ESTIMATING LIGHT INTERCEPTION BY THE COTTON CROP USING A DIGITAL IMAGING TECHNIQUE

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Abstract

Calculation of fractional light interception by the crop is commonly performed by measuring photosynthetically active radiation above and below the canopy using a line-source quantum sensor. However, this method is limited by the time of measurement and the presence of clouds. For soybeans, ground coverage values estimated from digital images taken above the canopy have been correlated to light interception measurements without the above limitations. In this study an equation between fractional ground coverage and fractional light interception for cotton has been developed. The digital imagining technique was confirmed for cotton and shown not to be influenced by the limitations of the quantum sensor measurements.

Introduction

The most common method of measuring the fraction of radiation intercepted by the crop canopy is using a line-source quantum sensor. The fraction of intercepted radiation is calculated by measuring photosynthetically active radiation above and below the canopy. In cotton, with a row spacing of approximately one meter, a 1-m line quantum sensor is placed perpendicularly across the two rows. The limitation of this method is that measurements should be taken in unobstructed sunlight and close to solar noon (Board et al., 1992; Egli, 1994). Purcell (2000) described a method for estimating light interception in soybean that was not affected by the above limitations. In this technique, ground area coverage was determined by digital images taken above the canopy. The canopy coverage values were similar throughout the day, and were correlated in a one-to-one relationship with light interception measurements made with a line quantum sensor at solar noon (Purcell, 2000). In this study the digital imaging technique was tested for use in cotton.

Material and Methods

The fraction of intercepted radiation was calculated by measuring photosynthetically active radiation (PAR) above and below the canopy in unobstructed sunlight, close to solar noon, using a LI-191S line-source quantum sensor (Li-Cor, Lincoln, NE). Three measurements were recorded for each plot.

Following the light interception measurements, digital images were taken above the crop canopy from the center of each plot. The pole, at which the camera was mounted, was inclined by 30^o to prevent the pole from being included in the image. By adjusting the height of the camera above the ground, the width of the image was set at 1 m. The SigmaScan Pro software (v. 4.0, SPSS, Inc., Chicago, IL) was used to determine the number of canopy pixels (green) of each image.

Data were collected from four studies, across two years (2006 and 2007) and two locations (Fayetteville, AR and Marianna, AR). For the analysis of variance JMP 6 software was used. Means were separated at α=0.005.

Results

Correlation

Data were collected from four studies, across two years (2006 and 2007) and two locations (Fayetteville, AR and Marianna, AR). Fractional light interception (LI) values by the crop canopy were plotted against fractional ground coverage (GC) values estimated by the digital imaging software (Fig. 1). The two measurements were found to be highly correlated (R^2=0.93) following a quadratic relationship, described by the equation: $LI = -0.5399 \times GC^2 + 1.6366 \times GC - 0.1202$

