LOBLOLLY PRUNING AND GROWTH CHARACTERISTICS AT DIFFERENT PLANTING SPACINGS

J.C. Adams and T.R. Clason[1]

Abstract—In 1990, an abandoned farm pasture located on the Calhoun Research Station, Calhoun, Louisiana was planted in loblolly pine (*Pinus taeda L.*) at five different spacings. The spacings were 12X6, 12X8, 10X6, 16X6 and 24X6. Variables measured were DBH, height, branch diameter, height to first branch and first branch whorl, fusiform occurrence, and forking. Ice damage after an initial thinning was evaluated. The wider spacings generally produced trees with the largest limbs and the shortest height to retained limbs. The higher density stands produced slightly taller but smaller DBH trees. Fusiform and forking were significant but not related to the spacing density. The two highest density stands (10X6 and 12X6) were greatly affected after thinning by the ice storm in 2001. Overall the 12X8 spacing was the best for growth, pruning and had minimal damage when exposed to ice.

INTRODUCTION

Loblolly pine (*Pinus taeda* L.) is a fast growing conifer species with the ability to self-prune when growing in stands that have sufficiently dense competition. In stands that have lower planting densities the tendency is to retain limbs longer and produce larger limbs which leads to larger knot size and the production of lower lumber and plywood grades. The densities that produce the most desirable boles (knot free or small knots) do not optimize diameter growth and rapid production of high value saw and plywood logs. There is a fine line between planting density, natural pruning, sustained rapid growth, and yield of economically useable wood. An ideal spacing is one that profitably grows the smallest size usable tree (Smith and others 1997).

The question is, what is the optimum planting density that will maintain consistent growth rates and stimulate natural pruning, decreasing the number and size of limbs, and increasing the height to retained limbs? Also, initial spacing affects bole strength during early plantation development (Wiley and Zeibe 1991; Amateis and Burkhart 1996; Belanger and others 1996). Trees planted at wider initial spacings have slightly more taper are less likely to suffer the effect of strong winds and ice damage problems when thinned. The key to productive loblolly pine plantations is to maintain an acceptable growth rate and develop a strong central bole with enough intraspecific competition to facilitate natural pruning.

There is limited information on the development and loss of limbs at various spacings and the growth of the stands in diameter, height, and bole strength. A loblolly pine plantation planted at various spacings in north central Louisiana was used to evaluate the effect of various levels of competition on branching characteristics and tree growth.

METHODS

In February 1990, a loblolly pine plantation was established on the Calhoun Research Station, Louisiana Agricultural Experiment Station, Calhoun, Louisiana. The area had been part of a pasture and cattle management research program for several decades and was covered with bahiagrass, bermudagrass, and other forages. The soils are composed of approximately 50/50 Ora-Savannah and Ruston-Lucy associations. The Ora is a fine loamy, siliceous, semi active, thermic Typic Fragiudult, and the Savannah is a fine-loamy, siliceous, semi active, thermic Typic Fragiudult. The Ruston is a fine-loamy, siliceous, semi active, thermic Typic Paleudult, and the Lucy is a loamy, kaolinitic, thermic Arenic Kandiudult. These pastures had been limed and fertilized for forage production.

The site was originally planted to investigate straw production for the landscaping industry and the impact that the repeated removal of straw would have on the long-term site productivity. Five different planting densities were used to facilitate and evaluate the removal of the pine straw and the application of chicken litter as a fertilizer. They included 10X6, 12X6, 16X6, 24X6, and 12X8 foot spacing arrangements having initial seedling densities of 726, 605, 454, 302, and 454 seedlings/acre. These planting densities were duplicated over the 50-acre site. Planting stocks were

[1]Professor, School of Forestry, Louisiana Tech University, Ruston, Louisiana 71272; Professor, Louisiana State University Agricultural Center, Hill Farm Research Station, Homer, Louisiana 71040.

Citation for proceedings: Outcalt, Kenneth W., ed. 2002. Proceedings of the eleventh biennial southern silvicultural research conference. Gen. Tech. Rep. SRS–48. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 622 p.

commercially available, genetically improved seedlings and were machine planted. Herbaceous weed control in the row was done with a herbicide tank mixture of oust/velpar.

In 1999, the stand was measured for natural pruning and growth characteristics. No fertilizer had been applied or straw removed prior to the initiation of the measurements. Four one-tenth acre plots were randomly selected and measured in each of the spacings. Measurements taken were height to the first limb stub, height to the first live limb, height to the first branch whorl, diameter of whorl limbs, DBH, total height, height to first fork, and occurrence of fusiform rust. The design was a completely randomized with five treatments. Analysis of variance was done to determine significance and Duncan's Multiple Range Test was conducted for means separation (SAS 1995).

RESULTS AND DISCUSSION

Limb Height Characteristics

The height from the ground to the first non-pruned dead limb was significant (P > 0.05)(table 1). The 10X6 had the greatest height (1.36 ft.) to the first dead branch and the 12X8 had the least (1.15 ft.). However, the difference between the largest and smallest mean was only 0.21 inches, which has little impact on stand development.

The height to the first live limb and first whorl were both significant (P<0.05). The emerging pattern was expected, and natural pruning was less on wider spaced (table 1). The height to the first live limb was greatest in the 12X6 (12.1 ft.) and the least was in the 24X6 (7.3 ft.). The height to the first whorl was similar with the 10X6 having the greatest height (14.8) and the 24X6 having the least height (9.9).

Branch and Stem Diameter

The size of the live branches was related to planting density, wider the spacing the greater the branch diameter (table 1). Branch diameter was significant (P<0.05) with a range from 0.70 for the 10X6 spacing to 0.94 for the 24X6 spacing, a considerable size difference for nine-year-old trees.

