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Diffuse Light Panels Slightly Increase Canopy Light Use Efficiency but Decrease Light Intensity and Canopy Photosynthesis of Lettuce

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Over-absorption of light by the upper plant canopy limits light to the lower leaves and thus reduces canopy light use efficiency (photosynthesis per unit absorbed light).

Diffuse light penetrates to the lower leaves of a canopy better than direct light, resulting in more uniform distribution of light (Tubiello et al. 1997). Increasing the fraction of diffuse light might increase light use efficiency.

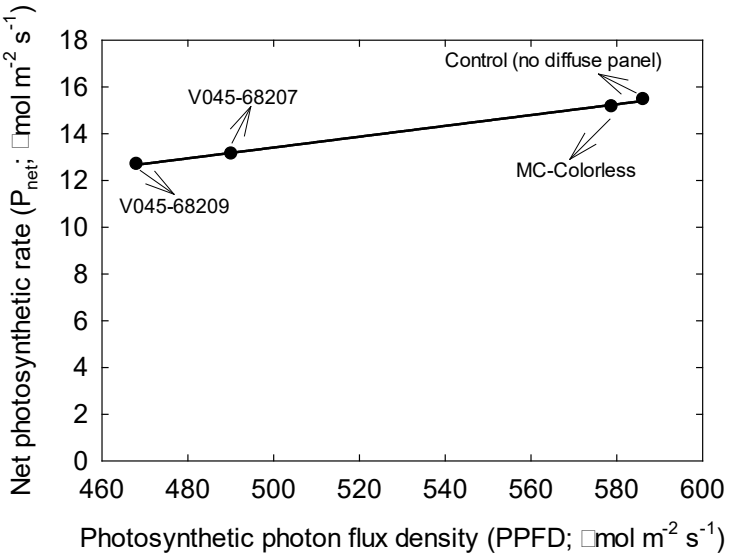
The objective of this study was to determine if increasing the fraction of diffuse light could increase canopy light use efficiency and photosynthesis.

Lettuce in the whole-canopy gas exchange chamber

We measured whole-canopy photosynthesis of lettuce under a red (70%) and blue (30%) LED light. Red and blue light is quickly absorbed by the upper plant canopy compared to white light, which contains green photons that penetrate deeper into the canopy. Therefore, increasing the fraction of diffuse light should have a bigger effect on photosynthesis under red and blue light than that under white light.

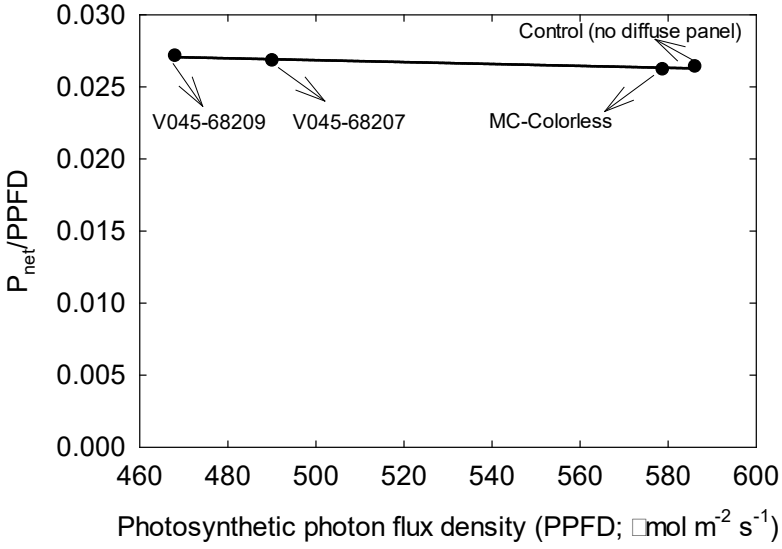
Four mature plants were placed in the gas-exchange chamber to achieve nearly 100% canopy closure. The chamber was maintained at 25 C and enriched to 800 ppm CO_2. After steady state canopy photosynthesis was reached, a diffuse light panel was placed underneath the LED light bars to increase the fraction of the diffuse light inside the chamber. Three types of diffuse panels were tested (V045-68207, V045-68209, and MC-Colorless). Light intensity at the top of the plant canopy was measured at 12 locations inside the chamber under different treatments.

The diffuse light panels caused photosynthetic photon flux density (PPFD) to decrease by 1 to 20%, depending on the type of the panel. Consequently, canopy net photosynthesis decreased by 2 to 18% compared to the control treatment without diffuse panel.



Canopy light use efficiency, the ratio of P_{net} to incident PPFD, increased slightly by 2 to 3% under diffuse panels V045-68207 and V045-68209.

The small increase in canopy light use efficiency may be associated with the lower light intensity under diffuse panels: it is a common to have higher light use efficiency under lower light.



Note that the gas exchange chamber had highly reflective walls that increase the uniformity of canopy light distribution. The fraction of diffuse light inside the chamber is likely high even before inserting the diffuse panels.

It is possible that diffuse light may have a bigger effect on light use efficiency when scaled up to a larger plant canopy.

Reference: **Tubiello, F., T. Volk, and B. Bugbee. 1997. Diffuse light and wheat radiation-use efficiency in a controlled environment. Life Support Biosphere Sci., 4, 77-85.**