Effects of Intensive Forest Management on Wood Quality of Loblolly Pine

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Intensive forest management practices are being applied to improve growth and profitability of plantation grown southern pines, but minimal attention is being paid to the impact of intensive cultural practices on wood quality. In order for the southern pine industry to maintain its competitive position in the global market it must produced wood from intensively managed plantations with the properties required meet product standards. Young fast growing plantation southern pines contain large volumes of juvenile wood. Juvenile wood is characterized as having low specific gravity, short trachieds, large microfibril angles, and low strength and stiffness compared to mature wood. To determine the effect of intensive forest management on loblolly pine (*Pinus teada* L.) wood quality the Wood Quality Consortium has sampled replicated silvicultural studies across the south

METHODS AND RESULTS

The effect of controlling competing vegetation for the first 3 to 5 years after planting on annual growth, specific gravity, and length of juvenility was examined by sampling the Auburn University Silvicultural Herbicide Cooperative COMP study (Miller et al, 1991). The study was sampled at age 15 at 13 locations across the south. Results show that controlling woody plus herbaceous competition did significantly increase growth, did not significantly reduce ring specific gravity and did not significantly affect the proportion of latewood in the annual ring (Clark et.al, 2006). Woody plus herbaceous competition control did significantly increase growth during juvenile wood formation at breast height in years 1 to 5 and thus increased the diameter of the juvenile wood core by an average of 19 percent. The long-term impact of site preparation, competition control, fertilization and competition control plus fertilization at planting was examined at four installations of the Regionwide 7 Study (NCSFNC, 1996). The study was established in 1978 to 1981 by the North Carolina State Forest Nutrition Cooperative and sampled in 2002. Fertilization (49 Kg N per hectare plus 56 Kg P per hectare) was applied at planting and weed control was applied for two years after planting. Results show individual tree volumes were increased up to 33 percent by competition control plus fertilization compared to site preparation only. Competition control for two years after planting plus fertilization at planting did not significantly affect wood specific gravity, proportion of latewood or wood strength or stiffness (Mora, et al, 2006). The effect of intensive site preparation, annual vegetation control, annual high rates of nitrogen fertilization (168 Kg ammonium nitrate/hectare/year) on tree growth and wood properties was examined by sampling a long term monitoring study at age 12. The study was established in 1987 in the Coastal Plain and in 1988 in the Piedmont of Georgia by the University of Georgia Consortium for Accelerated Pine Production (Borders and Bailey 2001). In response to annual intensive cultural treatments, growth increased 270 percent in the Coastal Plain and 158 percent in the Piedmont compared to the intensive mechanical site preparation treatment. Annual ring earlywood specific gravity was not affected by

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treatments, but annual ring latewood specific gravity was significantly reduced in annually fertilized and herbicide plus annually fertilized trees (Clark et al, 2004). Annual heavy fertilization alone or in combination with vegetation control significantly reduced toughness, strength and stiffness of juvenile wood.

To examine the effect of different levels of nitrogen fertilization at mid-rotation on wood properties the North Carolina State Forest Nutrition Cooperative Regionwide 13 Study installation near New Bern, NC was sampled in 2003 (NCSNC, 1997). The study trees were planted in 1970 and thinned in 1983 to 605 TPH and fertilizer treatments were applied in the spring of 1984. The fertilization treatments sampled include: 28 Kg P per hectare (control), 112 Kg N + 28 Kg P per hectare; 224 Kg N + 28 Kg P per hectare, and 336 Kg N + 28 Kg P per hectare. Results show that increased levels of N increased annual growth for 3 to 4 years after treatment. Increased levels of N fertilization did not significantly affect the proportion of latewood in the annual ring but did significantly decrease the specific gravity of the latewood. 112 and 224 kilograms of N fertilizer per hectare did not significantly reduce wood specific gravity, strength or stiffness but 336 Kg of N per hectare at mid-rotation resulted in a significant reduction in wood specific gravity, strength and stiffness in wood formed 2 to 3 years after fertilization.

A 20 year old unthinned spacing study was sampled to determine the effect of initial planting density on tree growth and wood properties. The study was established in the Coastal Plain of Georgia in1984 on an excellent site (SI=27 meters base age 25) with loblolly pine family 7-56 seedlings. Seven planting densities (1.8 x 2.4-, 1.8 x 3.0-, 1.8 x 3.7-, 2.4 x 3.0-, 2.4 x 3.7-, 3.0 x 3.7-, 3.7 x 3.7- meters) were sampled. Twenty one trees per spacing were felled, all branches were measured and trees were destructively sampled for wood properties. Tree survival increased with increased spacing and ranged from only 65 percent survival at age 20 for the 1.8 x 2.4 meters spacing to 90 percent survival for the 3.0 x 3.7- and 3.7 x 3.7- meter spacings. Stem taper as measured by Girard form class increased from an average of 75 for the 1.8 x 2.4-meters spacing to 78 for 2.4 x 3.7-meter spacing and then decreased to an average of 76 in the 3.7 x 3.7 feet spacing. Tree average dbh increased with increased spacing and ranged from 24.1 centimeters in the 1.8 x 2.4 meter spacing to 29.7 centimeters in the 3.7 x 3.7 meter spacing. Average total height increased only slightly with increased spacing ranging from 25 meters in the 1.8 x 2.4 meter spacing to 26 meters in the 3.7 x 3.7 meter spacing. However, the height of the sawlog merchantable stem to a 15.2 centimeter dob top increased significantly with increased spacing. Sawlog merchantable height averaged 12 to 13 meters in the 1.8 x 2.4-, 1.8 x 3.0-, 1.8 x 3.7- and 2.4 x 3.0- meter spacings compared to 15- to 16- meters in the 2.4 x 3.7-, 3.0 x 3.7- and 3.7 x 3.7-meter spacings. Total merchantable stem biomass/hectare was highest in the 1.8 x 3.7-, 2.4 x 3.7- and 2.4 x 3.0-meter spacings. Estimated volume of lumber/hectare was highest in the 2.4 x 3.7-meter spacing, slightly lower in the 3.0 x 3.7- and 3.7 x 3.7- meter spacings and lowest in the 1.8 x 2.4 meter spacing. Average knot diameter per 4.9 meter sawlog did not increase with increased spacing but average number of knots and average maximum knot diameter per sawlog increased with increased spacing. The diameter of knots on the side of the stem within the row and between rows did not vary significantly. Initial planting density did not significantly affect annual ring specific gravity or the proportion of latewood in the annual ring. Initial spacing did not significantly affect wood strength or stiffness.

SUMMARY

Based on the studies sampled competition control and competition control plus fertilization at planting can significantly increase growth with no significant effects on wood properties. However, heavy annual fertilization or heavy mid-rotation fertilization with 336 Kg N or more per hectare can significantly reduce latewood specific gravity and thus significantly reduce wood stiffness and strength. Average knot diameter, wood specific gravity, strength or stiffness did not vary significantly with initial planting densities ranging form 1.8 x 2.4- to 3.7 to 3.7- meters on an excellent site in the Coastal Plain. Initial planting densities of 2.4 x 3.7-, 3.0 x 3.7-, 3.7 x 3.7- meters per hectare yielded the highest volume of lumber per hectare at age 20 from unthinned loblolly pine stands .

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