Promoting shortleaf pine: Canopy openness and pine regeneration in closed canopy forests

Light is a limiting factor in the regeneration and recruitment of shortleaf pine. Light is transmitted to the understory as either direct radiation (light unimpeded in transmission) or diffuse radiation (light emanating from other parts of the sky as a result of scattering of light by the atmosphere). The amount of direct and diffuse radiation transmitted to the understory is directly related to the percent of overstory canopy openness. Therefore, knowing the percent of canopy openness is particularly useful for promoting shortleaf pine success.

In oak-pine forests of the Missouri Ozarks tree growth responses to changes in direct and diffuse radiation are not well understood. The intensity and quality of direct and diffuse light limits shortleaf pine seed germination, photosynthesis and growth. Understory shortleaf pines can have annual height increases ranging from 7 to 28 cm (2.8 to 11.0 in) per year immediately following canopy opening. In comparison, deciduous saplings can have average height growth rates of up to 1 meter (3.28 ft) per year. Although shortleaf pine seedlings are moderately shade tolerant (Shelton and Cain 1999), without adequate light they rarely grow to sapling size or maintain desirable growth form. Reukema (1959) reported that the degree of canopy opening influences crown development and increases the total number of branches per seedling during the first four years following canopy opening. Light is important for reasons other than attempting to increase shortleaf pine’s competitive edge over hardwoods. Increases in the light environment can accelerate rates of litter decomposition, another important limiting factor of pine regeneration (Shelton and Cain 1999).

We measured canopy openings using several methods including ground and canopy opening dimensions and computer analysis of canopy images. Ground dimensions of canopy gaps were measured using the equation of an ellipse (Figure 1) and provided the best estimate of percent canopy openness. The equation for estimating percent canopy openness from ground measurements is:

\[ PCO = 14.25 + 0.008 \times CGA \]

\( \tau^2 = 0.70, p < 0.01 \)

Where \( PCO \) is percent canopy openness and \( CGA \) is canopy gap area (m\(^2\)). The equation
was generated from data of 42 canopy openings in a mature closed canopy oak-pine forest. The opening sizes ranged from approximately 50 to 2000 m².

We found that the maximum number of shortleaf pine seedlings regenerating increased with increasing canopy opening size (Figure 2). These data are limited in sample size and site replication; therefore the equation should be used with caution and evaluated through field trials. Other important limiting factors for shortleaf pine regeneration such as hardwood competition, litter depth and seed source will likely confound the relationship between canopy openness and pine regeneration success presented here. Our attempt to relate canopy openness to pine regeneration abundance represents preliminary work and further research is needed to improve our understanding of pine regeneration following canopy opening and the estimation of canopy openness for various stand densities.

References:


