2024 NCERA-101 Station Report – University of Delaware

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1. New facilities and equipment

The University of Delaware developed a new indoor photobiology laboratory space (240 ft^2), which was equipped with three heavy-duty growing racks, each with two shelves and four color-tunable LED fixtures per shelf. Air-circulation fans, hydroponic trays, and temperature and humidity data loggers were also installed.

2. Unique plant responses

- The University of Delaware performed a greenhouse experiment to improve germination and growth of four hydroponic baby spinach cultivars. Reduced moisture levels in the pre-moistened peat-based substrate improved germination. Active aeration of the nutrient solution increased dissolved oxygen availability and plant growth.
- The University of Delaware investigated whether a calcium-mobilizing biostimulant mitigated tipburn in greenhouse hydroponically grown lettuce 'Rex' and 'Dragoon'. The optimal biostimulant concentration was identified to effectively decrease tipburn occurrence and severity with little to no biomass reduction at maturity.
- The University of Delaware performed a greenhouse experiment to evaluate how the timing of nighttime photoperiodic lighting influenced flowering of long-day plants under warm-white or red + far-red (R+FR) light-emitting diodes (LEDs). When delivered for 8 h at night, warm-white LEDs are generally less effective than R+FR LEDs at promoting flowering of long-day ornamentals but similarly effective as 4-h night-break lighting. The effectiveness of day-extension lighting is generally independent of timing, although for R+FR LEDs, 8-h after-dusk and/or before-dawn lighting was generally more effective than 4-h night-break lighting.

3. Accomplishments

3.A. Short-term outcomes

- The University of Delaware collaborated with an industry partner, Croda, Inc. and found that a calcium-mobilizing biostimulant continued to show high efficacy against tipburn in greenhouse hydroponic lettuce production while maintaining high biomass accumulation. The product was applied in the nutrient solution at varying concentrations on two lettuce cultivars grown under high daily light integrals and controlled tipburn occurrence and severity at the optimal concentration.

3.B. Outputs

- The University of Delaware collaborated with an industry partner, Croda, Inc. on a peer-reviewed publication in HortScience. This paper showed that a chemical biostimulant

was effective at reducing tipburn of greenhouse hydroponic lettuce 'Rex' without compromising biomass accumulation.
- The University of Delaware published a peer-reviewed article in HortScience based on a NASA-funded study. This paper characterized mustard green growth with or without far-red light under ambient-Earth and elevated CO_2 concentrations.
- The University of Delaware published an article on photoperiodic lighting control of flowering in greenhouse ornamental production in the trade magazine GrowerTalks based on a study funded by the American Floral Endowment (AFE).

3.C. Activities

- The University of Delaware (Project Director, PD), Arizona State University (Co-PD), and Colorado State University (Co-PD) collaborated on a research-education grant proposal and received a multi-year USDA NIFA Urban, Indoor, and Emerging Agriculture grant (titled Tailoring Hydroponic Factors to Controlled-Environment Production of Emerging Food Crops).
- The University of Delaware collaborated with an industry partner, Croda, Inc., to evaluate the efficacy of a calcium-mobilizing chemical biostimulant at mitigating lettuce tipburn in greenhouse hydroponic production. We conducted one greenhouse experiment and worked on data analysis and interpretation.

3.D. Milestones

- The University of Delaware led a successful renewal of the multistate NE-2335 (formerly NE-1835, Resource Optimization in Controlled Environment Agriculture) project that will continue to benefit the controlled-environment agriculture industry. The University of Delaware also organized the in-person NE-1835 annual meeting on July 31, 2023 in Orlando, FL, where members discussed collaborative efforts and shared project progress.
- The University of Delaware is on track to advance greenhouse and indoor crop production research planned through grant-funded projects.

4. Impact statements

- Tipburn of lettuce is a major crop physiological disorder that severely affects crop quality and leads to economic losses in the controlled-environment agriculture industry. The collaboration between the University of Delaware and Croda, Inc. has identified the optimal concentration of a chemical biostimulant as an effective solution to decrease the lettuce tipburn rating by 88% without affecting yield in greenhouse conditions. This product thus has potential for wider industry adoption to enhance crop quality and harvestable yield.

5. Published written works

5.A. Scientific peer-reviewed journal articles

- Biradar, K. and Q. Meng*. 2024. Nutrient solution application of a calcium-mobilizing biostimulant mitigates tipburn without decreasing biomass of greenhouse hydroponic lettuce. HortScience 59(1):92–98. [CrossRef]

- Kennebeck, E.J. and Q. Meng*. 2024. Mustard 'Amara' benefits from superelevated CO_2 while adapting to far-red light over time. HortScience 59(2):139–145. [CrossRef]
- Kennebeck, E.J. and Q. Meng*. 2024. Far-red light and nitrogen concentration elicit crop-specific responses in baby greens under superelevated CO_2 and continuous light. J. Amer. Soc. Hort. Sci. 149(2):92–98. [CrossRef].
- Meng, Q.* and S.N. Severin. 2024. Continuous light can promote growth of baby greens over diurnal light under a high daily light integral. Environ. Exp. Bot. 105695. [CrossRef]

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5.B. Scientific presentation abstracts

- Biradar, K.* and Q. Meng. 2023. A calcium-mobilizing biostimulant mitigates lettuce tipburn in greenhouse hydroponic production (abstr). HortScience 58(9S):S129. [oral]
- Biradar, K.* and Q. Meng. 2023. Low substrate moisture improves germination while active aeration of the nutrient solution increases growth of greenhouse hydroponic baby spinach (abstr). HortScience 58(9S):S19. [poster]
- Elias, S.*, Q. Meng, E. Ervin, and G.C. Johnson. 2023. Phytocompounds concentrations in baby ginger (*Zingiber officinale*) plant parts: Prospect toward sustainable consumption (abstr). HortScience 58(9S):SR40. [oral]
- Elias, S.*, Q. Meng, E. Ervin, and G.C. Johnson. 2023. Unexploited potential for baby ginger (*Zingiber officinale*) farming and consumption in the Mid-Atlantic region of the United States (abstr). HortScience 58(9S):SR10. [oral]
- Kohler, A.E., E.M. Birtell, E.S. Runkle, and Q. Meng*. 2023. Day-extension blue light inhibits flowering of chrysanthemum when the short main photoperiod includes far-red light (abstr). HortScience 58(9S):S249. [oral]
- Meng, Q.*, E. Kennebeck, and I. Kelly. 2023. Reduced black cloth application saves on labor while ensuring flowering of chrysanthemum (abstr). HortScience 58(9S):S44. [oral]
- Meng, Q.* and I. Kelly. 2023. Nighttime light quality determines flowering of long-day ornamentals irrespective of timing (abstr). HortScience 58(9S):S226. [oral]
- Meng, Q.* and S.N. Severin. 2023. The alternating light pattern and daily light integral interactively determine crop-specific growth responses indoors (abstr). HortScience 58(9S):S286. [oral]

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5.C. Trade magazine articles

- Meng, Q. 2023. Measuring the efficacy of LEDs: Timing white versus red + far-red LEDs to control flowering. GrowerTalks 4:42–43.