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Stock Type, Subsoiling, and Density Impact Productivity and Land Value of a Droughty Site

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ABSTRACT

Management practices that overcome low seedling survival and poor tree growth of well-drained, droughty sites can improve their productivity and profitability. This study was established to explore tree and stand growth trends, potential forest product yields, and land expectation values of loblolly pine on a droughty site in response to (1) seedling stock type, (2) subsoiling, and (3) stand density regime. In winter 1993, container (CONT) and bareroot (BARE) seedlings were planted with or without subsoiling at 746 trees per hectare (TPH). BARE seedlings were planted without subsoiling at 1,493 TPH to provide a comparison between low-density treatment combinations and a conventional (CONV) management regime for this site type. Tree growth was monitored periodically through age 13 years. Yield trajectories were estimated by predicting forest product yields with FASTLOB using age 13 years stand characteristics, and land expectation value was determined from revenue predictions and costs associated with each treatment. Low-density regimes that included CONT seedlings or subsoiling before BARE seedling planting improved tree growth through midrotation and had yield estimates comparable with that of a CONV regime. However, land expectation values associated with subsoiling were lower than those of low-density CONT and CONV regimes because of its cost and negligible benefits for seedling survival.

Keywords: loblolly pine, container seedlings, tillage

The southeastern United States is a predominant producer of the world's timber products, in part because of increasing pine plantation productivity via intensive silviculture (Prestemon and Abt 2002, Allen et al. 2005). To maintain its competitiveness, further increases in productivity will be necessary because world demand for forest products is anticipated to escalate in the coming decades in tandem with human population growth (Youngquist and Hamilton 2000, Allen et al. 2005). However, returns on investment for intensive silvicultural practices are under increasing scrutiny as some costs (e.g., labor, equipment, and fuel) rise, the timber market becomes more volatile, and forest ownership in the region shifts from forest products companies to investment groups (Yin and Caufield 2002, Smidt et al. 2005).

Well-drained soils are among the most problematic on which to establish productive and profitable loblolly pine (*Pinus taeda* L.) plantations. Poor loblolly pine survival and growth are often exhibited on such soils because of inadequate soil moisture supply and retention (Pritchett and Fisher 1987, Allen et al. 2005). Forest managers commonly plant at relatively high densities (more than 1,700 trees per hectare [TPA]) on droughty sites in anticipation of survival problems. However, this tendency to plant surplus seedlings potentially reduces economic returns by raising planting costs and decreasing average diameter growth rates (Dean and Chang 2002a). Reduced diameter growth results in the development of fewer trees in relatively valuable chip-and-saw and sawtimber product classes during the rotation, which can reduce profitability (Clason 1994, Dean and Chang 2002a, Harris et al. 2004).

Low-density plantation management regimes can improve profitability of pine plantation management by reducing planting costs and emphasizing sawtimber growth (Clason 1994). Low-density regimes effectively improve productivity of inferior sites when measures are taken to overcome early mortality problems (Schultz 1997). Pine survival and growth on marginal sites can be markedly increased by planting container (CONT) seedlings (Barnett 1984, South et al. 2005). CONT stock is often superior to bareroot (BARE) stock on adverse sites because of their intact root systems, which reduce transplanting shock (Barnett 1984). CONT seedlings typically cost three times more than BARE stock, but planting relatively fewer seedlings as part of a low-density management regime may offset this extra expense. Subsoiling can increase loblolly pine drought survival and height growth on well-drained sites by breaking up soil layers, concentrating organic matter near seedlings, and improving soil aeration and water-holding capacity (Wittwer et al. 1986, Fallis and Duzan 1995). Planting on relatively wide rows (more than 5.5 m) as part of a low-density regime reduces subsoiling costs by reducing the number of passes per site (Smidt et al. 2005). Similarly, planting on wide rows decreases herbicide application costs because wide rows are conducive to band applications (VanderSchaaf and South 2004). Improvements in southern pine plantation survival and growth in response to herbicide treatments have been well established (Clason 1991, Lauer and Glover 1998, Zutter and Miller 1998).

Despite the potential benefits of a low-density management regime for well-drained sites, there are potential risks. Stands planted with relatively low densities take longer to reach crown closure,

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