**Annual Meeting**

Virtual Meeting, Hosted by University of Florida

via Zoom

August 3rd, 2020

**Multistate Research Project**

**Annual Station Publications Report**

PROJECT NUMBER: NE-1835

TITLE: Resource Optimization in Controlled Environment Agriculture

PROJECT DURATION: October 1, 2018 – September 30, 2023

EXPERIMENT STATION: Arizona, Florida, Maine, Michigan, Nebraska, New Jersey, Ohio (OSU and USDA-ARS, Toledo), Texas, Utah

PARTICIPANTS: AZ: Gene Giacomelli and Murat Kacira, CT: Rosa Raudales, FL: Celina Gomez, Ying Zhang, and Marlon Cordero, ME: Stephanie Burnett, MI: Roberto Lopez and Kellie Walters, NE: Ellen Paparozzi, NJ: AJ Both, and Robin Brumfield, OH: Chieri Kubota, Peter Ling, Jennifer Boldt, and Kale Harbick, TX: Genhua Niu, UT: Youping Sun

REPORTING PERIOD**:** April 15, 2019 – July 31, 2020

REPORT DATE: August 3, 2020

PUBLICATIONS:

**Dissertations, Theses (Published):**

AZ

**Allgeyer**, Allie. 2020. Evaluating Mini Tomato Production in a Closed Loop Hydroponic System. Professional Science Master’s Thesis, June 2020, Applied Biosciences, CEA Track, GIDP, the University of Arizona, Tucson, AZ. [Advisor **Gene Giacomelli**]

**Heintz**, Robert. 2020. Curative Peracetic Acid Treatment for Reuse of Organic Hydroponic Substrates. Professional Science Master’s Thesis, March 2020, Applied Biosciences, CEA Track, GIDP, the University of Arizona, Tucson, AZ. [Advisor **Gene Giacomelli**]

**Parrish**, Charles. 2020. Quantum Dots Optimize Spectral Quality to Enhance Crop Yield in Controlled Environments. Professional Science Master’s Thesis, July 2020, Applied Biosciences, CEA Track, GIDP, the University of Arizona, Tucson, AZ. [Advisor **Gene Giacomelli**]

**Recsetar**, Matthew. 2019. Design and Performance of a Hydroponic Bioreactor for Removing Emerging Contaminants from Wastewater Effluent. PhD Dissertation, July 2019, Biosystems Engineering Department, The University of Arizona, Tucson, AZ. [Advisors **Joel Cuello and Kevin Fitzsimmons**]

**Zhang**, Ying. 2019. Improving Climate Uniformity and Energy Use Efficiency in Controlled Environment Agriculture. PhD Dissertation, November 2019, Biosystems Engineering Department, The University of Arizona, Tucson, AZ. [Advisor **Murat Kacira**]

MI

Craver, J.K. (Ph.D.) 2019. Manipulating light quality, light intensity, and carbon dioxide

concentration to optimize indoor and greenhouse production of annual bedding plant seedlings.

NJ

Li, Y. 2020. The effects of Silicon nutrition on hydroponically grown lettuce, bok choy, and basil. Ph.D. Dissertation. Rutgers University Libraries. 219 pp. (A.J. Both served as major advisor)

OH

Gillespie, D.P. 2019. Influence of Nutrient Solution pH on Hydroponic Basil and Spinach Plant Growth, Nutrient Concentration, and Pythium Disease Incidence and Severity. Dept. of Horticulture and Crop Science. The Ohio State University., Columbus, OH, MS Thesis.

McKean, T.W. 2019. Effects of Soilless Substrate Systems and Environmental Conditions on Yield, Total Soluble Solids, and Titratable Acidity of Greenhouse Strawberry (*Fragaria × ananassa*). Dept. of Horticulture and Crop Science. The Ohio State University., Columbus, OH, MS Thesis.

Ertle, J.M. 2020. Effects of Short-term Chilling Stress on Seedling Quality and Post-transplanting Growth of Grafted and Nongrafted Watermelon. Dept. of Horticulture and Crop Science. The Ohio State University., Columbus, OH, MS Thesis.

**Books (Published):**

TX

Kozai, T., G. Niu, and M. Takagaki (eds.). 2019. Plant factory: An Indoor Farming System for Efficient Quality Food Production. Academic Press, Elsevier Publisher, Second Edition, pp. 487.

**Book Chapters (Published):**

AZ

*Afterward* written by **G. Giacomelli** for the 10th anniversary edition of The Vertical Farm by Dickson Despommier 2020.

*Forward* written by **G. Giacomelli** in Growing by Plant Empowerment by P.A.M Geelen, J.O. Voogt and P.A.M. van Weel. 2019.

CT

Raudales RE, PR Fisher,NMattson. Water Quality CH1 in: Ball Red Book 19th Edition (in press)

NJ

Shelford, T.J. and A.J. Both. 2020. Plant production in controlled environments. In *Introduction to Biosystems Engineering*, N.M. Holden, M.L. Wolfe, J.A. Ogejo, and E.J. Cummins (Eds.). Published by ASABE in association with Virginia Tech Publishing. 28 pp.

OH

Kubota, C. 2019. Understanding crop responses to controlled climates in greenhouses. Chapter 7. (P.205-223) In: (L.F.M. Marcelis and E. Heuvelink eds.) Achieving sustainable greenhouse cultivation. Burleigh Dodds Science, Cambridge, UK.

TX

Dou, H. and G. Niu. 2019. Plant responses to light. In: Plant Factory: An Indoor Farming System for Efficient Quality Food Production, T. Kozai, G. Niu, and M. Takagaki (eds.), pp. 153-166. Academic Press, Elsevier Publisher, Second Edition.

Kozai, T. and G. Niu. 2019. Role of plant factory with artificial lighting (PAFL) in urban areas, In: Plant Factory: An Indoor Farming System for Efficient Quality Food Production, T. Kozai, G. Niu, and M. Takagaki (eds.), pp. 7-34. Academic Press, Elsevier Publisher, Second Edition.

Kozai, T. and G. Niu. 2019. Plant factory as a resource-efficient closed plant production system. In: Plant Factory: An Indoor Farming System for Efficient Quality Food Production, T. Kozai, G. Niu, and M. Takagaki (eds.), pp. 93-115. Academic Press, Elsevier Publisher, Second Edition.

Niu, G., T. Kozai, and N. Sabeh. 2019. Physical environmental factors and their properties. In: Plant Factory: An Indoor Farming System for Efficient Quality Food Production, T. Kozai, G. Niu, and M. Takagaki (eds.), pp. 185-195. Academic Press, Elsevier Publisher, Second Edition.

Kozai, T. and G. Niu. 2019. Challenges for the next generation PFAL. In: Plant Factory: An Indoor Farming System for Efficient Quality Food Production, T. Kozai, G. Niu, and M. Takagaki (eds.), pp. 463-469. Academic Press, Elsevier Publisher

Kozai, T. and G. Niu. 2019. Conclusions: resource-saving and resource-consuming characteristics of PFALs. In: Plant Factory: An Indoor Farming System for Efficient Quality Food Production, T. Kozai, G. Niu, and M. Takagaki (eds.), pp. 471-475. Academic Press, Elsevier Publisher.

He, D., T. Kozai, G. Niu, X. Zhang. 2019. Light-emitting diodes for horticulture. In: Light-Emitting Diodes, Solid State Lighting Technology and Application Series 4, edited by Li, J and G.Q. Zhang, Springer International Publishing AG, part of Springer Nature.

**Refereed Journal Articles (Published):**

AZ

Zhang, Y., **M. Kacira**. 2020. Comparison of energy use efficiency of greenhouse and indoor plant factory system. European Journal of Horticultural Science, Special Thematic Issue. (*In Press*).

