CULTURAL INTENSITY AND PLANTING DENSITY EFFECTS ON INDIVIDUAL TREE STEM GROWTH, STAND AND CROWN ATTRIBUTES, AND STAND DYNAMICS IN THINNED LOBLOLLY PINE PLANTATIONS DURING THE AGE 12- TO AGE 15-YEAR PERIOD IN THE UPPER COASTAL PLAIN AND PIEDMONT OF THE SOUTHEASTERN UNITED STATES

Evan Johnson, Michael Kane, Dehai Zhao, and Robert Teskey[1]

Three existing loblolly pine (*Pinus taeda* L.) installations in the Plantation Management Research Cooperative's Upper Coastal Plain/Piedmont Culture Density Study were used to examine the effects of two cultural intensities, four initial planting densities, and their interactions on stem growth at the individual tree level from age 12 to 15 years and at the stand level in thinned plantations during the age 13 to 15 year period. These plots were also studied to determine how treatments affected crown characteristics such as leaf area index (LAI), specific leaf area (SLA), intercepted photosynthetically active radiation (IPAR), and foliar nitrogen concentration and content. The two cultural intensities include maximum intensity, which consisted of sustained competing vegetation control and frequent fertilization and operational intensity, which consisted of less frequent competing vegetation control and fertilization.

The four planting densities were 740; 1,480; 2,220; and 2,960 trees ha^{-1}. Each installation of three planting densities (1,480; 2,220; and 2,960 trees ha^{-1}) was thinned during the age 12 dormant season. These plots were thinned to the same trees ha^{-1} on the 740 trees ha^{-1} density sites with corresponding cultural intensities.

There were no significant effects of culture or culture x density treatments on any individual tree-level or stand-level attribute (table 1) measured during the 14^{th} or 15^{th} year. Density had a significant effect on many post-thin attributes. Crown attributes were mainly stable during the time period analyzed. The general stand-level density trends were that trees planted at 740 trees ha^{-1} were largest, followed by 1,480 trees ha^{-1}; then 2,220 trees ha^{-1}; and finally 2,960 trees ha^{-1}. Stand level-stem attributes in thinned plots continued to increase and approach attribute measures on the non-thinned low-density counterpart (fig. 1). No significant effects were detected on growth efficiency measures, but growth efficiencies were greater under operational culture when soil nutrition was sufficient. Individual tree-level diameter at breast height growth post-thinning was greater in higher densities but declined in the highest density, due to the initial size of individual trees relative to others in plots of the same density and also due to ongoing crown development in the highest density at age 15. These results indicate that when site resource availability is adequate or abundant, density has greater effects on stem, crown, and growth efficiency attributes than culture on these installations during the time period analyzed.

[1]Graduate Research Assistant, Professor, Research Scientist, and Distinguished Research Professor, respectively, University of Georgia, Warnell School of Forestry and Natural Resources, Athens, GA 30602.

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Table 1—P-values for the effects of culture, density, and their interactions on mean stem, crown, and efficiency attributes on three thinned loblolly pine installations during the 14th and 15th growing seasons and at ages 14 and 15

	--14th growing season and age 14--			--15th growing season and age 15--		
	Culture	Density	Interaction	Culture	Density	Interaction
Stem attributes						
D.b.h.	0.1466	0.0001	0.3808	0.1240	<0.0001	0.5263
Total stem height	0.3886	0.3695	0.5261	0.3741	0.3154	0.2639
Total stem volume ha^{-1}	0.2000	0.0001	0.5621	0.1824	<0.0001	0.7811
BA ha^{-1}	0.1435	0.0001	0.5258	0.1273	<0.0001	0.6227
Current density	0.3315	0.3317	0.6842	0.3266	0.2196	0.7295
Gross CAI	0.1929	0.0055	0.5615	0.1917	0.5225	0.1643
New CAI	0.1816	0.9149	0.8455	0.3239	0.4117	0.5504
Crown attributes						
Live crown length	0.8100	0.0003	0.9993	0.2294	0.0541	0.3806
Crown ratio	0.2170	0.0002	0.8255	0.9644	0.1399	0.1998
SLA	0.2788	0.4355	0.3681	---	---	---
Foliar N concentration	0.2959	0.0001	0.1404	---	---	---
Foliar biomass	0.2312	0.0001	0.7527	0.3364	0.0026	0.6889
LAI	0.1816	0.0001	0.6526	0.2419	0.0038	0.6551
Foliar N content	0.0700	0.0001	0.5277	0.2614	0.0001	0.6453
IPAR	---	---	---	0.1317	0.0008	0.1252
Efficiency attributes						
GE_{FOLBIO}	0.4585	0.4919	0.2958	0.6926	0.2018	0.5126
GE_{LAI}	0.3754	0.6887	0.5890	0.6076	0.2152	0.6315
NUE	0.1531	0.3110	0.3400	0.5707	0.0730	0.6334
IPAR efficiency	0.2194	0.0001	0.0904	0.2719	0.3958	0.1749

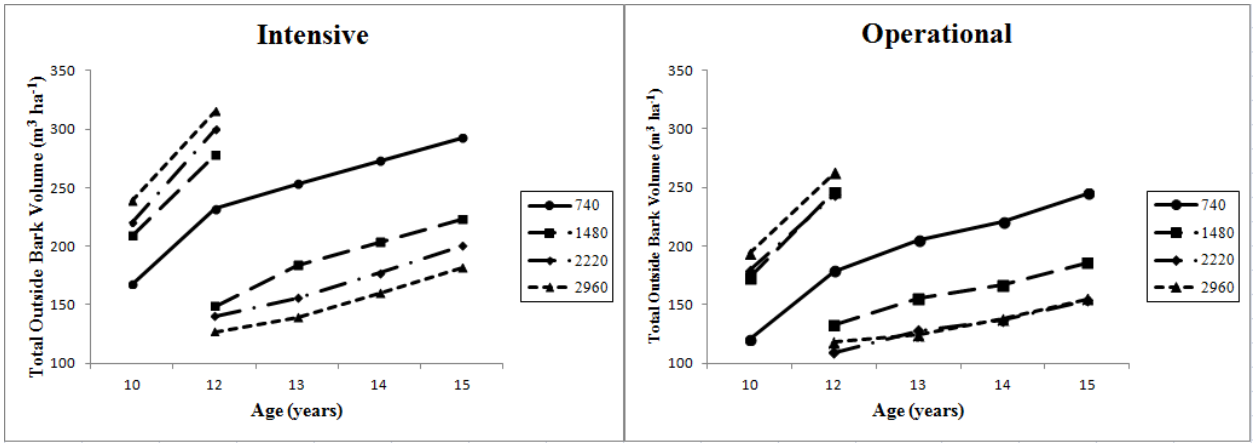

Figure 1--Total volume in thinned installations from age 10 to age 15.