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Nursery response of container *Pinus palustris* seedlings to nitrogen supply and subsequent effects on outplanting performance

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ABSTRACT

Container longleaf pine (*Pinus palustris*) seedlings often survive and grow better after outplanting than bareroot seedlings. Because of this, most longleaf pine are now produced in containers. Little is known about nursery fertilization effects on the quality of container longleaf pine seedlings and how that influences outplanting performance. We compared various fertilization rates (0.5, 1, 2, 3, or 4 mg nitrogen (N) per week for 20 weeks) for two crops (2004 and 2005) of container longleaf pine, grown inside a fully-controlled greenhouse (2004 and 2005) or in an outdoor compound (2005). Seedlings grew larger in the nursery with increasing amounts of N. After 20 weeks of fertilizer treatment, seedlings received two additional fertigations at the same treatment rate to promote hardening, N concentrations declined sharply, and seedlings shifted biomass production toward roots. Overall, shoots showed more plasticity to N rate than did roots. Survival of either crop after outplanting was unaffected by nursery N rate. For both crops, no seedlings emerged from the grass stage during the first year after outplanting, and during the second year, more seedlings exited the grass stage and were taller as N rate increased up to 3 mg per week. By the third field season, nearly all seedlings in the 2004 crop had exited the grass stage, whereas 44% of 2005 crop grown at 1 mg N had yet to initiate height growth, either because of differences in seed source between the two crop years or because of droughty conditions. Our data suggests that an application rate of about 3 mg N per week for 20 weeks plus two additional applications during hardening yields satisfactory nursery growth as well as field response for the container type we used. The potential for improving field performance by using more robust fall fertilization during nursery production should be investigated.

1. Introduction

The longleaf pine (*Pinus palustris* Mill.) ecosystem once dominated the southeastern United States, occupying more than 36 million hectares. Longleaf pine features a stemless grass stage to ensure its seedlings survive the frequent, low-intensity surface fires characteristic of their fire-adapted ecosystem (Barnett, 1999). For decades, foresters discriminated against planting longleaf pine. Low seedling survival due to poor seedling quality, grass stage persistence for several years, and faster initial growth from other southern conifer species led to the reluctance to plant longleaf pine (Croker, 1990; Barnett, 2002). In addition, intense harvesting during the past century reduced this forest type by nearly 98% and caused many other terrestrial species to become threatened and endangered (Noss et al., 1995; Outcalt, 2000; Barnett, 2002; Jose et al., 2006).

Two recent shifts in focus have brought attention to the production of longleaf pine for restoration and reforestation. First, federal incentive programs have encouraged restoration of longleaf pine ecosystems (Hainds, 2002), and second, land managers are moving from pulpwood to sawtimber production because of higher economic returns (Kush et al., 2004). To meet this demand, use of container longleaf pine has increased dramatically because survival and growth often exceeds bareroot stock (Boyer, 1989; Barnett and McGilvary, 1997; South et al., 2005). In 2008, 84% of the 76 million longleaf seedlings produced were grown in containers (Dumroese et al., 2009). Despite high demand for container longleaf pine seedlings, detailed research is lacking concerning its production and an absence of standards has caused subsequent variation in stock quality (Hainds, 2004). Based on the limited research, Barnett et al. (2002a,b) published interim guidelines for producing container longleaf pine, and these standards were recently updated (Dumroese et al., 2009). Although a target seedling is described, no fertilizer regimes to obtain that target are provided.

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