Real-Time Imaging of Ground Cover: Relationships with Radiation Capture, Canopy Photosynthesis, and Daily Growth Rate

We have long known that crop yield is determined by the efficiency of four component processes: (i) radiation capture, (ii) quantum yield, (iii) carbon use efficiency, and (iv) carbon partitioning efficiency. Cumulative absorbed radiation is highly correlated with crop biomass and yield. In this paper we describe the use of a digital camera and commercial imaging software for estimating daily radiation capture, canopy photosynthesis, and relative growth rate in a controlled environment.

Digital images were used to determine percentage of ground cover of lettuce (*Lactuca sativa* L.) communities grown at five temperatures. Plants were grown in a steady-state, 10-chamber CO_2 gas exchange system, which was used to measure canopy photosynthesis and daily carbon gain. As temperature increased, so did the ratio of carbon gain to ground cover, indicating an increase in photosynthetic activity. This was expected since plants in the warmer treatments had more upright growth, a higher leaf area index, and greener leaves than cooler treatments (Figure 1). With increasing temperature, the ratio of radiation absorption to ground cover tended to increase, indicating the amount of light available to the plants for photosynthesis increased (Figure. 2). Ground cover was also highly correlated with daily carbon gain at each temperature. Based on daily carbon gain the 30°C treatment was optimal. Light absorption is more directly related to daily carbon gain than ground cover, and the relationship was thus more linear.

Figure 1-Successive overhead pictures of the 21°C (bottom) and 30°C (top) canopies showing the differences in color and growth between these treatments.

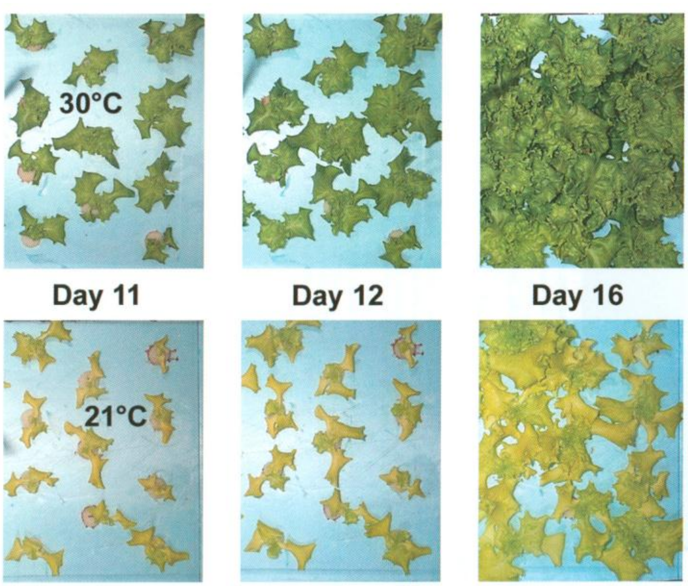
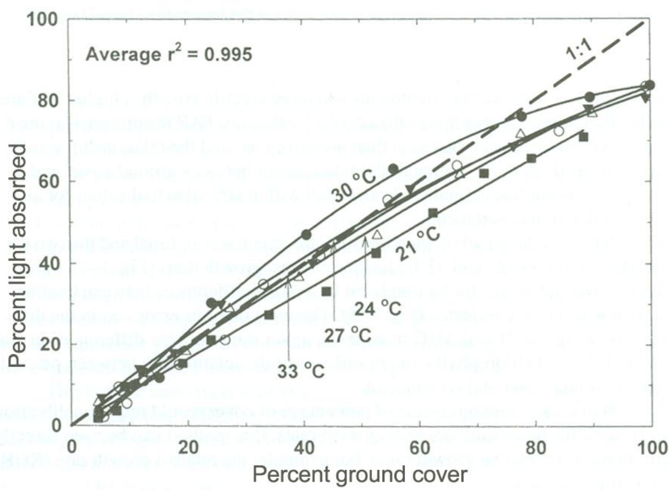
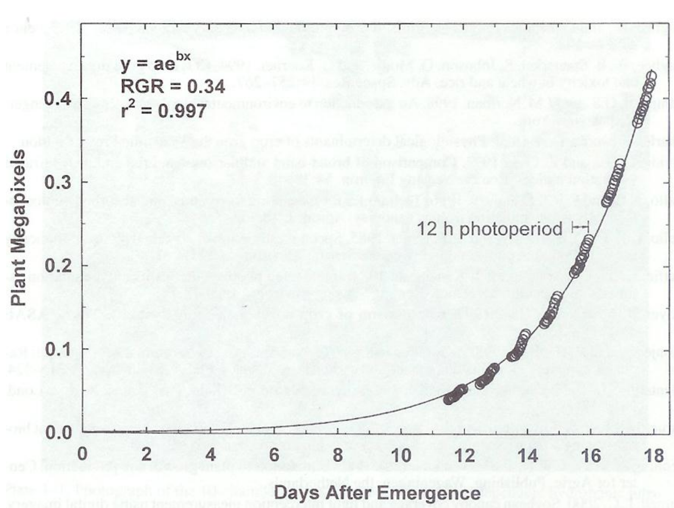


Figure 2-Relationship between fraction of ground cover to light absorption. Different temperatures had slightly different correlations because the color of the leaf changed causing different amounts of light to be reflected or absorbed.



Data also shows that hourly growth of a single plant can be monitored by using an automated digital camera (Figure 3). The increase in size of a single lettuce plant was measured by overhead images taken hourly during the light period for seven days. The relative growth rate of the plant was calculated and showed that this type of hourly analysis may be a useful tool for the early detection of plant stresses that influence rates of leaf expansion such as drought or flooding stress.

Figure 3-Hourly measurements of plant growth (measured by number of pixels in digital image). This resolution permits measurements of plant stresses that influence leaf expansion rates



For more information, contact: Jonathan Frantz, jonathanfrantz319@gmail.com. Dr. Frantz now works for Dupont Pioneer.

Klassen, S. P., Ritchie, G., Frantz, J. M., Pinnock, D., and Bugbee, B. 2003. Real time imaging of ground cover: relationships with radiation capture, canopy photosynthesis, and relative growth rate. Special pub. of the Crop Science Society of America, No 66:3-14.