Magadley, E., Teitel, M., Peretz, M. F., **Kacira, M.,** Yehia, I. 2020. Outdoor Behavior of Organic Photovoltaics on Greenhouse Roof. *Sustainable Energy Technologies and Assessments*, 37:100641.

Perezt, F. A., S. Ozer, F. Geoola, E. Magadley, I. Yehia, A. Levi, R. Brikm, S. Gantz, A. Levy, **M Kacira**, M Teitel. 2020. Microclimate and crop performance in a tunnel greenhouse shaded by organic photovoltaic modules – Comparison with conventional shaded and unshaded tunnels. *Biosystems Engineering*, 197: 12-31.

Peretz, M. F., F. Geoola, I. Yehia, S. Ozer, A. Levi, E. Magadley, R. Brikman, L. Rosenfeld, A. Levy, **M. Kacira**, M. Teitel. 2019. Testing organic photovoltaic modules for application as greenhouse cover or shading elements. *Biosystems Engineering*, 184, 24-36.

Rojano, F., P. E. Bournet, M. Hassouna, P. Robin, **M. Kacira**, C. Choi. 2019. Modelling the impact of air discharges caused by natural ventilation in a poultry house. *Biosystems Engineering*, 180, 168-181.

CT

McGehee CS, P Apicella, RE Raudales, G Berkowtiz, Y Ma, S Durocher, J Lubell. 2019. First Report of root rot caused by *Pythium myriotylum* on hemp (*Cannabis sativa* L.) in the United States. Plant Disease <https://doi.org/10.1094/PDIS-11-18-2028-PDN>

Gomez C, C Currey, R Dickson, HJ Kim, R Hernández, N Sabeh, **R Raudales**, R Brumfield, A Laury–Shaw, A Wilke, S Burnett. 2019. Controlled Environment Food Production for Urban Agriculture. HortScience 54(9): 1448–1458 <https://doi.org/10.21273/HORTSCI14073-19>

McGehee CS, RE Raudales, WH Elmer, RJ McAvoy. 2019. Efficacy of Biofungicides against root rot and damping-off of microgreens caused by *Pythium* spp. J. Crop Protection 121:96-102 <https://doi.org/10.1016/j.cropro.2018.12.007>

FL

Shahid, M.A., A. Sarkhosh, N. Khan, R.M. Balal, S. Ali, L. Rossi, **C. Gómez**, N.S. Mattson, F. García-Sánchez. 2020. Insights into the physiological and biochemical impacts of salt stress on plant growth and development. Agronomy 10:938.

**Gómez, C.** and J. Jimenez. 2020. Effect of end-of-production high-energy radiation on nutritional quality of indoor-grown red-leaf lettuce. HortScience 55:1055–1060.

Gibson, K.E., A.J. Lamm, F. Masambuka-Kanchewa1, P.R. Fisher, and **C. Gómez**. 2020. Identifying indoor plant propagation research and education needs of specialty crop growers. HortTechnology *doi.org/10.21273/HORTTECH04622-20*.

Solis-Toapanta, E., A. Kirilenko, and **C. Gómez**. 2020. Indoor gardening with hydroponics: A reddit community analysis to identify knowledge gaps. HortTechnology. 29:880–888.

Solis-Toapanta, E., P. Fisher, and **C. Gómez**. 2020. Growth rate and nutrient uptake of basil in small-scale hydroponics. HortScience. https://doi.org/10.21273/HORTSCI14727-19

Solis-Toapanta, E. and **C. Gómez**. 2019. Effects of increasing daily light integral on growth and photosynthetic capacity of basil grown indoors. HortTechnology. 29:880–888.

Paz, M., P.R. Fisher, and **C. Gómez**. 2019. Minimum light requirements for indoor gardening of lettuce. Urban Agriculture & Regional Food Systems 4:1–10.

**Gómez, C.**, C.J. Currey, R.W. Dickson, H-J. Kim, R. Hernández, N.C. Sabeh, R.E. Raudales, R.G. Brumfield, C. Singer, A. Laury-Shaw, A. Wilke, R.G. Lopez, and S.E. Burnett. 2019. Controlled environment food production for urban agriculture. HortScience 9:1448-1458.

