Early gains from planting large-diameter seedlings and intensive management are additive for loblolly pine

DAVID B. SOUTH1, JAMES L. RAKESTRAW2 and GEORGE A. LOWERTS2
1School of Forestry and Wildlife Sciences and Alabama Agricultural Experiment Station, Auburn University, AL 36849-5418, USA; 2Union Camp Corporation (now International Paper), PO Box 1391 Savannah, GA 31402, USA

Accepted 10 August 2000

Key words: establishment, fertilizer, herbicide, insecticide, seedling quality, silvicultural interactions, transplant stress index

Abstract. A seedling size/intensive management study with Pinus taeda L. was established in 1993 on two sites in the Coastal Plain of Georgia and South Carolina. Each site contained a 2 × 2 split-plot study involving two seedling sizes and two levels of establishment intensity. Ideotype “B” seedlings averaged 5.0 mm in diameter (at the root collar) and were 43 cm tall. Ideotype “A” seedlings averaged 8.5 mm in diameter and were 50 cm tall. “Standard” establishment practices included herbicides (hexazinone and sulfometuron) and fertilizer (DAP) applied during the first year. The “intensive” management involved two herbicide applications during the first year and two during the second year, fertilizer during the first and third years, and insecticide applications during the first two years (for control of tip moth, Rhyacionia frustrana Comstock). Intensive management did not affect survival but planting larger seedlings increased survival slightly on one site. However, treatments affected early growth at both sites. On both sites, fourth-year plot-volumes were increased with greater establishment intensity and larger seedlings but there was no interaction between stock size and establishment intensity. Early growth gains were greatest when both intensive management and larger seedlings were combined. Depending on site, this combination resulted in 21% to 51% more volume (at age 4) than the next best treatment (standard seedlings with intensive management).

Introduction

Loblolly pine seedlings produced at many nurseries in the southern United States often have an average root-collar diameter (RCD) at lifting of less than 4 mm (South and Barnett 1986; Barnett and McGilvary 1993; Miller et al. 1995; Cram et al. 1997; Sung et al. 1997). This size of seedling has been commonly produced for several reasons. Traditionally, this is the size that
most nursery managers have been told to produce for more than 50 years (Cossitt et al. 1949). Those in charge of budgets know it is less expensive to produce seedlings at 300 m$^{-2}$ than to produce larger seedlings at 150 m$^{-2}$. In addition, planters who are paid by the tree prefer to plant seedlings with small roots. A shallow planting hole will usually accommodate small roots while preparing a wide and deep planting hole by hand would reduce planter productivity (Blake and South 1991; Harrington and Howell 1998). Since the tree planter’s salary is typically not based on high survival or early growth, low field performance of seedlings can result when “target” seedling characteristics are based mainly on hand-planting efficiency. Therefore, at several nurseries, the “target” RCD for loblolly pine is less than 4 mm.

In contrast, some regeneration specialists believe that seedling price and planting cost should not be the sole criterion on which seedling characteristics are based. Some believe that tree size at planting can affect the quantity of wood produced at age 12 to 15 (South et al. 1985; South 1993; South et al. 1995). As a result, some organizations have grown seedlings at low seedbed densities for several years. However, only a few regeneration studies in the South have compared the gains from intensive management with the gains from improved nursery practices (Barber et al. 1991). Therefore, two studies were established to test for an interaction between seedling ideotype and intensive management.

Materials and methods

Seed from a half-sib family were sown at the Union Camp Nursery in Bellville, Georgia in the spring of 1992. Different nursery management regimes were used to produce two ideotypes (type A and B). Type “B” seedlings were typical of operational 1+0 seedlings from the Bellville Nursery. They were grown at a seedbed density of approximately 280 m$^{-1}$ and were fertilized during the growing season. The total amount of nitrogen applied to ideotype B seedlings was 336 kg ha$^{-1}$ of nitrogen (as ammonium nitrate). They had an average RCD of 5.0 mm and shoot heights averaged 43 cm. Type “A” seedlings were grown at a density of 205 m$^{-2}$ with RCD and heights averaging 8.5 mm and 50 cm, respectively. In addition to operational nitrogen fertilization, four weekly applications of 21 kg ha$^{-1}$ of nitrogen (as ammonium nitrate) were applied beginning the first week of November. Therefore, the total amount of nitrogen applied to ideotype A seedlings was 420 kg ha$^{-1}$.

On January 11, 1993, seedlings were hand-lifted, measured for height and RCD, individually tagged, and then placed in temporary cool storage. Type “B” seedlings larger than 6 mm RCD were not outplanted. Likewise, Type