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Wide-Spacing Plantings of Loblolly Pine

Age 15 Results

John A. Scrivani and Wayne F.Bowman

Introduction

Early tree plantings in Virginia followed the European tradition of planting 1000 trees per acre at the spacing of 6.6 feet by 6.6 feet. Over the decades these densities declined, but even into the late 1980's many stands were still being planted at 700 to 800 trees per acre. In the last couple of decades, recommended spacings have been in the 400-600 trees per acre range.

Planting density is an important management decision. It largely determines the time of crown closure, the rate of total stand volume growth, the rate of individual tree diameter growth, and the rate of crown recession or natural pruning. Lower planting densities result in faster individual tree diameter growth, but at a cost of slower total stand volume growth, and slower natural pruning. As a result, planting density has a large impact upon the timing of thinning, the intensity of thinning, and the products removed in thinning.

Interest in even lower planting densities has risen in recent years. Lower densities, in the 200-400 trees per acre range, may be of interest to landowners who wish to maximize diameter growth, obtain sawtimber as soon as possible, delay crown closure, and even forego thinning of their stands.

High survival rates of most loblolly plantings, and the availability of genetically improved loblolly pine seedlings, have both increased the feasibility of lower density plantings. Landowners can expect 85-95 % survival; and nearly every surviving tree can be expected to make a desirable final crop tree, with good bole straightness and crown form.

Methods

In the springs of 1990, 1992 and 1993, plantings of 100%-genetically-improved first-generation loblolly seedlings, obtained from the Virginia Department of Forestry tree nurseries, were planted on tracts located in the Appomattox-Buckingham State Forest in the Piedmont of Virginia. Each year three replications were planted on a single tract. The spacing and number of seedlings were varied in three plots per replication to obtain densities of 200, 300, and 400 trees per acre (TPA), as detailed in Table 1.

Table 1, Planting densities, seedling numbers, and plots size.

Density (TPA)	Spacing (ft)	Trees Planted	Plot size (acres)
200	14.8	49	0.20
300	12.0	64	0.21
400	10.4	81	0.25

Each tract was a cutover site that had been prepared with a prescribed burn. Each planting was released from hardwood competition by spot spraying of hardwood clumps with Arsenal using a backpack sprayer. Each tract has had some mowing since to facilitate tree measurements.

Table 2. Measurement schedule.

Year	Tract	Measurement Ages
1990	Rhinehart	7, 9, 12, 15
1992	Talbert	5, 7, 10, 13
1993	Abbitt	6, 9, 12

Several measurements have been made since planting, as detailed in Table 2. Height was measured at all ages, and diameter at breast height (dbh) at ages 6 and above.

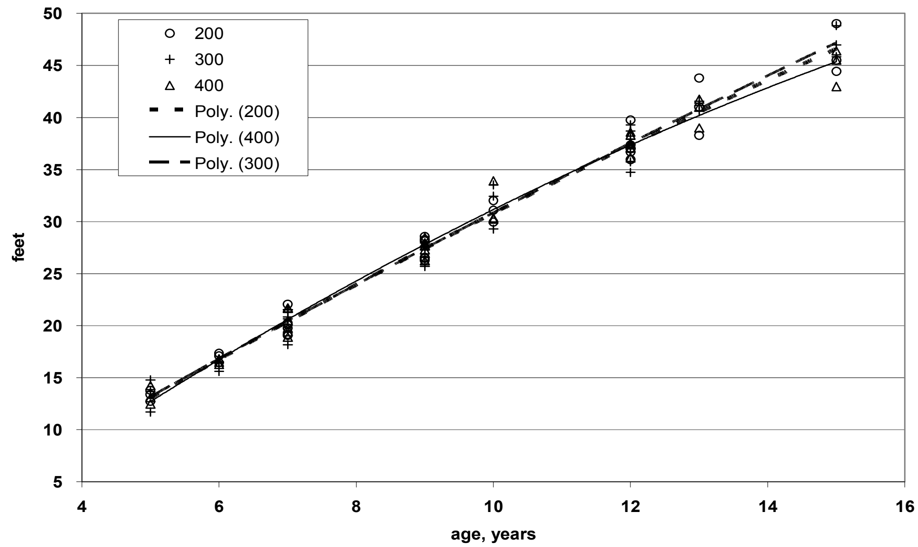
Results

With the measurements made after the 2004 growing season, age 5 through 15 results are available for analysis. The mean for each age measurement is presented in Table 3. Since not all replications were measured are at each age, some values may appear a bit anomalous.

Table 3. Measurement means at each measurement age.

