BIOMASS AND NITROGEN DYNAMICS OF FOUR PLANTATION TREE SPECIES RECEIVING IRRIGATION AND FERTILIZATION

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In addition to fiber and wood production, there has been renewed interest in using forest biomass for energy production through both direct combustion and through technologies to produce liquid fuels from wood. In addition, growth and productivity of forests have important potential implications in terms of carbon sequestration and carbon credits because growth is directly related to carbon removal from the atmosphere. To better meet these current and future biomass related objectives, there are several important issues that need to be better understood related to growth potential, biomass partitioning to different aboveground stand components, and nitrogen demand and partitioning among stand components.

Our objectives were to: 1) determine the growth potential of four fast-growing species that are suitable for plantation culture, i.e., loblolly pine (*Pinus taeda*), slash pine (*Pinus elliottii*), sweetgum (*Liquidambar styraciflua*), and sycamore (*Platanus occidentalis*); 2) quantify the effect of resource availability (water and nutrients) on aboveground biomass accumulation and partitioning; and 3) quantify the effect of resource availability on aboveground nitrogen accumulation and distribution.

The study area was an 11.7-ha study site established in 1997 near Mt. Pleasant, GA by Plum Creek Inc. The sandy soil is a mesic, coated Aquic Quartzipsamments (Klej series). Treatments were laid out in three blocks (n = 3). Nutrient and water additions were applied during each growing season beginning year one. Treatments consisted of control (C), 3.05 cm-water/wk (I), 3.05 cm-water/wk + 57 kg-N/ha/yr (I + 57N), 3.05 cm-water/wk + 85 kg-N/ha/yr (I + 85 N), 3.05 cm-water/wk + 114 kg-N/ha/yr (I + 114N). All nutrient and water additions were evenly applied via drip irrigation throughout the growing season. The fertilization mix also included P, K, and micronutrients. Measurements were taken during the sixth growing season. Following the sixth growing season, three trees per plot were harvested and stem volume and dry biomass were determined. Bark and wood were separated. Total branch biomass was determined for the same harvest trees. Stem and branch biomass were scaled to the plot basis using regressions between dbh^2*height and biomass. Treatments did not affect these relationships. Leaf biomass was determined from periodic collections of litter in five 1-m^2 traps per plot. Nitrogen concentrations of stem wood, stem bark, branch wood, and branch bark were determined at the time of the harvest. Foliar N was measured based on mean of several growing season samples. Nitrogen contents were calculated by multiplying the biomass component by the corresponding N. For all analyses, the experimental unit was the plot-level estimate of biomass, nitrogen concentration, or nitrogen content. For all variables, differences due to fertilization were evaluated by comparing treatments receiving water additions (i.e., I, I+57N, I+85N, and I+114N). The effects of irrigation were evaluated by comparing the control (C) and irrigated only (I).

Compared to the control treatment, irrigation and fertilization increased stem wood biomass for sweetgum (1,860 to 27,600 kg/ha) and sycamore (3,800 to 37,400 kg/ha) more than for loblolly pine (24,410 to 42,150 kg/ha) and slash pine (14,000 to 26,660 kg/ha). In addition, irrigation and fertilization increased growth efficiency (stem growth per unit of foliage) of the hardwood stands while partitioning within the pine stands did not change. Fertilization increased foliar N in sweetgum (1.4 to 2.0 percent) and sycamore (1.5 to 2.0 percent) and also increased nitrogen use efficiency (stem wood growth per unit of foliar N) in these species. Fertilization did not affect foliar N dynamics of the pines. However, because of the large increases in stand biomass with irrigation and fertilization, total nitrogen content of the aboveground biomass increased for all species (154 to 252 kg-N/ha for loblolly pine, 121 to 205 kg-N/ha for slash pine, 44 to 238 kg-N/ha for sweetgum, and 45 to 203 kg-N/ha for sycamore). These results quantify the potential growth rate and nitrogen demand of four fast growing species and indicate that growth, biomass partitioning, and foliar N of sweetgum and sycamore are more responsive to resource availability than for loblolly and slash pine.

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