Total Height and DBH

Mean total height among planting densities differed significantly (P<0.05) (table 2). The widest spacing, 24X6, had the shortest trees (27 feet), which can be attributed to the lack of competition causing wide crown architecture and short trees. The 12X8 had the tallest trees with a mean height of 36 feet. The other three spacings were intermediate. These trees are only nine years old and, with the exception of the widest spacing, the spacings are becoming less variable over time and will probably reach an equality in height in a few years. This would follow the pattern described by Barnes and others (1998) on the use of height as an indicator of site and the use of height as the major component in site index determinations.

DBH differed significantly among planting densities (P<0.05)(table 2). Mean DBH on the 12X8 spacing exceeded all other planting densities with the 10X6 and 12X6 having the smaller DBH. Since diameter is sensitive to intraspecific competition, this was expected. However, DBH on the widest spacing (24X6) ranked third among treatments and was significantly smaller than the 16X6 DBH. The unusual competition pattern with competition rectangles of 6 feet on one side and 24 feet on the other may have influenced tree growth on the 24x6 spacing.

Fusiform, Forking and Ice Damage

Fusiform and forking were present in the stand with approximately 22 percent of the stems damaged by fusiform and approximately 20 percent having a fork. Although there were significant differences between the spacings for the occurrence of fusiform and forking, there appeared to be no pattern between fusiform and spacing and between forking and spacing. The initial hypothesis was that the density of spacing might affect the movement of the fusiform spores and thus cause differing infection rates. The 12x6 and 16x6 spacings had the highest infection rate while the 10x6 spacing had one of lower infestation rates and the 24X6 spacing had the lowest infection rate (table 2). Thus the hypothesis was rejected and there is no pattern in this stand for fusiform infestation. Forking appeared to be uniform among the spacings except for the 12X6, which had a significantly lower forking rate. However, this appears to be chance and no pattern was detectable.

Table 1—Height to limbs and diameter of live limbs in stands with different spacing densities

Spacing	Height First Live Limb	Height First Live Whorl	Height Diameter of	Diameter First Live limb
	----------------	Feet	----------------	Inches
12X8	1.15[b]	10.8[b]	13.1[bc]	0.82[bc]
12X6	1.22[b]	12.1[a]	13.4[b]	0.76[c]
10X6	1.36[a]	11.9[a]	14.8[a]	0.70[d]
16X6	1.35[a]	9.6[b]	12.9[c]	0.86[b]
24X6	1.16[b]	7.3[b]	9.9[d]	0.94[a]

Means followed by the same letter are not significantly different at the P<0.05 probability level.

Table 2—DBH, total height, fusiform, and forking occurrence and ice damage in stands of different spacing densities

Spacing	DBH	Height	Fusiform	Forking	Unsalvageable
	inches	feet	------------------Percent--------------------		
12x8	7.2[a]	36[a]	20	23	5
12x6	6.3[c]	32[c]	29	11	25
10x6	5.8[d]	34[b]	18	27	41
16x6	7.0[ab]	32[c]	29	20	7
24x6	6.7[b]	27[d]	14	20	2

Means followed by the same letter are not significantly different at the $P < 0.05$ probability level.

After the measurements were completed the stand was row thinned with individual selection within the rows (summer 2000) to bring standing density to 200 trees/acre or to a basal area of 50 to 60 $feet^2$/acre. In December 2000, two consecutive ice storms occurred in the thinned stands. The results were very dramatic. Trees in the two higher planting densities (10X6 and 12X6) were damaged significantly, 41 and 25 percent of the respective stems non-salvageable because of breakage of the main bole or extreme, non-recoverable bending of the main stem. Non-salvageable stems on the other three densities average five percent or less. Wider spaced trees had significantly larger diameters and apparently stronger central stems than the trees planted at the closer spacings. This resulted in the considerably less ice damage in the wider spaced stands, and these stands will continue to grow and produce whereas the high-density stands will have to be replaced.

CONCLUSIONS

Although these stands were originally designed for access in needle collection and poultry litter application, the different initial spacings and their growth provide some insight into the development of the various density stands. Generally, trees planted at wider spacings had shorter retained limb distance, larger limb diameter and larger tree diameters. The widest spacing (24x6) reduced height growth; trees had wider, shorter crowns and were generally rough in appearance. The two denser stockings (10X6 and 12X6) received severe damage in an ice storm, which suggests the central stems were weaker than trees in the wider spaced treatments. Overall the 12X8 spacing with 454 initial seedlings per acre had the best combination of traits measured. Trees in the 12X8 spacings had better growth, form, natural pruning and were more resistant to ice damage**.** This study does not support the common view that large numbers of trees (700-800) are required and necessary to adequately regenerate stands. It does support the concept of ensuring that strong trees make continuous fast growth with enough competition to enhance form but not cause weakened stand.

REFERENCES

Amateis, R. L.; H. E. Burkhart. 1996. Impact of heavy glaze in a loblolly pine spacing trial. Southern Journal of Applied Forestry. 20(3): 151-155.

Barns, B. V.; D. R. Zak; S. R. Denton; S. H. Spurr. 1998. Forest Ecology. New York: John Wiley and Sons, Inc. 774 p.

Belanger, R.P.; J. F. Godbee; R. L. Anderson; J. T. Paul. 1996. Ice damage in thinned and unthinned loblolly pine plantations infected with fusiforn rust. Southern Journal of Applied Forestry. 20(3): 136-140.

Smith, D. M.; B. C. Larson; M. J. Kelty; P. M. S. Ashton. 1997. The Practice of Silviculture: Applied Forest Ecology. New York: John Wiley and Sons, Inc. 537 p.

Wiley, S.; KB. Zeide. 1992. Development of a loblolly pine plantation. Arkansas Agricultural Experiment Station Report Series. 322 p.