From Forest Nursery Notes, Winter 2010

86. © Long-term effects of site preparation treatments, complete competition control, and repeated fertilization on growth of slash pine plantations in the flatwoods of the southeastern United States. Zhao, D., Kane, M., Borders, B., and Harrison, M. Forest Science 55(5):403-410. 2009.

Long-Term Effects of Site Preparation Treatments, Complete Competition Control, and Repeated Fertilization on Growth of Slash Pine Plantations in the Flatwoods of the Southeastern United States

Dehai Zhao, Michael Kane, Bruce Borders, and Mike Harrison

Abstract: Data through age 26 from a well-designed study established in 1979 were analyzed with a repeated-measures analysis of variance approach to evaluate effects of site preparation treatments, complete competition control, and repeated fertilization on growth of slash pine (*Pinus elliottii* Engelm.) plantations on Spodosols and non-Spodosols in the flatwoods region of southern Georgia and northern Florida. Complete and sustained vegetation control and repeated fertilization consistently and significantly increased slash pine productivity, with greater responses occurring on Spodosols than on non-Spodosols; their combination had less than additive effects on Spodosols and additive effects on non-Spodosols. Complete and sustained vegetation control resulted in greater cumulative responses than repeated fertilization over more than 20 years, and then the gains from repeated fertilization had caught or surpassed the gains from complete vegetation control. Bedding resulted in significant responses in the early ages. Burning improved stand basal area and volume growth rather than average tree height and dbh on non-Spodosols and had little effect on Spodosols. Chopping had no significant effect on either soil group. Results of this study emphasize the need for site-specific silvicultural prescriptions. FOR. SCI. 55(5):403–410.

Keywords: site preparation, slash pine, vegetation control, fertilization, growth response

SLASH PINE (*Pinus elliottii* Engelm.), a fast-growing commercial pine native to the southeastern United States, has been widely grown in plantations. Intensive management practices that include deployment of genetically improved seedlings, mechanical and chemical site preparation, and fertilization are commonly used to increase productivity in slash pine plantations. Various site preparation methods can be used alone or in combination with each other to reduce competition, improve the soil environment, and facilitate quality tree-planting (Morris and Lowery 1988). Where brush and small residual hardwoods are abundant, prescribed burning is often used in combination with either chemical site preparation or mechanical treatments such as chopping. Chemical site preparation has become a standard practice on many cutover sites with sufficient brush or arborescent competitors. Bedding is done frequently to improve soil aeration on poorly drained sites. Postplant herbicide treatment, for control of herbaceous and/or woody competitors, has become a common practice in commercial plantations in the southern United States. The soils used for pine plantations in the flatwoods of northern Florida and southern Georgia tend to be naturally deficient in nitrogen (N) and phosphorus (P); thus, the application of N and P fertilizer commonly elicits significant growth response in pines. Forest fertilization in the southern United States has increased greatly since the 1960s; more than a half million hectares of southern pine plantations were fertilized annually over the 1998–2004 period (Fox et al. 2007).

Several studies have shown that site preparation, understory competition control, and fertilization can influence the growth of pine plantations (Jokela et al. 2000, 2004, Zhao et al. 2008). Several types of responses to site preparation, herbicide release treatment, and fertilization have been reported or conceptually defined (Snowdon 2002, Nilsson and Allen 2003, Sutton 1995), although information about the long-term effects of experimental silvicultural treatments is still limited. Site preparation and herbicide treatments can result in growth gains that increase throughout the rotation (Zutter and Miller 1998), early growth gains that are maintained but do not increase after an initial response (Lauer et al. 1993, Mason and Milne 1999), early growth gains that are later lost, no growth gain, or even a negative growth response (Allen 1996, Nilsson and Allen 2003). Depending on the element, application rate, and site characteristics, fertilization may result in either a short- or long-term increase in nutrient availability and increased growth of planted seedlings/trees (Nilsson and Allen 2003, Jokela et al. 2004). Fertilization at the time of planting may also have no effect or even lead to a negative response (Sutton 1995). Despite the wealth of possible types of treatment combinations and associated responses over an array of sites and environmental conditions, the weight of evidence leads to a general conclusion that more intensive methods provide

Dehai Zhao, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602—Phone: (706) 542-6021; Fax: (706) 542-8356; dzhao@warnell.uga.edu. Michael Kane, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602—mkane@warnell.uga.edu. Bruce Borders, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602—borders@warnell.uga.edu. Mike Harrison, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602—mharrison@warnell.uga.edu.

Acknowledgments: We thank J.W. Rheney for his invaluable assistance with the data. We express our gratitude to the University of Georgia's Warnell School of Forestry and Natural Resources and the Plantation Management Research Cooperative for providing support and data for this research.

Manuscript received September 6, 2007, accepted May 12, 2009