ME

O. Sanchez, S.E. Burnett, and B.J. Peterson. Environment, photosynthesis, and adventitious rooting of manchurian lilac cuttings propagated in overhead mist, submist, and combination systems. 2020. HortScience 55:78-82.

C. Gómez, C.J. Currey, R.W. Dickson, H.J. Kim, R. Hernández, N. 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 54:1448-1458.

MI

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.

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.

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.

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

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.

Manjot, K.S., R.G. Lopez, S. Chaudhari, and D. Saha. 2020. A review of common liverwort

control practices in container nurseries and greenhouse operations. [HortTechnology](https://journals.ashs.org/horttech/view/journals/horttech/horttech-overview.xml) 30(4):471–479. <https://doi.org/10.21273/HORTTECH04652-20>

Garcia, C. and R.G. Lopez. 2020. Supplemental radiation quality influences cucumber, tomato,

and pepper transplant growth and development. HortScience 55(6):804–811. <https://doi.org/10.21273/HORTSCI14820-20>

Walters, K.J., B.K Behe, C.J. Currey, and R.G. Lopez. 2020. Historical, current, and future

perspectives for controlled environment hydroponic food crop production in the United States. HortScience 55(6):758–767. <https://doi.org/10.21273/HORTSCI14901-20>

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. Scientia Hort. 271:1–5. <https://doi.org/10.1016/j.scienta.2020.109470>

Craver, J.K., K.S. Nemali, and **R.G. Lopez**. 2020. Acclimation of growth and photosynthesis in

petunia seedlings exposed to high-intensity blue radiation. J. Amer. Soc. Hort. Sci.

145:152–161. <https://doi.org/10.21273/JASHS04799-19>

NE

Stewart, Z. P, Ellen T. Paparozzi, M. Djanaguiraman, Charles A. Shapiro. 2019. Lipid-based Fe- and Zn- nanoformulation is more effective in alleviating Fe- and Zn- deficiency in maize. J. Plant Nut. 42:1693-1708. DOI: [10.1080/01904167.2019.1617314](https://doi.org/10.1080/01904167.2019.1617314)

NJ

Li, Y., A.J. Both, C.A. Wyenandt, E.F. Durner, and J.R. Heckman. 2019. Applying Wollastonite to soil to adjust pH and suppress powdery mildew on pumpkin. HortTechnology. https://doi.org/10.21273/HORTTECH04391-19. 10 pp.

Gomez, C., C.J. Currey, R.W. Dickson, H.J. Kim, R. Hernandez, 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. https://doi.org/10.21273/HORTSCI14073-19.

OH

Gillespie, D.P., C. Kubota, and S. Miller. 2020. Effects of low pH of hydroponic nutrient solution on plant growth, nutrient uptake, and root rot disease incidence of basil (*Ocimum basilicum* L.). HortScience. 55:1251-1258.

Wang, Jizhang, W. Lee, and P. Ling. 2020. Estimation of Thermal Diffusivity for Greenhouse Soil Temperature Simulation. Applied Sciences. 10. 653. 10.3390/app10020653.

Cui, S., [E. Inocente](https://www.mdpi.com/search?authors=Elvia%20%20Adriana%20Alfaro%20Inocente&orcid=), [N. Acosta](https://www.mdpi.com/search?authors=Nuris%20Acosta&orcid=), [H. Keener](https://www.mdpi.com/search?authors=Harold.%20%20M.%20Keener&orcid=), [H. Zhu](https://www.mdpi.com/search?authors=Heping%20Zhu&orcid=), and [P. Ling](https://www.mdpi.com/search?authors=Peter%20%20P.%20Ling&orcid=). 2019. Development of Fast E-nose System for Early-Stage Diagnosis of Aphid-Stressed Tomato Plants. Sensors 2019, 19(16), 3480; https://doi.org/10.3390/s19163480

Lin, Jeng-Liang, Heping Zhu, and Peter Ling. 2019. Amendment of herbicide spray solutions with adjuvants to modify droplet spreading and fading characteristics on weeds. Applied Engineering in Agriculture Vol. 35(5): 713-721.

