X - .345X^2,\ R^2 = .393$$

1966 Sowing

$$\text{Height at age } 2 = 2.185 + 3.010X - .082X^2,\ R^2 = .463$$
$$3 = 9.290 + 5.037X - .130X^2,\ R^2 = .371$$
$$4 = 20.786 + 8.615X - .328X^2,\ R^2 = .281$$

1967 Sowing

$$\text{Height at age } 2 = 3.834 + 1.984X - .033X^2,\ R^2 = .501$$
$$3 = 11.095 + 4.448X - .159X^2,\ R^2 = .294$$
$$4 = 23.939 + 9.323X - .435X^2,\ R^2 = .251$$

7/ The curves in Figure 2 were derived by applying the method of least squares to individual seedling heights. Linear equations were used when the reduction in residual sum of squares from fitting the square of first year height was not significant at the .05 level.

Table 3. Survival at Age 4, by Height at the End of the First Season.

First Year Height, Inches	1965 Sowing No. Plotted	1965 Sowing Surv. %	1966 Sowing No. Plotted	1966 Sowing Surv. %	1967 Sowing No. Plotted	1967 Sowing Surv. %
1	14	79	57	77	38	76
2	71	85	248	85	160	85
3	75	92	268	87	214	89
4	98	93	158	94	207	94
5	101	95	82	100	121	97
6	74	99	47	98	101	95
7	61	98	18	94	60	100
8	48	98	12	100	20	100
9	29	100	4	100	16	100
10	19	100	1	100	5	80
11	10	100	1	100	1	100
12	2	100	-	-	-	-
13	5	100	-	-	1	100
14	2	100	-	-	-	-
15	1	100	-	-	-	-
Totals & Means	610	94	896	89	944	92

Table 4. Average Height Growth from the End of the First to the End of the Fourth Growing Season.

First Season Height, Inches	3-Year Height Growth, In Inches 1965 Sowing	1966 Sowing	1967 Sowing
1	31	28	32
2	38	35	39
3	44	41	45
4	50	46	50
5	56	51	55
6	60	55	58
7	64	58	61
8	67	61	63
9	70	63	64
10	72	64	64
11	73	65	63
12	73	-	61
13	73	-	59
14	72	-	-
15	70	-	-

