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Soil change and loblolly pine (*Pinus taeda*) seedling growth following site preparation tillage in the Upper Coastal Plain of the southeastern United States

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Abstract

To determine the relationship between changes in soil physical properties due to tillage and growth of loblolly pine (*Pinus taeda* L.) seedlings, we measured soil moisture and penetration resistance for a range of tillage treatments on two Upper Coastal Plain sites in Georgia and correlated these measurements to the growth of individual seedlings. The five tillage treatments were: no-till (NT), coulter only (C), coulter + subsoil (CS), coulter + bed (CB), and coulter + subsoil + bed (CSB). The effects of tillage on soil penetration resistance and volumetric water content were isolated from the potentially confounding effects of tillage on competition and soil fertility by completely eliminating all competing vegetation and by comparing tree response with and without periodic nutrient additions. At the site with a clay B-horizon at the surface, the tillage treatments increased relative height and relative diameter growth compared to the NT treatment during the first season, decreased soil penetration resistance, and decreased volumetric soil moisture (VWC). At the sandy site with a loamy sand topsoil averaging 15–40 cm in depth over a sandy clay loam B-horizon, bedding, subsoiling and the minimal tillage associated with machine planting increased seedling growth compared to the C treatment. Soil penetration resistance and VWC were greatest in the C treatment, intermediate in the NT treatment, and lowest in the treatments receiving bedding. Soil penetration resistance between 40 and 50 cm ($p = 0.03$, $r^2 = 0.40$) was negatively correlated with seedling relative diameter growth at the clay site. Soil penetration resistance between 10 and 40 cm ($p < 0.02$, $r^2 = 0.35$) was negatively correlated with seedling diameters at the sandy site. Overall, the positive effects of soil tillage on growth were relatively small (i.e., increases in height and diameter of about 20%). Most of the positive benefits of tillage on growth and soil physical properties were captured with less intensive treatments such as machine planting (sandy site) or the coulter only (clay site).

Keywords: *Pinus taeda*; Loblolly pine; Tillage; Bedding; Subsoiling; Upper Coastal Plain

1. Introduction

Mechanical site preparation is a common silvicultural treatment used in plantation forest management in all areas of the southeastern United States (Lantagne and Burger, 1987). Benefits of mechanical site preparation include improved drainage, improved micro-site environment (nutrients, aeration, temperature, and moisture) for root development, and reduced competition (Haines et al., 1975). Many upland sites of the Coastal Plain have thin topsoil above a restrictive subsoil that may inhibit seedling root growth and limit nutrient availability (McKee and Wilhite, 1986; Wheeler et al., 2002). Additionally, soil compaction caused by trafficking of heavy equipment is a problem on many of these sites. Between 25 and 50% of a site is

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