CHANGE IN COTTON LIGHT EXTINCTION COEFFICIENT WITH ROW SPACING

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Abstract

Crop simulation models estimate potential plant growth as a function of the leaf area index and the amount of incoming photosynthetically active radiation intercepted by the canopy using a derivative of Beer's Law. Beer's Law assumes that the plants and leaf area over the soil surface are distributed in a random, uniform fashion. Because leaf arrangement and plant spacing vary among crops, crop models employ an empirically derived canopy light extinction coefficient (k) to overcome these differences in leaf and plant arrangements among crops. Studies by Flenet et al. (1996) found that the light extinction coefficient for corn, grain sorghum, soybeans, and sunflowers increased linearly as the distance between rows declined. With increasing interest of cotton growers in the use of ultra-narrow row systems, it is appropriate we know the relationship between the light extinction coefficient of cotton and row spacing.

The Beer's Law equation estimates intercepted photosynthetically active radiation (IPAR) by a canopy as: IPAR = PAR X (1 – exp (-k X LAI)) where PAR is the incoming photosynthetically active radiation, k is the light extinction coefficient, and LAI is the leaf area index (Thornley, 1976). The light extinction coefficient k can be calculated from the transmitted PAR (TPAR) and incoming PAR data by: k = -ln (TPAR/PAR)/LAI (Flenet et al. 1996).

In this study we attempted to characterize the effect of row spacing on the light extinction coefficient (k) of cotton. The experiment was conducted on Burleson clay (fine, montmorillonitic, thermic Udic Pellusterts) at the Stiles Farm near Taylor, TX. Before planting 168 kg N/ha and 33.6 kg P_2O_5/ha were applied. Radiation measurements were taken at 35, 48, and 62 days after planting at 900 h, 1030 h, and 1230 h under clear skies. Three measurement areas within each plot were selected randomly with a border remaining on either side of the selected sites. Plots consisted of five 0.15 m rows, two 0.38 m rows, one 0.76 m row or one 1.00 m row all one meter in length. Two 0.8 m Decagon Sunfleck Ceptometers were used to measure the above-canopy-incoming, above-canopy-reflected, and the below-canopy-intercepted PAR. Ten measurements each for above-incoming, above-reflected, and below-intercepted were taken in rapid succession. The above-reflected measurements were taken by inverting the ceptometer above the canopy. Aboveground plant material was harvested from the measured areas described above, and the plants were separated into leaves and stems. Leaf area was obtained from three representative plants per plot using a LI-COR 3100 area meter. The number of plants and average stem length were recorded for each area harvested. Leaf and stem weights were determined after drying at 65ºC for four days. From the dried weights and leaf area, the LAI was calculated for the areas measured. Finally, the light extinction coefficient (k) was calculated using the equation previously defined.

Smoke and haze caused by fires burning in Mexico reduced incoming photosynthetically active radiation at first square by about 25%. Drought severely restricted plant canopy and leaf development. Leaf water potentials were approximately –1.5 Mpa at first square (35 DAP) and rapidly declined thereafter reducing leaf growth and canopy development. The LAI (1.5) and plant height (30-cm) were approximately one-half of that we typically observe at first flower (60 DAP). Complete canopy cover was observed in the 0.15 and 0.38-m rows by first flower (60 DAP), but not in the 0.76 and 1.00-m rows. Contrary to the Flenet et al. (1996) findings, the light extinction coefficient did not change with row spacing. The regression coefficients (e.g., the slope) of the light extinction coefficient on row spacing were not statistically different. The LAI's were too low for row spacing to modify the efficiency of light interception by the canopy. The study must be repeated next year, but steps will be taken to ensure that leaf area and canopy formation represent the typical development pattern. However, if Flenet et al. (1996) findings prove correct for cotton under typical growing conditions, our results suggest that the light extinction coefficient must be treated differently when the crop is subjected to severe drought.

References

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