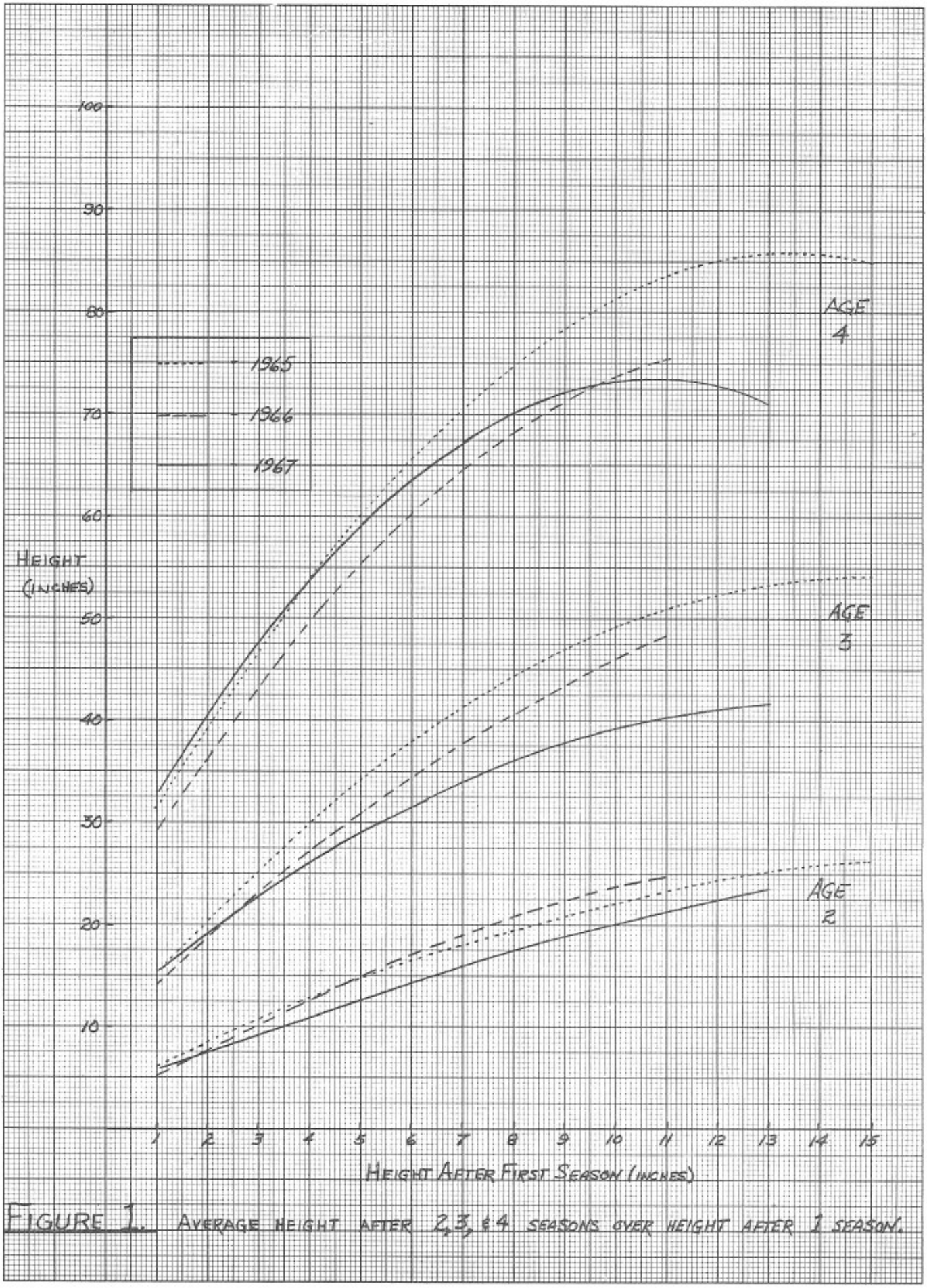


FIGURE 1. AVERAGE HEIGHT AFTER 2, 3, & 4 SEASONS OVER HEIGHT AFTER 1 SEASON.