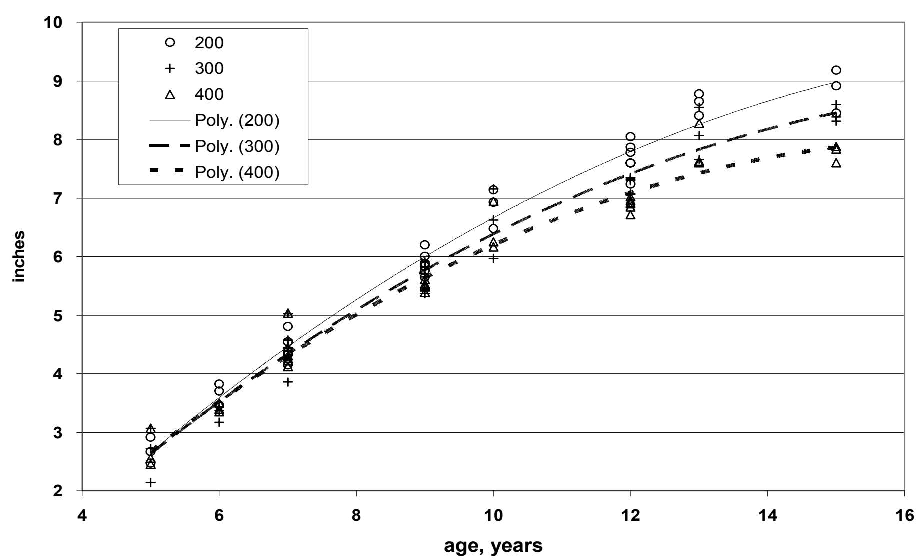
Age	**DBH** inches			**Basal area** Square feet per acre			**Height** feet		
density	***200***	***300***	***400***	***200***	***300***	***400***	***200***	***300***	***400***
5	2.7	2.6	2.7	8	11	15	13	13	13
6	3.7	3.3	3.4	13	16	23	17	16	17
7	4.4	4.5	4.4	20	31	39	20	21	20
9	5.9	5.7	5.5	34	47	60	27	27	28
10	6.8	6.6	6.5	50	66	84	31	32	32
12	7.7	7.2	6.9	58	75	94	37	37	38
13	8.6	8.1	7.8	79	99	123	39	40	39
15	8.8	8.4	7.8	79	109	124	45	44	43

Figure 1. Mean Stand Height



Height Growth. (Figure 1) No significant impact on height growth was noticed across the range of planting densities in this study. This agrees with other spacing studies (Sharma et al 2002) that have shown height growth to be relatively constant across a broad range of intermediate densities, with declines in stand height growth only at extremely low densities (150 or less trees per acre) or extremely high densities (1000 or more trees per acre).

Figure 2. Mean Stand Diameter



Diameter Growth. (Figure 2). Up to age 6 or 7 there was little difference in mean tree dbh growth at the different spacings. Following crown closure inter-tree competition began to influence diameter growth to varying degrees according to planting density. By age 15 the 200 trees per acre spacing was one inch greater in diameter than the 400 trees per acre spacing.

Since many of the smaller trees in the 400 trees per acre spacing may be removed in a thinning, it may be useful to look at the diameters of the final crop trees. Figure 3 presents the mean diameter of the 125 largest diameter trees in each of the spacings at ages 12, 13 and 15. At age 15, the crop trees in the 200 trees per acre spacing have 0.6 inch advantage over the crop trees in the 400 trees per acre spacing. Inter-tree competition has already decreased the growth of the crop trees at the denser spacings.

Figure 3. Mean Crop Tree Diameters (largest 125 per acre)

