Michigan State University 2019 Station Report

NCERA-101: Committee on Controlled Environment Technology & Use

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New equipment and facilities

- We received 18 new Phytofy RL fixtures (each with 6 independently controlled LED channels) from Osram/Fluence, which are used to light 6 growing canopies inside the Controlled-Environment Lighting Laboratory. These fixtures replace 25% of the prototype fixtures delivered in early 2017.
- We purchased a CID Bio-Science CI-340 Handheld Infrared Gas Analyzer to analyze leaf photosynthesis, respiration, transpiration, stomatal conductance, and internal CO_2, a CID Bio-Science CI-110 Plant Canopy Analyzer to capture 150° images of plant canopies and estimate canopy leaf area index, a Felix-750 Near-Infrared Spectrometer to measure crop color (anthocyanins), and a Li-Cor LI-180 Spectroradiometer to measure light intensity and quality.

Accomplishment summaries

- Coordinated several outreach programs that delivered unbiased, research-based information on producing plants in controlled environments, including the Michigan Greenhouse Growers Expo and the Floriculture Research Alliance annual meeting.
- Developed a new page on the MSU Extension Floriculture & Greenhouse Crop Production website that includes MSU-authored resources on the production of plants in controlled environments, with categories such as “greenhouse temperature management” and “light management in greenhouses & controlled environments”.
- Runkle is project director and Lopez is a principal investigator in a new, four-year project supported by the USDA Specialty Crops Research Initiative entitled “Improving the profitability and sustainability of indoor leafy-greens production”, in collaboration with colleagues at Arizona, Michigan State, Purdue, Ohio State, and the USDA-ARS.
- Former Ph.D. student Qingwu Meng and Erik Runkle studied the effects of green and blue light on plant morphology and quality attributes of red-leaf lettuce. The research results indicate that growth attributes were primarily controlled by blue light, and green light maintained or suppressed lettuce growth, depending on the intensity of blue light.
- Former post-doctoral research associate Yujin Park and Erik Runkle investigated how substituting green with red radiation influenced plant growth with and without far-red radiation in an indoor environment. The results showed the utility of including far red in an indoor radiation spectrum, but there was little to no value of including green radiation.
- M.S. student Annika Kohler and Roberto Lopez quantified how air and root-zone temperature influence rooting and morphology of cold-tolerant, cold-intermediate, and cold-sensitive bedding plants and herbs. The results indicate that un-rooted cutting responses to air and root-zone temperature are species-dependent. Most cold-tolerant species can be propagated with air average daily temperatures and root-zone temperatures of 16 °C and 21 to 24 °C, respectively, without sacrificing plant quality or delaying rooting.

- M.S. student Anthony Soster and Roberto Lopez investigated if supplemental lighting containing a moderate amount of blue light ($\geq$15 µmol·m^{-2}·s^{-1}) was as effective as low intensity photoperiodic or high-pressure sodium (HPS) lamps at inducing long day perennials into flower. The results indicate that providing 30 µmol·m^{-2}·s^{-1} of blue light is as effective as low-intensity photoperiodic and HPS lamps. Additionally, plants finished under 50 to 90 µmol·m^{-2}·s^{-1} of supplemental light are generally of higher quality than those finished under photoperiodic lighting.
- Ph.D. candidate Kellie Walters and Roberto Lopez quantified the influence of daily light integral and CO_2 concentration on growth and development of dill, parsley, and sage transplants produced indoors. The results indicate that increasing the light intensity from 100 µmol·m^{-2}·s^{-1} to 400 or 600 µmol·m^{-2}·s^{-1} results in increased mass at transplant and increased subsequent yields while elevating CO_2 concentration during the seedling stage has minimal to no affect.

Impact statements

- The Michigan Greenhouse Growers Expo and Floriculture Research Alliance meeting delivered unbiased, research-based information to over 400 greenhouse growers, plus additional growers and marketers of vegetable and fruit crops.
- We learned more about the advantages and disadvantages of including green light in an indoor lighting spectrum. This information helps indoor (vertical) farm growers determine what lighting spectrum to deliver to their crops.
- Due to increased plant densities during seedling production, fewer inputs per plant are required, creating the potential to increase production efficiency. Faster growth rates can result in reduced production time and increased yields. By understanding and modeling the effect of daily light integral and CO_2 concentration on culinary herbs, growers can conduct cost-benefit analysis to increase profitability and group plants with similar daily light integral and CO_2 responses in a common environment.

Published written works (*denotes peer reviewed)

1. *Craver, J.K., J.K. Boldt, and R.G. Lopez. 2019. Comparison of supplemental lighting provided by high-pressure sodium lamps or light-emitting diodes for the propagation and finishing of bedding plants in a commercial greenhouse. HortScience 54(1):52–59.
2. Craver, J., K. Nemali, and R. Lopez. 2019. Monitoring growth of bedding plant seedlings using images. Greenhouse Management 39(10):53−56.
3. *Gomez. C., C.J. Currey, R.W. Dickson, H. Kim, R. Hernández, N.C. Sabeh, R.E. Raudales, R.G. Brumfield, A. Laury-Shaw, A.K. Wilke, R.G. Lopez, and S.E. Burnett. 2019. Controlled environment food production for urban agriculture. HortScience 54(9):1448–1458.
4. *Hurt, A., J.K., Craver, and R.G. Lopez. 2019. Supplemental but not photoperiodic lighting increased seedling quality and reduced production time of annual bedding plants. HortScience 54(2):289–296.
5. Lopez, R.G. 2019. Will greenhouse crops recover from chilling or freezing injury? e-GRO Alert 8(11):1–5.
6. Lopez, R.G. and W.G. Owen. 2019. Preparing your greenhouse for the next cold spell or polar vortex. e-GRO Alert 8(8):1–5.
7. Meng, Q. and E. Runkle. 2019. Green and blue LED lighting. Produce Grower (Mar.):20-24.
8. Meng, Q. and E. Runkle. 2019. Green & far red LED lighting. Produce Grower (Feb.):22-25.