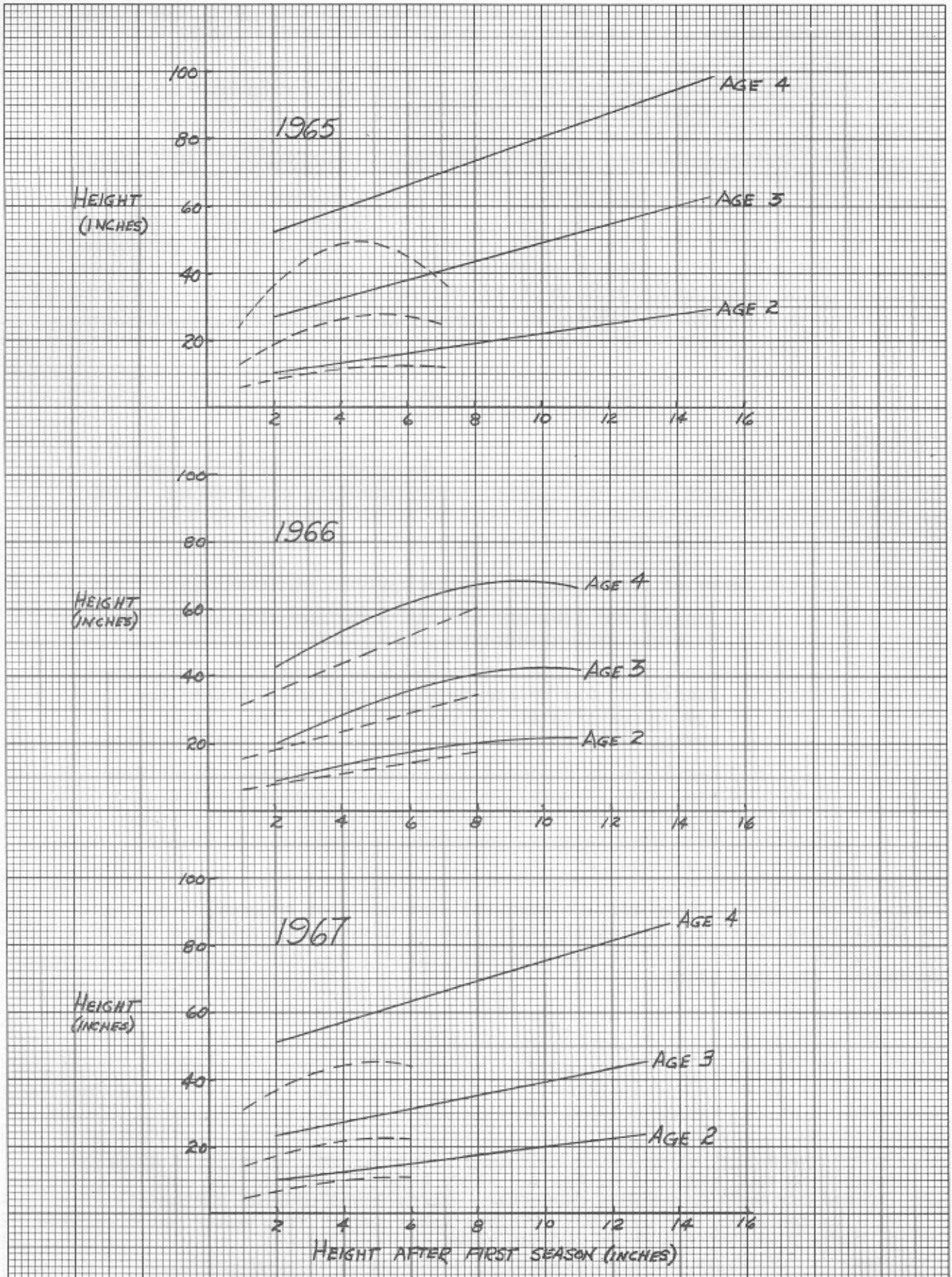


FIGURE 2. HEIGHT AFTER 2, 3, & 4 SEASONS OVER HEIGHT AFTER 1 SEASON, FOR SEEDLINGS WITH SECONDARY NEEDLES (SOLID LINE) & WITHOUT SECONDARY NEEDLES (DASHED LINE).

Non-stratified seed sown in April resulted in the lowest stocking, and also produced the shortest seedlings at age 4, as shown in Table 5. 8/

Table 5. Average Seedling Height at Age 4, by Year and Sowing Date (treatments listed in order from tallest to shortest).

1965 Sowing		1966 Sowing		1967 Sowing	
Treatment	Ht., Inches	Treatment	Ht., Inches	Treatment	Ht., Inches
January, NS	68	March, S	49	March, NS	57
April, S	65	January, NS	47	January, NS	57
March, NS	61	March, NS	45	February, NS	55
February, NS	59	February, NS	44	April, S	54
March, S	59	April, S	40	March, S	51
April, NS	45	April, NS	39	April, NS	47

SUMMARY AND CONCLUSIONS

Stocking.

1. Adequate stocking at age 3 was obtained with all treatments. Even with the 1/2 pound rate, the lowest average stocking obtained was 1,300 seedlings per acre from non-stratified seed in April, 1965. Overstocking will be more of a problem on these plots than understocking.

2. In terms of producing the greatest number of seedlings:

   a. January and February sowings using non-stratified seed were the best treatments.

   b. March sowing with stratified seed produced just as many seedlings, but by sowing in January and February the trouble of stratifying seed can be avoided. March sowing with non-stratified seed produced fewer seedlings.

   c. April sowing produced the fewest seedlings. Stratified seed sown in April produced about as many seedlings as non-stratified seed sown in March, but non-stratified seed sown in April consistently produced the fewest seedlings.

3. The stocking results reported were obtained by careful sowing on small plots that were thoroughly scarified by disking twice with a single disc. Lower stocking would be expected from operational sowings on less thoroughly prepared sites.

8/ Separate analyses of variance were made for each year, of average seedling heights on each transect at age 4. There were 3 transects for each of the 1 pound per acre treatments each year. Differences between treatments were tested using Duncan's New Multiple Range Test. Treatments not bracketed in Table 5 are different at the .05 level of significance.

Mortality and Height Growth.

1. Seedlings surviving at the end of the first growing season are apparently good prospects to survive until mortality from competition begins.

2. Seedlings which were taller at the end of the first growing season survived better and grew faster during the next 3 growing seasons.

3. Seedlings with secondary needles survived slightly better and grew faster than seedlings of the same first year height that did not have secondary needles.

4. First year height by itself is a good indicator of future survival and growth. First year seedling height together with presence or absence of secondary needles is an even better indicator.