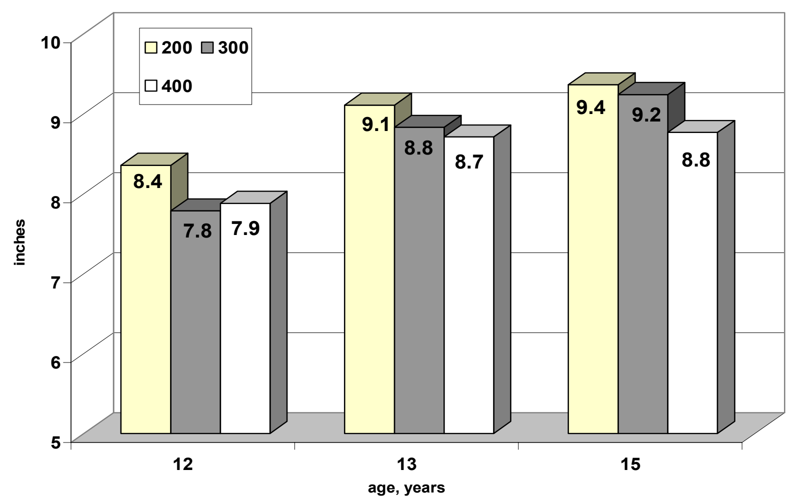
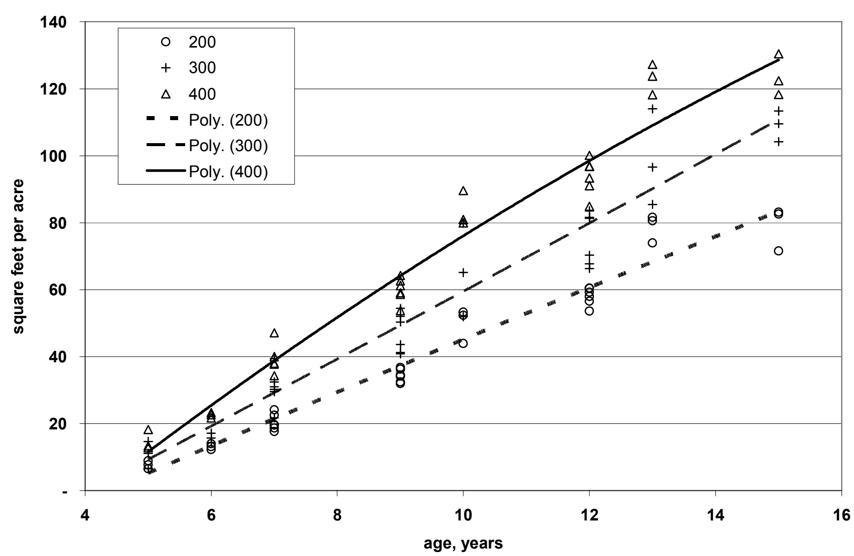


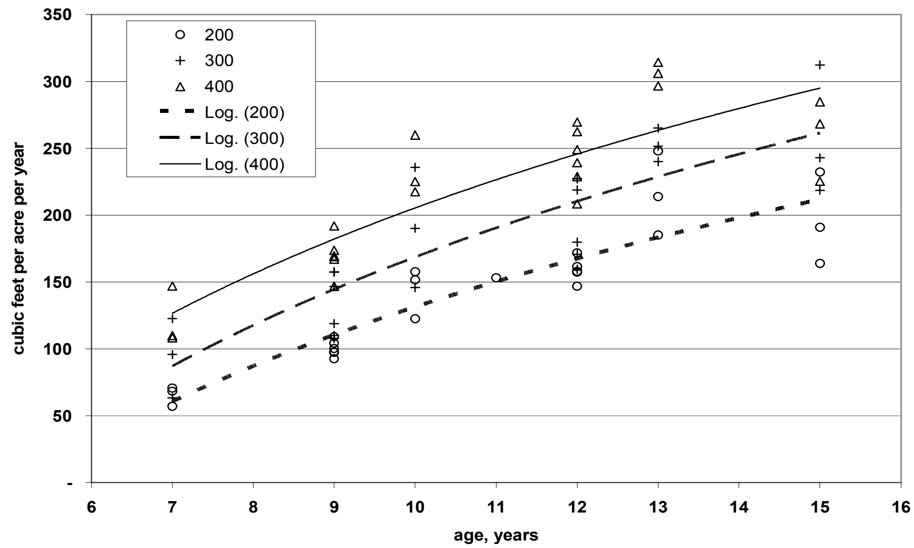
Figure 4. Basal Area Accumulation



<u>Basal Area Growth</u>. The higher stocking of the closer spacings resulted in greater basal area accumulation as would be expected. (Figure 4) At age 15 basal areas in the 400 trees per acre plots have exceeded 120 square feet per acre, while in the 200 trees per acre

