Optimizing Hydroponic Plant Growth and Energy Usage with LED Spectral Manipulation

Pivonka, April (School: Camp Hill High School)

Feeding nine billion people is a daunting task, but the reality we will face by the mid twenty-first century. Population growth and climate change will require alteration of agricultural practices. One method is hydroponics, where plants are grown without soil in a controlled greenhouse, producing starter plants. This method is being implemented to meet food demands. Modern greenhouse practices involve 2 growing processes. Currently, seedlings are developed for 11 days of the 35-day cycle utilizing fluorescent lighting. They are transferred to the cultivation process using natural sunlight. Contrary to common practice, advances in Light-emitting diode (LED) technology have made them a better choice for starter plant production. Advantages over fluorescent lighting include cooler temperatures, lower energy costs, and the ability to select light spectrums. This experiment focused on determining which LED color/wave lengths or combinations are most beneficial in producing hydroponic lettuce starter plants. I built a greenhouse with 4 Hydroponic growing systems which were Blue LEDs, Red LEDs, Blue/Red LEDs, and fluorescent lights (industry standard). I concluded that Blue LED or Full Spectrum (Blue/Red) LED lighting would provide a good replacement source for lettuce starter plant growth. Also, both systems had nearly identical energy savings. In terms of plant size and stem structure, the Blue LED system had the lowest shoots to roots ratio of the LED lighting systems, thus indicating healthy plant growth after transplantation. By utilizing hydroponics with LED lights, we can maximize electrical efficiency, thus reducing the agricultural footprint and allowing for mass production of food.

Awards Won: