USING LEDs TO MANIPULATE RED:FAR-RED RATIO AND PHOTOMORPHOGENESIS IN CONTROLLED ENVIRONMENTS

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Light signals play a crucial role in determining the architecture of individual plants and canopies. In dense stands of plants, reflected far-red light (wavelengths in the range 700-750 nm) signals lead to reductions in red:far-red ratio (R:FR ratio), which are perceived by the phytochromes, a family of photochromic regulatory photoreceptors. Reductions in R:FR ratio trigger shade avoidance reactions, resulting in increased elongation of internodes and petioles with a concomitant reduction in allocation of resources to harvestable components such as seeds, roots or tubers.

Our understanding of the perception of R:FR ratio signals and the roles of individual members of the phytochrome family, as well as efforts to experimentally eliminate shade avoidance responses in crop plants, has been dependent on the construction of controlled environments in which R:FR ratio can be manipulated. The conventional approach to manipulating R:FR ratio has been to create polychromatic light sources where white light is supplemented with high photon irradiances of far-red light, generated by filtering the output of high-energy incandescent lamps through appropriate filters. The use of high-energy incandescent lamps consumes significant amounts of energy and generates massive amounts of heat. The greatest challenge in constructing low R:FR ratio controlled environments has been the dissipation of excess heat, usually involving windows of flowing refrigerated water.

Recently, we have created a new generation of low R:FR ratio controlled environments using optoelectronics. By manufacturing arrays of LEDs (light emitting diodes) with emission maxima at 735 nm, we have been able to produce low R:FR ratio sources by a simple modification of existing controlled environment growth rooms or cabinets. The LEDs generate virtually no heat, have very low energy consumption and estimated lifetimes of several years.