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Cultural intensity and planting density effects on aboveground biomass of 12-year-old loblolly pine trees in the Upper Coastal Plain and Piedmont of the southeastern United States

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ABSTRACT

We examined the effects of cultural intensity (operational and intensive), planting density (741, 1483, 2224, 2965, 3706 and 4448 trees ha^{-1}) and their interaction on aboveground biomass accumulation and allocation for 12-year-old loblolly pine (*Pinus taeda* L.) trees in the Upper Coastal Plain and Piedmont of the southeastern United States. Cultural intensity significantly affected accumulation of stem, bark, dead-branch and total aboveground biomass and biomass allocation in the dead-branch component. Accumulation of total aboveground biomass and each component biomass and biomass allocation to each component were significantly affected by planting density. The only significant culture × density interaction was for dead-branch biomass accumulation.

1. Introduction

Loblolly pine plantations in Georgia and Alabama comprise approximately 4 million hectares. With a total land area of approximately 21 million hectares, the Upper Coastal Plain and Piedmont of Georgia and Alabama are major regions where loblolly pine (*Pinus taeda* L.) plantation management has been carried out for more than four decades. Loblolly pine dominates well drained sites in the Coastal Plain and disturbed sites in the Piedmont (Hodler and Schretter, 1986).

Research on forest biomass production has been conducted over the past four decades to better understand timber production potential, ecosystem productivity, energy and nutrient flow, and forestland contribution to the global carbon cycle (Zeide, 1987; Waring and Running, 1998; Parresol, 1999). Particular interest has been directed towards carbon (C) stocks in forests because these ecosystems are the main terrestrial sinks for C (Murias et al., 2006). Recently, there has been a renewed interest in biomass research due to the need to predict forest C stocks and the potential amount of biomass available as a source of energy (Moore, 2010). It is important to quantify forest biomass to assess forest productivity and C sequestration because approximately 50% of the tree dry biomass is C (Losi et al., 2003).

The effects of fertilization and irrigation (Albaugh et al., 1998; King et al., 1999; Jokela and Martin, 2000), competition control (Colbert et al., 1990), planting density (Baldwin et al., 2000; Burkes et al., 2003; Ares and Brauer, 2005), and age (Larsen et al., 1976; Pehl et al., 1984; Van Lear and Kapeluck, 1995) on loblolly pine biomass accumulation and allocation have been extensively studied. The results show that biomass accumulation and allocation to different components of the tree are affected by resource availability and age. Overcoming resource deficiencies causes greater biomass allocation to aboveground components at the expense of roots (Linder, 1989; Albaugh et al., 1998; Coyle et al., 2008). In the humid southeastern United States, nutrition is often a more limiting factor for pine growth than moisture (Jokela et al., 2004), and fertilization, spacing, and competition control are key practices for managing site nutrition and improving biomass production. Accurate estimates of biomass accumulation and allocation to components are needed to better estimate potential yield for different products. While much research has focused on the cultural intensity or planting density effects on stem biomass accumulation (Quicke et al., 1999; Carlson et al., 2009; Zhao et al., 2011), relatively less is known about the effects of planting density, cultural intensity, and their interaction on biomass accumulation and allocation.

The present study examined the effects of different cultural regimes and planting densities on aboveground biomass accumulation and allocation in 12-year-old loblolly pine trees. The following two hypotheses were examined: (i) culture, density, and their interaction have significant effects on aboveground biomass accumulation of loblolly pine trees: (ii) culture, density, and their interaction have significant effects on the biomass allocation to aboveground components of loblolly pine trees.

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