Yan, Tingting, [Heping Zhu](https://www.mdpi.com/search?authors=Heping%20Zhu&orcid=), Li Sun, [Xiaochan Wang](https://www.mdpi.com/search?authors=Xiaochan%20Wang&orcid=),and [Peter Ling](https://www.mdpi.com/search?authors=Peter%20Ling&orcid=). 2019. Investigation of an experimental laser sensor-guided spray control system for greenhouse variable-rate applications. Transactions of the ASABE 62(4): 899-911.

Yan, T., X. Wang, H. Zhu, and P. Ling. 2019. Evaluation of object surface edge profiles detected with a 2-D laser scanning sensor. Sensors. 18(11): 1-17.

Chowdhury, B.D.B., S. Masoud, Y.J. Son, C. Kubota, and R. Tronstad. 2020. A dynamic data driven indoor localization framework based on ultra high frequency passive RFID system. Int. J. Sensor Networks. (accepted for publication)

TX

Yan, Z., D. He, **G. Niu**, Q. Zou, and Y. Qu. **2019**. Growth, nutritional quality, and energy use efficiency of hydroponic lettuce as influenced by daily light integrals exposed to white versus white plus red light-emitting diodes. HortScience 54(10): 1737-1744.

Dou, H., **G. Niu**, and M. Gu. **2019**. Photosynthesis, morphology, yield, and phytochemical accumulation in basil plants influenced by substituting green light for partial red and/or blue light. HortScience 54(10): 1769–1776. 2019. <https://doi.org/10.21273/HORTSCI14282-19>.

Cheng, Y., D. He, J. He, **G. Niu**, and R. Gao. **2019**. Effect of light/dark cycle on photosynthetic pathway switching and CO2 absorption in two Dendrobium species. Frontiers in Plant Science. Vol 10, article 659, doi: 10.3389/fpls.2019.00659

Yan, Z., D. He, **G. Niu**, and H. Zhai. **2019**. Evaluation of growth and quality of hydroponic lettuce at harvest as affected by the light intensity, photoperiod, and light quality at seedling stage. Scientia Horticulturae. 248: 138-144.

UT

**Sun, Y.**, J. Chen, H. Xing, A. Paudel, and G. Niu. 2020. Morphological responses of twelve viburnum taxa to saline water irrigation. HortScience 55: 1-9. <https://doi.org/10.21273/HORTSCI14940-20>.

Chen, J., H. Xing, A. Paudel, **Y. Sun**, and G. Niu. 2020. Gas exchange and mineral nutrients of twelve viburnum taxa irrigated with saline water. HortScience 55: 1-9. <https://doi.org/10.21273/HORTSCI14941-20>.

**Sun, Y.**, L. Li, Y. Wang, and X. Dai. 2020. Morphological and physiological responses of spirea species to saline water irrigation. HortScience 55:1-8. <https://doi.org/10.21273/HORTSCI14861-20>

Paudel, A., J. Chen, **Y. Sun,** Y. Wang,and R. Anderson. 2019. Salt tolerance of Sego Supreme™ plants. HortScience 54(11):2056-2062. https://doi.org/10.21273/HORTSCI14342-19

Chen, J., Y. Wang, A. Paudel, and **Y. Sun**. 2019. Comparing the salt tolerance of three landscape plants using a near-continuous gradient dosing system. HortTechnology 29(5):1-8. https://doi.org/10.21273/HORTTECH04385-19.

