SEASONAL DYNAMICS IN LEAF AREA INDEX IN INTENSIVELY MANAGED LOBLOLLY PINE

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Abstract—Leaf area index (LAI; leaf area per ground area) was measured monthly or bimonthly for two years (March 1999 to February 2001) with the LAI-2000 in intensively managed plantations of loblolly pine (Pinus taeda L.) at Eatonton and Waycross GA. Since establishment of the three age classes at each site, the stands have received combinations of complete weed control and annual fertilization. The youngest age class at Eatonton continued to accumulate LAI for the duration of the study, while LAI did not differ significantly among age classes at Waycross. Fertilization caused increases in LAI by as much as a full unit, except in the youngest age class at Eatonton. Seasonal development of LAI from associated hardwoods and shrubs was more evident for the deciduous community at Eatonton than for the evergreen community at Waycross. The LAI-2000 successfully detected differences in LAI due to seasonal change, stages of stand development, stand nutrition, and presence or absence of non-pine woody vegetation.

INTRODUCTION

Leaf area is the most important morphological feature affecting productivity of a forest stand because it is the primary site of energy and gas exchange for photosynthesis and respiration. Soon after crown closure, forest stands begin an asymptotic approach to their maximum LAI. Maximum LAI occurs at full stocking and it can vary with site quality and silvicultural inputs. Recent interest in the use of LAI as a management diagnostic for predicting stand productivity and potential for treatment response of loblolly pine has prompted the development of field estimation techniques (Sampson and others 1996). However, an incomplete understanding currently exists regarding how LAI varies seasonally, especially for stands managed with different silvicultural intensities. Previous research on LAI of loblolly pine has focused on peak growing season values derived from needlefall or branch samples (Vose and Allen 1988, Dalla-Tea and Jokela 1991, McCrady and Jokela 1996) and has not considered seasonal dynamics. Therefore, the objective of this research was to characterize seasonal dynamics of loblolly pine LAI as influenced by weed control and fertilization.

METHODS

The research was conducted at mechanically prepared sites in the Piedmont (Eatonton) and Lower Coastal Plain (Waycross) of Georgia. Four treatments were compared: 1) untreated check, 2) annual fertilization with nitrogen, plus first- and second-year applications of phosphorus and potassium, 3) complete weed control, and 4) the combination of annual fertilization and complete weed control. At each site loblolly pine was planted at a 2.4-meter square spacing in 0.15-hectare plots. Each treatment was replicated in two blocks per site. To study treatment effects over different time periods, the entire study was planted at each site during different years to provide three age classes: oldest (1987 and 1988 plantings for Waycross and Eatonton, respectively), middle (1989 and 1990 plantings) and youngest (1993 and 1995).

Monthly or bimonthly measurements of LAI were taken from March 1999 to February 2001 with the LAI-2000 canopy analyzer (Li-Cor, Inc., Lincoln NB). A total of twelve LAI readings were taken at the same randomly located points on each plot. An above-canopy sensor logged readings in a nearby large opening (no vegetation at greater than 15 degrees above the horizon) while a below-canopy sensor was used to log readings within the study area. All LAI-2000 readings were taken with the sensor facing north at 1.4 meters above ground and a 90-degree view cap attached to the lens. In the laboratory, data from the two sensors were merged and LAI was calculated with Li-Cor software. Data from each location were analyzed separately. Plot averages for each sample date were subjected to analysis of variance to test main effects (treatment and age class) and their interaction.

RESULTS

At Eatonton, LAI of the youngest age class continued to increase for the duration of the study, while LAI of the middle and oldest age classes had similar peak values during the 1999 and 2000 growing seasons. The interaction of weed control and age class was significant for most of the sample dates. In the youngest age class, LAI was greater in the presence versus absence of weed control because this treatment greatly accelerated the development and dominance of a pine canopy. Shrub and hardwood species contributed little to LAI in these five- to six-year-old stands.

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However, in the oldest age class, growing season LAI was greater in the absence versus presence of weed control because the addition of non-pine woody vegetation increased LAI by up to 30 percent. Fertilization was associated with significant increases in LAI by as much as a full unit, but these responses were limited primarily to the middle and oldest age classes.

At Waycross, there were no significant differences in LAI among age classes. In addition, the effects of weed control and fertilization were additive and did not interact significantly with age class. Weed control was associated with a reduction in LAI because of the resulting absence of non-pine woody vegetation. Fertilization was associated with increases in LAI by as much as a full unit.

At each site, increases in LAI from fertilization were sustained throughout the growing and dormant seasons. This indicates that the pine canopy is maintaining a larger surface area of needles throughout the year, and not just during periods of active shoot growth.

Development of LAI in the absence of weed control differed strongly between the two sites. At Eatonton, LAI of the deciduous hardwood and shrub community climbed rapidly in the spring and declined rapidly in the fall. At Waycross, the seasonal change in LAI resulting from associated hardwoods and shrubs was less conspicuous, probably because many of the species are evergreen, such as gallberry (*Ilex glabra* L.) and wax myrtle (*Myrica cerifera* L.).

CONCLUSIONS

LAI development of the youngest age class at Eatonton lagged behind that of Waycross. Likewise, LAI responses to fertilization were not yet detectable in the youngest age class at Eatonton. In contrast, peak LAI values and responses to fertilization and weed control differed little among age classes at Waycross. Thus, stands of the youngest age class at Eatonton continued to accumulate leaf area, while those at Waycross had already reached stable values. Differences in LAI due to stand nutrition were maintained throughout the year, and not just during periods of active shoot growth.

The LAI-2000 was able to detect differences in LAI of loblolly pine plantations attributable to seasonal change, age class, stand nutrition, and presence or absence of non-pine woody vegetation. Subtle differences in seasonal rates of LAI development between deciduous and evergreen hardwood and shrub communities also were evident.

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