Impacts of Genetic Variation and Silvicultural Treatments on Loblolly Pine Water Use

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12/15/2022

Masters project submitted in partial fulfillment of the requirements for the Master of Environmental Management degree in the Nicholas School of the Environment of  
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**Executive Summary**

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**Executive Summary**

Loblolly pine (*Pinus taeda*) is of high ecological and economical value in the U.S. for its abundance and rapid growth. *P. taeda* has adapted to a wide range of sites, exhibiting considerable variation in its physiology and morphology. In efforts of understanding such variation, transpiration has become a major study focus for its integral role in tree growth and survival. Past studies have developed methods of quantifying tree transpiration and explored the relationships between transpiration and productivity in *P. taeda*. Understanding factors that affect transpiration provides an opportunity to explain and to model *P. taeda* physiological and morphological variation for better forest management.

Transpiration is strongly influenced by crown traits and environmental conditions. In plantations, crown phenotype is developed as a mixed realization of individual crown architecture, silviculture treatments, and environmental variables. The crown architecture largely determines plant’s crown properties, meaning that it defines a plant’s ability to intercept light and transpire. While crown architecture can be innate, different planting densities can modify such innate crown architecture where low density planting promotes broad crown development and high planting density encourages narrow crown development due to competition. Vapor pressure deficit (VPD) determines the strength of the force pulling water from the soil through tree crowns into the air, while soil relative extractable water (REW) indicates water available for plants to supply transpiration. Transpiration can pause temporarily or permanently during drought conditions due to extreme water potential differences between roots and shoots. This Master’s Project (MP) assessed the variation in *P. taeda* water use related to planting densities, genetic variation in crown architecture, VPD and REW. With the overall objective of examining variation in *P. taeda* transpiration between silvicultural treatments, two questions were explored in this study:

1. Does transpiration differ with genotype and planting density?
2. How does transpiration respond to VPD and REW across treatments?

I examined sapflux data from an established experiment where four crown genotypes were planted at 1853 trees per hectare (TPH) and 618 TPH with four replications. Among the four genotypes chosen to represent different crown genotypes, two clones represented broad crown genotype, one clone represented narrow crown genotype, and one open-pollinated family possessed the crown size between broad and narrow crown genotypes. Transpiration and related properties across eight treatment combinations were compared throughout the growing season: 1) directly using the analysis of variance (ANOVA); 2) with VPD and REW as a continuous variables using analysis of covariance (ANCOVA).

Based on this study, sapflow was higher in broad-crown genotypes under low planting density but higher in narrow-crowned C3 under high planting density. Under high planting density, transpiration was more responsive to changes in REW across genotypes; between genotypes, the narrow-crowned C3 was more responsive to changes in VPD and REW than the broad-crown genotypes. Under low planting density, the genotypes showed similar transpiration responses to VPD, whereas the broad-crown genotypes were found to be more sensitive to REW than C3. While many of these conclusions were genotype-specific, additional crown trait measurements are necessary to explore the relationship between crown architecture and transpiration. Further recommendations in forest management include 1) consideration of the genetic variation in the effect of planting density on self-shading, water use efficiency, and carbon allocation; 2) adoption of site-specific silviculture treatments.