WATER AND NUTRIENT EFFECTS ON LOBLOLLY PINE PRODUCTION AND STAND DEVELOPMENT ON A SANDHILL SITE

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During the last decade, it has become apparent that production rates of pine plantations in the southeastern United States are far below levels that are biologically and economically optimal. By managing genetic and site resource effectively, production rates should exceed 350 ft^3/acre/year on most sites. In effort to better understand the ecophysiological constraints to production, the SETRES study was established in 1992 on a well-drained loamy sand site in Scotland County, NC. The experimental study consists of two levels of irrigation (none and optimum) and two levels of nutrient amendment (none and annual additions) replicated four times. Treatment plots measure 50 x 50 m with the internal 30 x 30 m as a measurement plot. Details of the experimental design, treatment regimes, and measurements are provided in Albaugh et al. 1998. Over the eight-year period since treatments were imposed, detailed assessments of individual tree and stand physiological, growth and development process have been examined.

Improved nutrition has had a very strong positive impact on production. Nitrogen, phosphorus, potassium, and boron were apparently the key limiting elements. Nutrient additions consistently increased peak leaf area by almost 100% over the eight years (figure 1).

Current annual volume increment was closely coupled with leaf area (figure 2). The combined gains in leaf area and growth efficiency (stemwood production per unit of leaf, GE) with nutrient additions resulted in a three-fold increase in annual stemwood production (80 to 240 ft^3/acre/year). After eight years of treatment, several water+nutrient plots had leaf area and current volume increment levels exceeding 3.5 and 350 ft^3/acre/year, respectively.

Over the eight years of study, GE varied from 55 to 70 ft^3/acre/year for control plots (figure 3). Water and nutrient additions increased GE but GE was not affected by stand age. GE reached 100 ft^3/acre/year on water+nutrient plots during the last two years of study.

Responses to water were much less than originally expected and there were no apparent interactions between water and nutrient additions. Although the soil has a very low water holding capacity, the rooting depth exceeded 10 feet apparently providing sufficient water for much of the growing season.

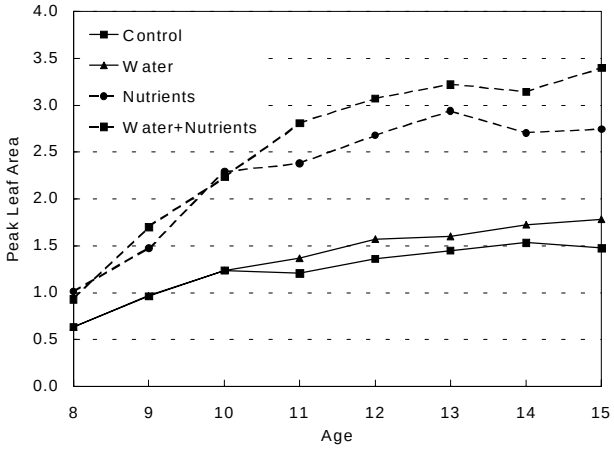

Figure 1— Peak leaf area with and without optimum water and nutrient additions in an eight- to 15-year old loblolly pine stand. By age 13, peak leaf area had stabilized at a maximum value of 1.5 on control plots, whereas leaf area on plots receiving nutrient additions averaged 3.0. Clearly, native nutrient availability now constrains leaf area levels rather than stocking.

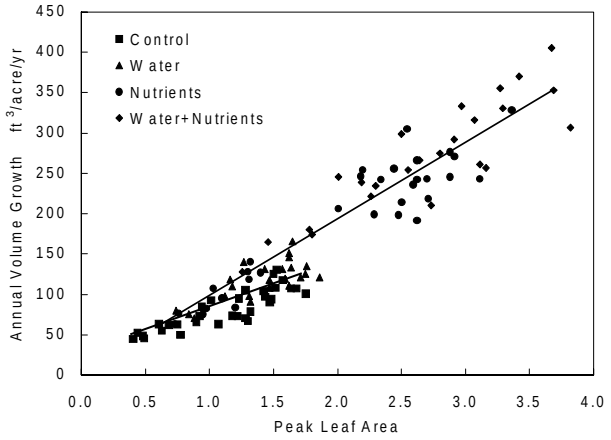

Figure 2—The relationship between current annual stemwood increment and peak leaf area across a range of water and nutrient availability conditions in an eight- to 15-year old loblolly pine stand.

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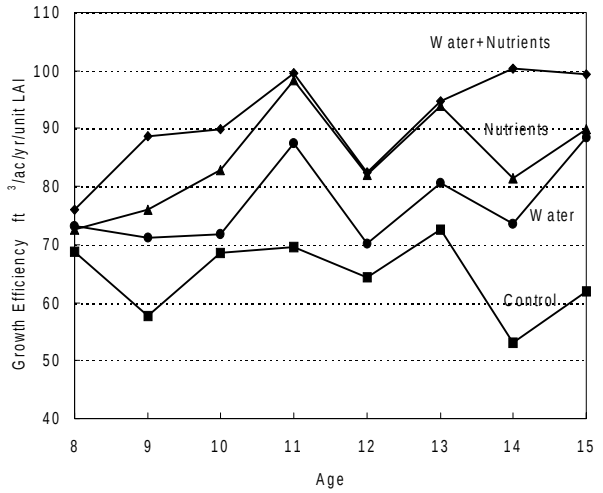

Figure 3— Growth efficiency (annual stemwood production per unit of peak leaf area) with and without water and nutrient additions in an eight- to 15-year old loblolly pine stand.

Interestingly, fine root production was not affected by the imposed treatments. However, aboveground production was dramatically increased with improved nutrition so a strong shift in biomass partitioning from roots to shoots was observed.

Estimates of nutrient use and soil nutrient uptake indicate that if the observed gains in production are to be sustained, soil nutrient availability will need to be maintained at a considerably higher level than naturally found on this site.

REFERENCES

Albaugh, T.J.; H.L. Allen; P.M. Dougherty; L.W. Kress; J.S. King. 1998. Leaf-area and above- and below-ground growth responses of loblolly pine to nutrient and water additions. Forest Science 44:317-328.