Michigan State University 2016 Station Report
NCERA-101: Committee on Controlled Environment Technology & Use

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Personnel

- Dr. Roberto Lopez joined the faculty in the Department of Horticulture in March, 2016 as an assistant professor in the production of specialty crops grown in controlled environments. He has a 45% research, 30% teaching, and 25% extension appointment.
- Dr. Garrett Owen was hired in the Department of Horticulture as an Outreach Specialist in greenhouse production of floriculture crops and other specialty crops grown in controlled environments, primarily serving southeast Michigan. He has an 85% outreach and 15% research appointment.

New Equipment and Facilities

- Room renovations for the Controlled-Environment Lighting Laboratory (CELL; www.hrt.msu.edu/labs/cell) are nearly complete. The facility consists of two independently controlled and refrigerated growth rooms, each with 12 deep-flow hydroponic shelves. Sole-source lighting in CELL utilizes customized, state-of-the-art LED arrays developed in collaboration with Osram and Osram Opto Semiconductors. Computer software enables digital light control of individual shelves, allowing for temporal alternations of light quality and intensity. The facility is expected to be completed in April, 2017. Erik Runkle developed CELL for:
    - Research on controlled-environment production of specialty food crops (such as leafy greens and herbs) and ornamentals (such as seedlings and cuttings);
    - Demonstration of indoor growing systems to inform growers and capture the interest of students and the public; and
    - Teaching applications for undergraduate students enrolled in relevant production courses in Horticulture at MSU.

Accomplishment Summaries

- Erik Runkle and Roberto Lopez organized and convened the ISHS 8th International Symposium on Light in Horticulture (http://www.lightsym16.com) in East Lansing, MI from May 22 to 26, 2016. There were 250 participants from 25 countries, 52 oral and 78 poster presentations, and 26 sponsors from leading lighting, growth chamber, and horticultural companies. The proceedings was peer-reviewed and published as Acta Horticulturae volume 1134 and contains 56 articles (http://www.actahort.org/books/1134).
- Ph.D. student Yujin Park and Erik Runkle evaluated the influence of including far-red radiation in sole-source lighting on ornamental seedling growth and subsequent flowering under different intensities of blue radiation and total photosynthetic photon flux. In general, inclusion of far-red radiation increased stem elongation, leaf expansion, and biomass accumulation and in some species, also promoted subsequent flowering. A

moderately high intensity of blue radiation attenuated the effects of FR radiation on stem elongation but minimally influenced flowering.

- Ph.D. student Qingwu (William) Meng and Erik Runkle assessed the usefulness of far-red radiation for indoor seedling production of leafy greens and herbs. When far-red light was added to red and blue light, it promoted leaf expansion and biomass accumulation but reduced leaf pigmentation.
- M.S. student Mengzi Zhang and Erik Runkle investigated responses of two cultivars of potted poinsettia grown in a greenhouse under different end-of-day lighting treatments. Generally, end-of-day lighting promoted extension growth of poinsettia and low-intensity far red radiation was less effective at inhibiting flowering than red+far red lighting.
- Ph.D. student Kellie Walters and Roberto Lopez evaluated the impact of carrier water alkalinity and air temperature at application on the efficacy of plant growth regulator ethephon sprays. High carrier water alkalinity (> 150 $mg \cdot L^{-1}$) and/or high air temperatures (>23 ºC) reduced chemical efficacy.
- M.S. student Allison Hurt and Roberto Lopez assessed plug quality of ornamental seedlings propagated under supplemental and photoperiodic lighting providing varying light intensities and qualities. Root dry mass increased and stem extension decreased under supplemental lighting from either HPS or LEDs than under photoperiodic lighting with or without far red radiation.
- M.S. student QiuXia Chen and Ryan Warner utilized a genetic mapping population in *Petunia* to identify chromosomal regions (QTL) that control important plant quality traits including development rate, branch number, flower production, flower size and internode length. Additionally, the influence of temperature on these traits was evaluated and used to understand potential genotype by environment interactions underlying the control of these traits.

