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Growth responses to planting density and management intensity in loblolly pine plantations in the southeastern USA Lower Coastal Plain

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Abstract

• **Background** A culture/density study was established in 1995 in the Lower Coastal Plain of the southeastern USA to evaluate the effects of intensive silviculture and current operational practices on the growth and yield of loblolly pine plantations across a wide range of planting densities (741–4,448 trees/ha). The operational regime consisted of bedding and herbicide application in site preparation and fertilizer applications at planting and in the eighth and 12th growing seasons. The intensive management regime had additional complete competition control, tip moths control, and more repeated fertilization treatments.

• **Methods** The data from 14 locations from this split-plot experiment design with repeated measurements were analyzed with a mixed-effects model approach in terms of average DBH, average height, average dominant height, survival, stand basal area, and stand volume.

• **Results** In the first few years after planting, there were no significant effects of management intensity and planting density. In later years, both management intensity and planting density significantly impacted response variables, and their interaction was only significant for average diameter at breast height (DBH). Responses to intensive management in DBH were greatest at the lowest planting densities. Intensive management resulted in larger average DBH, average height, dominant height, stand basal area, and volume. Intensively managed plots had more mortality at age 12. There were negative average DBH, average

height, dominant height, and survival responses but positive stand basal area and volume responses to increasing planting density. However, there were no significant differences for planting densities above 2,224 trees/ha.

• **Conclusions** The results demonstrate that both management intensity and planting density significantly affect loblolly pine productivity in the Lower Coastal Plain, and their effects are additive in nature due to the general lack of interactions.

Keywords Intensive forest management · Vegetation control · Fertilization · Split-plot with repeated measurements

1 Introduction

Loblolly pine (*Pinus taeda* L.) is the most common and commercially important species in the southeastern USA. Industrial forest landowners in this area have experienced an increasing pressure to maximize the volume per hectare production from loblolly pine plantations due to the increasing demand for wood products from a decreasing wood production land base. Intensive silvicultural treatments including deployment of genetically improved seedlings, site preparation, competing vegetation control, and fertilization are commonly used to enhance productivity and reduce rotation length in loblolly pine plantations (Martin and Jokela 2004). Several silvicultural studies have reported significant gains in pine growth and yield due to tree improvement and more intensive management practices (e.g., Zutter and Miller 1998; Shiver and Martin 2002; Martin and Shiver 2002; Miller et al. 2003; Nilsson and Allen 2003; Land et al. 2004; Borders et al. 2004; Zhao et al. 2008a; Zhao et al. 2009a, b).

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