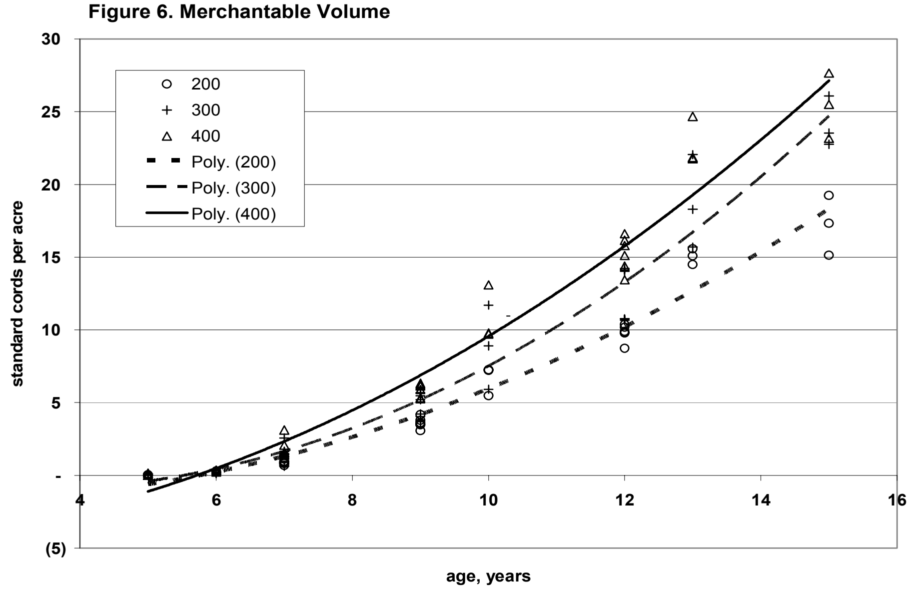
plots basal areas have just passed 80 square feet per acre. At 120 square feet per acre the 400 trees per acre plots are approaching the stocking level when a thinning will be necessary to maintain stand vigor, i.e. before exceeding 140 square feet per acre. The risk of bark beetle infestation also increases at this point.

Figure 5. Periodic Annual Increment



Volume Growth. As would be expected the higher stocking of the 400 trees per acre plots resulted in the highest periodic annual increment of the three densities at all ages. (Figure 5). Between ages 12 and 15, the periodic annual increment for the 200 density average just under 200 cubic feet per acre per year, while at the 400 density it averaged 260 cubic feet per acre per year. However, the 300 density average 258 cubic feet per acre per year, suggesting that it is close to a stocking level at which volume growth is near a maximum. Future measurements will be needed to confirm this.

Figure 6. Merchantable Volume



Merchantable volumes (4.5 minimum dbh and measured to a 4-inch top) are presented in Figure 6. At age 15 the 400 density, at 25 cords per acre, had 8 more cords of merchantable volume that the 200 density. However, the 300 density, at 24 cords, had only one cord less than the 400 density. Higher tree diameters at the lower densities are resulting in higher ratios of merchantable to total stem volume.

Crown Ratio. Clear bole height (height to first live limb) and crown ratio were measured on the 9 trees at the center of each plot at age 15. The means are presented in Table 4. Adequate (greater than 40 percent) crown ratio is being maintained at all three densities. As expected, crown recession has occurred faster on the 400 trees per acre density, but even at the 300 density the live crown has receded to the top of the first 16-foot log. While not measured, live branch diameters were ocularly estimated at each density. There did appear to be some increase in branch diameters at the lower densities, but even at the 200 density few branches have approached the 2-inch diameter that results in lumber degrade.

Table 4. Clear bole height and crown ratio at age 15.

Trees per acre	Clear Bole Height (feet)	Crown Ratio
200	13	71%
300	18	62%
400	20	57%

Discussion

This study has demonstrated that relatively low density plantings of genetically improved loblolly pine seedlings can result in well-stocked stands with high-quality crop trees with mean diameters of 8 to 9 inches by age 15. With merchantable volumes of 24 and 25 cords per acre the 300 and 400 trees per acre density stands could support a merchantable thinning at this time. With a mean stand height near 45 feet it may be necessary to wait 2 or 3 years to reach a more operable stand height of 50-60 feet. The current basal area and crown ratios indicate that waiting until age 17 or 18 would be feasible without losing stand vigor and ability to respond to thinning. If thinning is to be delayed 2 to 3 years, or longer, the 300 trees per acre stand may prove to yield as much as the 400 trees per acre stand, and will likely have greater stand vigor, residual crop tree diameter, and ability to respond to thinning and regain wind and ice-firmness quicker. The similarities of the 300 and 400 per acre stands indicate that planting densities anywhere in this range may be ideal for single thinning management regimes where thinning cannot be done until after 17 or 18 years of age.

The 200 trees per acre stand has the greatest diameter and stand vigor, and can be grown unthinned to a sawtimber harvest, or thinned for chip-and-saw products after 3-6 years additional growth and grown with approximately 100 crop trees per acre to a large diameter sawtimber harvest. This planting density may be an excellent choice for areas where intermediate harvests are not practical.

References

Schultz, Robert P. 1997. Loblolly pine: the ecology and culture of loblolly pine (*Pinus taeda* L.). Agriculture Handbook 713. Washington, D.C.: U.S. Department of Agriculture, Forest Service. 493 p.

Sharma, M., H. E. Burkhart and R. L. Amateis. 2002. Modeling the effects of density on the growth of loblolly pine trees. South. J. Appl. For. 26:124-133.