Impact Statements

- Far-red radiation can improve both plant shoot and root growth in vertical farms. A moderate addition of far red promoted red leaf lettuce yield by 17% to 48% and increased basil root growth by 18% to 26%. Faster growth rates with far-red radiation can reduce production time, potentially increasing the harvestable yield and thus, grower profitability. Growers can also use far red to customize crop appearance, such as shape and color, based on consumer and market preferences.
- Plant height of poinsettia can be increased by adding red and/or far-red radiation at the end of the day. This technique can potentially substitute for chemical treatments to increase plant height. It can also help growers meet specific height targets at flowering and thus, increase the quality and marketability of potted poinsettia.
- Including far-red radiation in sole-source lighting of ornamental seedlings increased biomass and leaf area, and in some crops, accelerated flowering (by 7-12 days). Results will better inform growers about the merits of far-red radiation, and interactions with blue radiation, when plants are grown under sole-source lighting.
- Improving ethephon spray efficacy can improve the control of flowering, branching, and plant growth for greenhouse growers. However, ethephon spray efficacy is significantly reduced by both high air temperatures at application and high carrier water alkalinity, which can cause the final spray solution pH to be higher than recommended. With increased efficacy comes the potential for lower chemical inputs and higher quality plants.

- Increased leaf area and internode elongation under photoperiodic lighting providing red+white+far-red light can give growers the perception that seedlings production time is reduced. However, seedlings under photoperiodic lighting or ambient light can be delayed by one and two weeks, respectively, compared to those produced under supplemental lighting.
- Molecular markers useful for breeding new petunia cultivars with improved traits were identified. Specifically, markers that could help develop cultivars with reduced production time sensitivity to temperature, improved branching habit, and greater floral production were developed.

Published Written Works (*denotes peer reviewed)

*Blanchard, M.G. and E.S. Runkle. 2016. Investigating reciprocity of intensity and duration of photoperiodic lighting to regulate flowering of long-day plants. Acta Hortic. 1134:41-48.

*Bombarely, A., M. Moser, A. Amrad, M. Bao, L. Bapaume, C. S. Barry, …, R.M. Warner, et al. 2016. Insight into the evolution of the Solanaceae from the parental genomes of *Petunia hybrida*. Nature Plants 2:16074.

*Craig, D.S. and E.S. Runkle. 2016. An intermediate phytochrome photoequilibria from night-interruption lighting optimally promotes flowering of several long-day plants. Environ. Exp. Bot. 121:132-138.

Craver, J. and R.G. Lopez. 2016. Control of morphology by manipulating light quality (blue, red, and far-red light) and daily light integral (DLI) using LEDs, p. 203-217. In: T. Kozai et al. (eds.). LED Lighting for Urban Agriculture. Springer, Singapore.

Craver, J.K. and R.G. Lopez. 2016. Comparison of young and finish plant production under LED toplighting and HPS lamps. Greenhouse Grower 34(11):30-34.

Currey, C.J., R.G. Lopez, and E.S. Runkle. 2016. VIII International Symposium on Light in Horticulture (Acta Hortic. 1134). 452 pp. East Lansing, MI.

*Gerovac, J.R., J.K. Craver, J.K. Boldt, and R.G. Lopez. 2016. Light intensity and quality from sole-source light-emitting diodes impact growth, morphology, and nutrient content of Brassica microgreens. HortScience 51:497-503.

Kozai, T., K. Fujiwara, and E.S. Runkle. 2016. LED Lighting for Urban Agriculture. 454 pp. Springer, Singapore.

Lopez, R.G. 2016. Retractable blackout curtains should not be used as greenhouse shading. e-GRO Alert 5(27):1-5.

Lopez, R.G. 2016. Measuring light in the greenhouse: 101. Greenhouse Management 36(11):52.

Lopez, R.G. 2016. Greenhouse shading: 101. Greenhouse Management 36(11):56.

Lopez, R.G. and J.K. Craver. 2016. How much do hanging baskets influence the light quality and quantity for crops grown below? e-GRO Alert 5(21):1-5.

Lopez, R.G. and J. Scruggs. 2016. The importance of H_2O to PGRs. Growertalks 80(5):62-63.

Meng, Q. and E.S. Runkle. 2016. Control of flowering using night-interruption and day-extension lighting, p. 191-201. In: T. Kozai et al. (eds.). LED Lighting for Urban Agriculture. Springer, Singapore.