Wang, Y., **Sun, Y**., G. Niu, Z. Deng, Y. Wang, and J. Gardea-Torresdey. 2019. Growth, gas exchange, and mineral nutrients of ornamental grasses irrigated with saline water. HortScience 54(10):1840-1846. <https://doi.org/10.21273/HORTSCI13953-19>

**Symposium Proceedings Articles (Published):**

AZ

**Giacomelli, G.A.,** P.A. van Weel, and C. Blok, 2020, Ebb and Flood Nutrient Delivery System for Sustainable Automated Crop Production, *ActaHorticulturae*, GreenSys2019, Angers, France. (*In Press*)

Gellenbeck, S., R. Furfaro. **G. Giacomelli** and R. Lepore, 2019. A Predictive Model For The Production Rates Of A Bioregenerative Life Support System. *49th International Conference on Environmental Systems*, 7-11 July 2019, Boston, Massachusetts. ICES-2019-258.

Staats, K., I. Molavanov, J. Adams, J. Deleeuw, K. Morgan, G. Schoberth, T. Curry, **G.A. Giacomelli,** 2019. An agent-based model for high-fidelity ECLSS and bioregenerative simulation. *49th International Conference on Environmental Systems*, 7-11 July 2019, Boston, Massachusetts. ICES-2019-258.

Montoya, A.P., **M. Kacira,** F.A. Obando. 2020. Design and implementation of a low-cost microcontroller in controlled environment agriculture. *ActaHorticulturae*. 1279: 287-294.

Zhang, Y., and **M. Kacira**. 2019. Enhancing Resource Use Efficiency in Plant Factory. *ActaHorticulturae*, 1271: 307-313

FL

Freyre, R., S. Flores, **C. Gómez** and P.R. Fisher. 2019. Evaluation of ginger as a greenhouse crop. Acta Hort. 1251:119–124.

**Zhang, Y.** and Kacira, M. (2020). "Enhancing Resource Use Efficiency in Plant Factory," Acta Horticulturae, 1271, 307-314

**Popular (Trade Journal) Articles (Published):**

AZ

**Giacomelli, G.** and E. Roth, 2020. Feeding the World with Controlled Environments. Agritecture blog post, July 16.

**Giacomelli**, **G.** 2020. The Critical Technologies That Sparked the CEA Revolution. Agritecture blog post, July 16.

CT

Raudales RE. 2020. Match the filter to the problem. e-Gro Alert 9(15):1-5

Raudales RE. 2020. Surface disinfectant for use against SARS-CoV-2. [E-Gro Edible: 5(07):14](http://e-gro.org/pdf/E507.pdf)

Raudales RE. 2020. Test & adjust nutrient in hydroponics. [e-Gro Edible 5(3): 1-4](http://e-gro.org/pdf/E503.pdf)

Raudales RE. 2020. Three steps to ensure water quality for greenhouse crops. Greenhouse Grower, February: <https://www.greenhousegrower.com/technology/3-steps-to-ensure-water-quality-for-greenhouse-crops/>

Raudales RE. 2020. The trigonometry of root rot diseases. GrowerTalks. [February: 68-69](https://www.ballpublishing.com/magazine/gt_20_02/index.aspx)

McGehee, C.S., R.E. Raudales, L. Pundt. Put a hold on gray mold. Produce Grower.December 2019.

Raudales RE. 2019. Three reasons pursuing work-life balance should be your priority. Greenhouse Grower, November. 2019.

McGehee CS, RE Raudales. 2019. Put a hold on gray mold. Produce Grower Magazine: December: <http://magazine.producegrower.com/article/december-2019/pest-and-disease-put-a-hold-on-gray-mold.aspx>

Cabrera JC, RE Raudales. 2019. The insoluble iron issue. Greenhouse Grower Magazine: July 2019. <https://www.greenhousegrower.com/technology/how-to-address-insoluble-iron-issues-in-the-greenhouse/>

Fisher P, G Grant, R Raudales. 2019. Clean up your water with carbon filtration. GPN Magazine: 32-36

FL

P. Fisher, **C. Gómez**, M. Poudel, and E. Runkle. 2019. The economics of lighting young plants indoors. GrowerTalks, June issue <https://www.growertalks.com/Article/?articleid=24186>

ME

Burnett, S., A. Bayer, and M. van Iersel. 2020. How to use moisture sensors to automate irrigation. Greenhouse Grower. <https://www.greenhousegrower.com/technology/how-to-use-moisture-sensors-to-automate-greenhouse-irrigation/>

MI

Craver, J., K. Nemali, and R. Lopez. 2019. Monitoring growth of bedding plant seedlings using

images. Greenhouse Management 39(10):53−56.