9. Meng, Q. and E. Runkle. 2019. How green light affects floriculture crops. Greenhouse Grower 37(2):26-28.
10. *Meng, Q. and E.S. Runkle. 2019. Far-red radiation interacts with relative and absolute blue and red photon flux densities to regulate growth, morphology, and pigmentation of lettuce and basil seedlings. Sci. Hort. 255:269-280.
11. *Meng, Q. and E.S. Runkle. 2019. Regulation of flowering by green light depends on its photon flux density and involves cryptochrome. Physiol. Plant. 166:762-771.
12. *Meng, Q., N. Kelly, and E.S. Runkle. 2019. Substituting green or far-red radiation for blue radiation induces shade avoidance and promotes growth in lettuce and kale. Environ. Exp. Bot. 162:383-391.
13. *Owen, W.G. and R.G. Lopez. 2019. Comparison of sole-source and supplemental lighting on callus formation and initial rhizogenesis of Gaura and Salvia cuttings. HortScience 54(4):684–691.
14. *Owen, W.G. and R.G. Lopez. 2019. Stacking substrate-filled containers influence root and shoot growth of bedding plants. Acta Hort. 1266:369–374
15. *Park, Y. and E.S. Runkle. 2019. Blue radiation attenuates the effects of the red to far-red ratio on extension growth but not on flowering. Environ. Exp. Bot. 168 (article 103871).
16. Park, Y. and E. Runkle. 2019. LEDs: Blue & far-red light. GrowerTalks 82(12):58-60.
17. Park, Y. and E. Runkle. 2019. LEDs: Far red & light intensity interaction. GrowerTalks 82(11):54-57.
18. Runkle, E. 2019. An overview of long-day lighting. Greenhouse Product News 29(7):58.
19. Runkle, E. 2019. Crops suitable for indoor farming. Greenhouse Product News 29(4):42.
20. Runkle, E. 2019. DLI ‘requirements’. Greenhouse Product News 29(5):50.
21. Runkle, E. 2019. Ethylene in floriculture. Greenhouse Product News 29(1):50.
22. Runkle, E. 2019. Greenhouse environment checklist. Greenhouse Product News 29(10):50.
23. Runkle, E. 2019. How much supplemental lighting do you need? Greenhouse Product News 29(12):42.
24. Runkle, E. 2019. Including far red in an LED lighting spectrum. Greenhouse Product News 29(9):58.
25. Runkle, E. 2019. Is green light useful to plants? Greenhouse Product News 29(6):50.
26. Runkle, E. 2019. Managing light pollution. Greenhouse Product News 29(8):50.
27. Runkle, E. 2019. Propagation pointers. Greenhouse Product News 29(11):42.
28. Runkle, E. 2019. Selecting an LED fixture. Greenhouse Product News 29(2):42.
29. Runkle, E. 2019. Success with PGRs. Greenhouse Product News 29(3):42.
30. *Runkle, E.S. 2019. Environmental control of the flowering process of Phalaenopsis orchids. Acta Hort. 1262:7-12.
31. *Runkle, E.S., Q. Meng, and Y. Park. 2019. LED applications in greenhouse and indoor production of horticultural crops. Acta Hort. 1263:17-30.
32. Runkle, E., Y. Park, M. Zhang, and P. Fisher. 2019. Lighting young plants indoors. GrowerTalks 82(10):58-60.
33. Soster, A., K. Walters, B. Poel, M. Yelton, and R. Lopez. 2019. Forcing long-day perennials into flower with high-intensity LEDs. Greenhouse Grower 37(11):28–30.
34. *Zhang, M. and E.S. Runkle. 2019. Regulating flowering and extension growth of poinsettia using red and far-red light-emitting diodes for end-of-day lighting. HortScience 54:323-327.
35. *Zhang, M., C.W. Whitman, and E.S. Runkle. 2019. Manipulating growth, color, and taste attributes of fresh cut lettuce by greenhouse supplemental lighting. Sci. Hort. 252:274-282.
36. Zhang, M., Y. Park, and E. Runkle. 2019. A little far-red light goes a long way. GrowerTalks 83(1):58-61.
37. *Walters, K.J., A. Hurt, and R.G. Lopez. 2019. Flowering, stem extension growth, and cutting yield of foliage annuals in response to photoperiod. HortScience 54(4):661–666.
38. Walters, K.J. and R.G. Lopez. February 2019. Basil raft system issues. e-GRO Blog.

39. Walters, K.J. and R.G. Lopez. March 2019. Reservoir nutrient solution siphoning. e-GRO Blog.
40. Walters, K.J. and R.G. Lopez. 2019. Lighting basil seedlings. Produce Grower:28−32.
41. Walters, K.J. and R.G. Lopez. 2019. Controlled environment agriculture (CEA) carbon dioxide injection. Produce Grower:26−28.