*Oh, W. and E.S. Runkle. 2016. Flowering and morphological responses of petunia and pansy as influenced by lamp type and lighting period to provide long days. Korean J. Hortic. Sci. Tech. 34:207-219.

*Olberg, M.W. and R.G. Lopez. 2016. High tunnel and outdoor production of containerized annual bedding plants in the midwestern United States. HortTechnology 26:651-656.

*Olberg, M.W. and R.G. Lopez. 2016. Growth and development of poinsettia (*Euphorbia pulcherrima*) finished under reduced air temperature and bench-top root-zone heating. Scientia Hortic. 210:197-204.
Olberg, M. and R.G. Lopez. 2016. High tunnel and outdoor production of cold-tolerant bedding plants. Greenhouse Product News 26(11):24-29.
Olberg, M. and R.G. Lopez. 2016. Using root-zone heating for energy-efficient petunia production. GrowerTalks 80(3):84-88.
*Owen, W.G., A. Hilligoss, and R.G. Lopez. 2016. Late-season high tunnel planting of specialty cut flowers in the midwestern United States influences yield and stem quality. HortTechnology 26:338-343.
Owen, W.G. and R.G. Lopez. 2016. Pre-transplant liner soak and post-transplant spray applications of Augeo influence growth and development of vegetatively propagated single-node *Pennisetum setaceum* 'Rubrum' culm cuttings. Proc. 42nd Annu. Plant Growth Reg. Soc. of Amer. Conf. 42:106-113.
Owen, W.G. and R.G. Lopez. 2016. Perennial propagators' successes and challenges: Results of a national survey. Greenhouse Grower 34(10):56-60.
Owen, W.G. and R.G. Lopez. 2016. The impact of DLI, light quality, and photoperiod on bedding plant flowering responses. Greenhouse Product News 26(8):30-34.
*Park, Y. and E.S. Runkle. 2016. Investigating the merit of including far-red radiation in the production of ornamental seedlings grown under sole-source lighting. Acta Hortic. 1134:259-266.
Runkle, E.S. 2016. Recent developments in plant lighting, p. 233-236. In: T. Kozai et al. (eds.). LED Lighting for Urban Agriculture. Springer, Singapore.
Runkle, E. 2016. Bedding plants with high base temperatures. Greenhouse Product News 26(12):38.
Runkle, E. 2016. Managing temperature to balance crop quality and timing. Greenhouse Product News 26(11):42.
Park, Y. and S. Runkle. 2016. Red light spectrum. GrowerTalks 80(7):68-72.
Runkle, E. 2016. LED lighting applications for plants. Greenhouse Product News 26(10):50.
Runkle, E. 2016. The economic viability of LED lighting. Greenhouse Grower Technology 1(5):22.
Runkle, E. 2016. Managing light to improve rooting of cuttings. Greenhouse Product News 26(9):62.
Runkle, E. 2016. Red light and plant growth. Greenhouse Product News 26(8):50.
Runkle, E. 2016. Success with succulents. Greenhouse Product News 26(7):58.
Runkle, E. 2016. Juvenility in perennials. Greenhouse Product News 26(6):50.
Runkle, E. 2016. A closer look at far-red radiation. Greenhouse Product News 26(5):50.
Runkle, E. 2016. Diffused glass. Greenhouse Product News 26(4):42.
Runkle, E. 2016. The boundary layer and its importance. Greenhouse Product News 26(3):34.
Runkle, E. 2016. Efficacy of lamp types at controlling flowering. Greenhouse Product News 26(2):46.
Runkle, E. 2016. Improve rooting of cuttings. Greenhouse Product News 26(1):50.
Wollaeger, H. and E. Runkle. 2016. VPD vs. relative humidity. InsideGrower Feb.:28-29.
Wollaeger, H. and R.G. Lopez. 2016. Increasing the rooting success of challenging vegetative cutting species. e-GRO Alert 5(6):1-5.

Websites Managed

- 8th ISHS International Symposium on Light in Horticulture, http://www.lightsym16.com
- Michigan Garden Plant Tour, http://planttour.hrt.msu.edu
- MSU Floriculture Production, http://www.flor.hrt.msu.edu