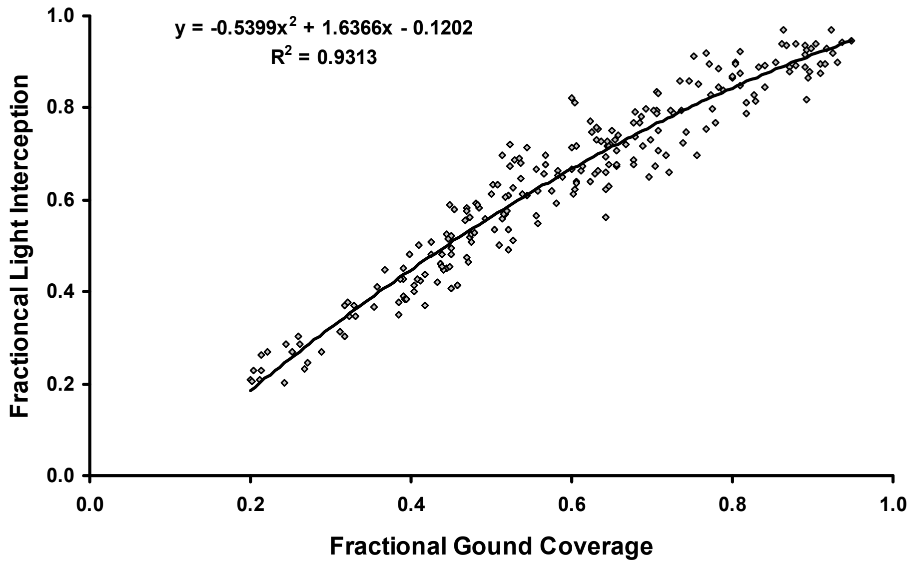

Fig. 1. Relationship between light interception and ground coverage.

Limitations

On July 17, 2007 images were taken every two hours between 9:00 a.m. and 5:00 p.m. from 20 plots. The estimated values of ground coverage did not significantly differ between sampling time (Fig. 2). In contrast to the light interception measurements that are limited to measurements made only close to solar noon, the digital imaging technique can be used at any time of the day.

Digital images were taken from eight plots in unobstructed sunlight and in the presence of passing clouds. The ground coverage values estimated by these images were not significantly different (Fig. 3). Therefore, the digital imaging technique is not limited by days with unobstructed sunlight.

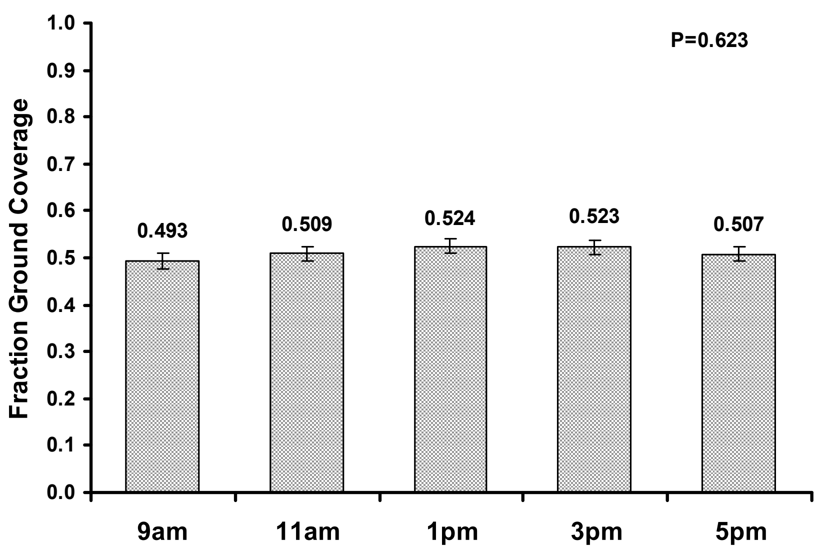

Fig. 2. Ground coverage estimates from digital images taken every two hours in unobstructed sunlight (P value and ± 1 std. error bars are shown).

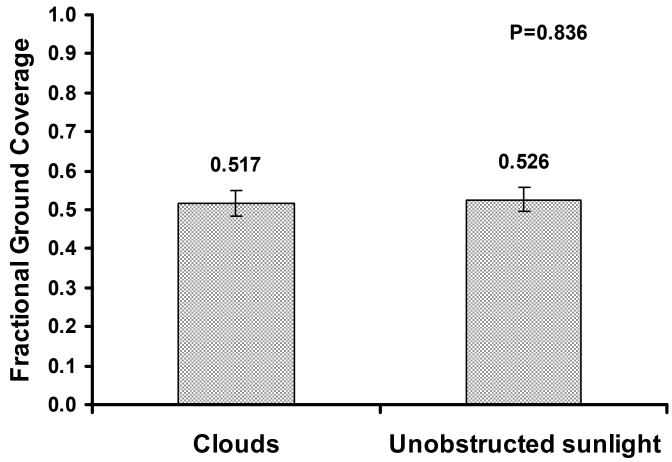

Fig. 3. Ground coverage estimates from digital images taken at the presence of passing clouds and in unobstructed sunlight (P value and ± 1 std. error bars are shown).

References

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