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.

Walters, K.J. and R.G. Lopez. 2019. Lighting basil seedlings. Produce Grower:28−32.

Walters, K.J. and R.G. Lopez. 2019. Controlled environment agriculture (CEA) carbon dioxide

injection. Produce Grower:26−28.

Lopez, R.G. 2020. LED supplemental lighting providing red and blue radiation = purple leaves

on some young plants. e-GRO edible Alert 5(11):1‒5.

Hausbeck, M., B. Harlan, and R.G. Lopez. 2020. 2020 Impatiens downy mildew refresher: Use

fungicides preventively. e-GRO eAlert 9(21):1‒5.

Behe, B.K. and R.G. Lopez. 2020. Retail garden center and florist strategies to sell in the current

environment. e-GRO Alert 9(19):1‒6.

Lopez, R.G. 2020. Tips for rooting difficult or slow-to-root cuttings. e-GRO Alert 9(4):1‒5.

Lopez, R.G., R. Heins, E.S. Runkle, and H. Lindberg. 2020. Tips for holding greenhouse crops

during COVID-19 restrictions. e-GRO Alert 9(24):1‒6.

[Jubenville](https://www.canr.msu.edu/people/jeremy_jubenville), J., [B.K. Behe](file:///C%3A%5CUsers%5CLopez%5CDropbox%5CMSU%5CReports%5CTenure%5CB.K.%20Behe), [**R.G. Lopez**](file:///C%3A%5CUsers%5CLopez%5CDropbox%5CMSU%5CReports%5CTenure%5CR.G.%20Lopez) and H. Lindberg. **2020. Garden center retail survival**

**strategy series: Overcoming challenges with a holistic approach.** Michigan State

University Floriculture Extension News. **April 9, 2020.**

<https://www.canr.msu.edu/news/garden-center-retail-survival-strategy-series-overcoming-challenges>

Hausbeck, M. and B. Harlan, and **R.G. Lopez**. 2020. Don’t let downy mildew on impatiens

surprise you. Michigan State University Floriculture Extension News. **April 9, 2020.**

<https://www.canr.msu.edu/news/dont-let-downy-mildew-on-impatiens-surprise-you>

Runkle, E.S., R.D. Heins, and **R.G. Lopez**. 2020. Holding greenhouse crops – When temperature

and PGRs don’t suffice. Michigan State University Floriculture Extension News. **April**

**16, 2020.**<https://www.canr.msu.edu/news/holding-greenhouse-crops-when-temperature-and-pgrs-don-t-suffice>

Lindberg, H., J. Jubenville, W.G. Owen, **R.G Lopez**, E.S. Runkle and B.K. Behe. 2020.

Resources for greenhouse growers, florists and retailers during the COVID-19 pandemic. Michigan State University Floriculture Extension News. **April 20, 2020.** <https://www.canr.msu.edu/news/resources-for-greenhouse-growers-florists-and-retailers-during-the-covid-19-pandemic>

Lindberg, H., Jubenville, J., B.K. Behe, and **R.G. Lopez**. 2020. Garden center retail survival

strategy series: Thinking through the shopping experience. Michigan State University Floriculture Extension News. April 20, 2020. <https://www.canr.msu.edu/news/garden-center-retail-survival-strategy-series-thinking-through-the-shopping-experience>

Lindberg, H., Jubenville, J., B.K. Behe, and **R.G. Lopez**. 2020. Garden center retail survival

strategy series: Marketing and merchandizing. Michigan State University Floriculture Extension News. April 20, 2020. <https://www.canr.msu.edu/news/garden-center-retail-survival-strategy-series-marketing-and-merchandizing>

Jubenville, J., B.K. Behe, **R.G. Lopez** and H. Lindberg. 2020. Garden center retail survival

strategy series: Communicating in extraordinary times. Michigan State University Floriculture Extension News. April 20, 2020. <https://www.canr.msu.edu/news/garden-center-retail-survival-strategy-series-communicating-in-extraordinary-times>

Kohler, A.E. and **R.G. Lopez**. 2020. How adding far-red radiation to supplemental lighting

affects plugs. Greenhouse Grower 38(12):61–62.

