2022 NCERA-101 Station Report – University of Delaware

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https://www.indooraglab.com/

1. New facilities and equipment

We purchased instruments including: 1) a freeze dryer (Harvest Right); 2) temperature and humidity sensors (Onset Computers); and 3) quantum sensors (Apogee Instruments).

2. Unique plant responses

- MS student, Emily Kennebeck, and Qingwu Meng investigated growth responses of mustard green 'Amara' seedlings to lighting treatments with and without far-red light in tandem with two ambient carbon dioxide concentrations from Earth and the International Space Station. 'Amara' seedlings decreased in shoot fresh and dry mass and leaf area when under lighting treatments with far-red light compared to treatments without far-red light. The superelevated carbon dioxide concentration increased shoot fresh and dry mass and leaf area of mustard 'Amara' seedlings and was not a plant growth stressor.
- PhD student, Eva Birtell, and Qingwu Meng assessed the influence of spectral quality and quantity on the vegetative growth and morphology of indoor-grown hot peppers. Increasing the blue light proportion decreased plant height but increased chlorophyll concentration and compactness. Increasing the PPFD proportionally did not affect most parameters, whereas increasing the PPFD with fixed blue and green light increased shoot dry mass, root dry mass, and stem width. Adding far-red light increased plant height but decreased the chlorophyll index, compactness, branching, and intumescence.
- Undergraduate student, Evyn Appel, and Qingwu Meng investigated the impact of nutrient solution concentration on lettuce grown in an unadjusted Kratky-style hydroponic setup. Results suggested that increasing the initial electrical conductivity increased shoot fresh mass following the law of diminishing returns. All other plant growth parameters plateaued as the initial electrical conductivity reached 0.5 or 1.0 dS/m.

3. Accomplishment summaries

- Undergraduate student, Evyn Appel, and Qingwu Meng explored programming of Raspberry Pi and installing imaging devices to track and monitor plant growth. With overhead infrared images, we quantified the progressive growth of the plant canopy.
- Qingwu Meng created and taught a new graduate-level course, Controlled Environment Crop Physiology and Technology, with 10 students enrolled. This course allowed students to gain insights on principle concepts and familiarity with practical tools in controlled environment agriculture.

4. Impact statements

- Our hydroponic leafy green research revealed species-dependent responses to far-red light under ambient-Earth and superelevated carbon dioxide concentrations, providing data to facilitate spectral customization in space crop production.
- We have gained experience with indoor hydroponic cultivation of hot peppers under different spectral conditions, fertilizer strengths, and nutrient management methods. This knowledge will advise future research on environmental and cultural optimization to improve pepper yield and quality.
- Qingwu Meng published two articles with Erik Runkle (Michigan State University) in the Produce Grower magazine. These articles summarized their latest research on LED lighting in indoor hydroponic lettuce production for professionals in the controlled-environment agriculture industry.

5. Published written works

Scientific publication

- Runkle, E.S., Y. Park, and Q. Meng. 2022. High photosynthetic photon flux density can attenuate effects of light quality. Acta Hort. 1337:333–340.

Trade magazine articles

- Meng, Q. and E.S. Runkle. 2022. Photoperiod, light intensity, and daily light integral. Produce Grower.
- Meng, Q. and E.S. Runkle. 2022. Fixed vs. dynamic light quality for indoor hydroponic lettuce. Produce Grower.