2021 NCERA-101 Station Report – University of Delaware

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https://www.indooraglab.com/

1. New facilities and equipment

We have completed the development of the Delaware Indoor Ag Lab (DIAL), which is housed in the Fischer Greenhouse Complex at the University of Delaware. This lab will serve as the main indoor agriculture research facility in Delaware with state-of-the-art LED technology and environmental control systems. It has three separate sections in the same room to allow for multiple simultaneous research projects:

- Two 3-tier shelving units are equipped with Osram Phytofy RL LED fixtures for indoor plant research on interactions among light quality, intensity, and duration. Each fixture has six independently programmable color channels, including ultraviolet-A, blue, green, red, far red, and warm white. We have installed vertical and horizontal fans to promote air movement and temperature and humidity sensors (Onset) to collect data on each shelf.

- Four 3-tier shelving units are equipped with arrays of Demegrow LED fixtures for indoor plant research on light intensity and duration. The warm-white LED fixtures are dimmable with adjustable timing through wireless smartphone control.

- Four reach-in plant growth chambers from Percival Scientific are dedicated to indoor plant research on environmental optimization. Each chamber has precise control of light, air temperature, relative humidity, and carbon dioxide concentration. Two tiers within each chamber have tunable LED arrays comprised of four independent color channels, including blue, green, red, and far red. All environmental parameters are adjustable and monitored through a touchscreen interface.

We have purchased a variety of instruments for plant data collection including: 1) a CIRAS-3 photosynthesis system (PP Systems); 2) a CI-202 leaf area meter (CID Bio-Science); 3) a CR-10 Plus color reader (Konica Minolta Sensing); 4) analytical and top-loading balances (A&D); 5) a Genesys 40 Vis spectrophotometer (Fisher Scientific); 6) quantum sensors and a field spectroradiometer (Apogee); 7) an MC-100 chlorophyll meter (Apogee); and 8) a forced-air drying oven (Shel Lab).

2. Unique plant responses

- Undergraduate student Stefanie Severin and Qingwu Meng investigated how alternate light intensities at 12-h intervals influenced indoor tomato, lettuce, and arugula seedling growth. Experimental results indicated that the effects of the daily light integral depended on the allocation of light over time and crop type. Doubling the daily light integral increased shoot mass of arugula but did not affect that of lettuce.

3. Accomplishment summaries

- Qingwu Meng designed, developed, and constructed the Delaware Indoor Ag Lab (DIAL) at the University of Delaware. In addition, Qingwu Meng led the construction of photoperiodic lighting structures in a research greenhouse.

- Qingwu Meng created and taught a new course, Hydroponic Food Production, in which 28 students learned about hydroponic techniques in controlled environments. A new hands-on lab section allowed students to build, test, and manage various hydroponic systems and grow leafy greens and culinary herbs in a greenhouse environment.

- Qingwu Meng published a series of three 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.

4. Impact statements

- The development and establishment of the Delaware Indoor Ag Lab (DIAL) have enabled controlled-environment research to optimize lighting and environmental variables for a wide range of specialty crops. We will use this research facility to help indoor growers determine efficient lighting and environment management strategies.

- Qingwu Meng was a featured speaker at the TEDxUniversityofDelaware event on October 1, 2021. His talk was entitled "How Do We Grow Food Anywhere, Without Soil?" This in-person event was livestreamed, attracting 283 participants (172 in-person and 111 virtual). It was the largest in-person event ever held by the TEDxUniversityofDelaware.

- Qingwu Meng created a YouTube channel, Grow Anywhere, to publish educational videos that teach the public to 1) understand plant responses to environmental variables in controlled environments; and 2) build hydroponic setups to grow food crops at home, in a greenhouse, or in an indoor facility. This channel has amassed 435 subscribers in a year. Two recent videos have gained 7,065 and 4,144 views.

5. Published written works

Refereed journal articles

1. Meng, Q. and E.S. Runkle. 2020. Growth responses of red-leaf lettuce to temporal spectral changes. Front. Plant Sci. 11:571788. DOI: https://doi.org/10.3389/fpls.2020.571788
2. Kelly, N., D. Choe, Q. Meng, and E.S. Runkle. 2020. Promotion of lettuce growth under an increasing daily light integral depends on the combination of the photosynthetic photon flux density and photoperiod. Sci. Hort. 272:109565. DOI: https://doi.org/10.1016/j.scienta.2020.109565

3. Lopez, R.G., Q. Meng, and E.S. Runkle. 2020. Blue radiation signals and saturates photoperiodic flowering of several long-day plants at crop-specific photon flux densities. Sci. Hort. 271:109470. DOI: https://doi.org/10.1016/j.scienta.2020.109470
4. Meng, Q., J. Boldt, and E.S. Runkle. 2020. Blue radiation interacts with green radiation to influence growth and predominantly controls quality attributes of lettuce. J. Amer. Soc. Hort. Sci. 145:75–87. DOI: https://doi.org/10.21273/JASHS04759-19

Trade magazine articles

- Meng, Q. and E.S. Runkle. 2021. Far-red and PPFD: a tale of two lettuce cultivars. Produce Grower. Link: https://www.producegrower.com/article/far-red-and-ppfd-a-tale-of-two-lettuce-cultivars/
- Meng, Q. and E.S. Runkle. 2021. Differentiating broad spectra. Produce Grower. Link: https://www.producegrower.com/article/differentiating-broad-spectra/
- Meng, Q. and E.S. Runkle. 2021. LEDs on lettuce: white light versus red + blue light. Produce Grower. Link: https://www.producegrower.com/article/production-leds-on-lettuce-white-light-versus-red-blue-light/

Conference presentations

- Meng, Q. and E.S. Runkle. 2021. Blue photons in broad spectra determine lettuce yield, morphology, and color. HortScience 56(9):S12 (oral presentation). YouTube link: https://youtu.be/F-MiNlbq4fo
- Meng, Q. and E.S. Runkle. 2020. Growth responses of red-leaf lettuce to temporal changes in light quality. HortScience 55(9):S32 (oral presentation). YouTube link: https://youtu.be/IapQWGAGcIM
- Stallknecht, E., E.S. Runkle, and Q. Meng. 2020. Phasic lighting strategies to improve indoor lettuce production. HortScience 55(9):S32 (poster presentation).

Website and social media developed

- Delaware Indoor Ag Lab (DIAL) website: https://www.indooraglab.com/
- DIAL YouTube: https://www.youtube.com/channel/UCWd-eVKfUUFO_gksFHi_Kzw
- DIAL Twitter: https://twitter.com/IndoorAgLab
- DIAL Facebook: https://www.facebook.com/IndoorAgLab
- DIAL Instagram: https://www.instagram.com/indooraglab/
- Grow Anywhere YouTube: https://www.youtube.com/channel/UCe5jYGpVL53pqFUxEni2xpg