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Relating the survival and growth of planted longleaf pine seedlings to microsite conditions altered by site preparation treatments

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ABSTRACT

Pine plantations in the southeastern United States are often created using site preparation treatments to alleviate site conditions that may limit survival or growth of planted seedlings. However, little is understood about how site preparations affect longleaf pine (*Pinus palustris* P. Miller) seedlings planted on wet sites. In a 2-year study (2004 and 2005) on poorly drained, sandy soils of Onslow County, North Carolina, we examined the effects of common site preparation treatments on microsite conditions and quantified relationships between microsite conditions and longleaf pine seedling survival and growth. Treatments used in the study included site preparations designed to control competing vegetation (chopping and herbicide) combined with those that alter soil conditions (mounding and bedding). During both years, mounding and bedding treatments reduced the amount of moisture within the top 6 cm of soil and increased soil temperatures when compared to flat planting ($p < 0.001$). Soil moisture was inversely related to seedling mortality in 2004 ($r^2 = 0.405$) and inversely related to root collar diameter in 2005 ($r^2 = 0.334$), while light was positively related to root collar diameter in 2005 ($r^2 = 0.262$). Light availability at the seedling level was highest on treatments that effectively reduced surrounding vegetation. Herbicides were more effective than chopping at controlling vegetation in 2004 ($p < 0.001$) and 2005 ($p = 0.036$). Controlling competing vegetation, especially shrubs, was critical for increasing early longleaf pine seedling growth.

1. Introduction

Restoring the longleaf pine (*Pinus palustris* P. Miller) ecosystem is currently a major focus of land managers throughout the southeastern United States. Widespread reduction since European settlement has left longleaf pine occupying approximately 3% of its original range (Frost, 1993; Landers et al., 1995), largely due to land conversion and fire exclusion. Areas still containing longleaf pine may be maintained successfully with natural regeneration and frequent prescribed fire. However, the majority of the original range no longer contains longleaf pine in the overstory to provide seed and therefore requires artificial regeneration (Barnett, 1999).

Land managers in the southeastern United States frequently use site preparation in conjunction with artificial regeneration of southern pine species. Previous studies have demonstrated the effectiveness of various types of site preparation for increasing early growth of loblolly pine (*Pinus taeda* L.) and/or slash pine (*Pinus elliottii* Engelm.) (e.g. Burger and Pritchett, 1988; Nilsson and Allen, 2003; Rahman and Messina, 2006). For example, Knowe et al. (1992) reported that herbicides and chopping increased loblolly pine height (2.65 m) and diameter (4.47 cm) after 4 years of growth when compared to an untreated control (1.46 m, 1.45 cm, respectively). Moreover, studies have indicated that site preparation intensity is positively related to seedling growth (Nilsson and Allen, 2003). Burger and Pritchett (1988) compared the effects of low intensity site preparation (chopping) and high intensity site preparation (windrowing, disc harrowing, and bedding) on loblolly pine seedling response. After two growing seasons, seedling height and diameter were significantly greater on the high intensity treatment (79.9 cm and 2.33 cm, respectively) than on the low intensity treatment (68.5 cm and 1.41 cm, respectively).

Barnett (1992) identifies well-prepared sites as a critical prerequisite for successful artificial regeneration of longleaf pine. Although limited to only a few studies, previous research has demonstrated the beneficial effects of mechanical treatments on survival and growth of planted longleaf pine seedlings (Croker, 1975; Croker and Boyer, 1975; Boyer, 1988). For instance, Boyer (1988) reported greater seedling survival 3 years after planting on sites treated with two passes of mechanical competition control

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