**R.G. Lopez** and C. Garcia. 2020. Beyond red and blue radiation: Explore the efficacy of LED

supplemental lighting for high-wire vegetable transplants. Produce Grower 18–21.

NJ

Both, A.J. 2019. Revisiting the measurement of light. GLASE Technical Article Series. Available at: <https://glase.org/>

OH

Wicks, Mary and Peter Ling. 2019. Sustainable and Safe Greenhouse Crop Production. Ohio Country Journal, Mid-December issue. October issue.

Ling, Peter and Mary Wicks. 2019. Space Age Crop Production on Planet Earth. Ohio Country Journal, Mid-December issue.

UT

Paudel, A., J. Chen, and **Y. Sun**. 2019. Determining the salt tolerance of two penstemon species using a near-continuous gradient dosing system. Bulletin of the American Penstemon Society 78:29-35.

Chen, J. and **Y. Sun**. 2019. Evaluating physiological responses of viburnums species to salinity stress. PP system application note. <https://ppsystems.com/application-notes>.

 **Presentations (Papers):**

AZ

Gellenbeck S., Pryor B., and **Giacomelli G**. 2019, Mushrooms on Mars: A Subsystem for Human Life Support, 49th International Conference on Environmental Systems, July 2019, Boston, Massachusetts, USA.

**Giacomelli, G.,** S. Gellenbeck and B. Pryor; 2019. Mushrooms on Mars project. Dubai Future Foundation (DFF), Dubai, UAE, (*Invited*)

**Giacomelli, G,** 2019. Seed Breeding panel Indoor AgCon 2019, with Aaron Crawford, Bayer Crop Science, Stacy Davis, Germains Seed, Kimberly Kuden, Sakata Seed. (Invited)

**Giacomelli, G** GreenSys 2019 Conference, Angers, France. Ebb and Flood Nutrient Delivery System for Sustainable Automated Crop Production.

**Giacomelli, G,** C. Parrish, S. Gellenbeck and KC Shasteen, 2019. Mars-Lunar Greenhouse - 50th anniversary of the first moon landing, 19th July. Poster and booth display at special commemoration event at the University of Arizona Lunar & Planetary Lab.

**Kacira, M. 2019.** Climate Management and Control in Controlled Environment Agriculture Systems. 3rd International Congress on Controlled Environment Agriculture, Nov 6-8, Panama City, Panama. (*Invited*)

**Kacira, M. 2019.** Climate Control in Vertical Farming. 1st International Workshop on Vertical Farming, Oct. 13-15, Wageningen University, Wageningen, The Netherlands. (Invited)

**Kacira, M. 2019.** Engineering Challenges and Opportunities in CEA. USDA-NIFA AzCEA Workshop, Sep. 9-12, Biosphere 2, Tucson, AZ. (*Keynote*)

**Kacira, M. 2019.** Environmental Uniformity and Climate Control in Plant Factory with Artificial Lighting. Indoor AgCafé, hosted by Ohio State University, April 23. (*Invited*)

CT

McGehee CS, **RE Raudales** (2020) Characterization of oomycetes and fungi from the substrate of marijuana (*Cannabis sativa* L.) plants. 79th Annual Meeting of the Northeast Division of the American Phytopathological Society.12 March 2020. Northampton, MA. Award to Best Graduate Oral Presentation

Arrunategui M, CS McGehee, **RE Raudales** (2020) Efficacy of biological fungicides against Pythium root rot of *Cannabis sativa*. 79th Annual Meeting of the Northeast Division of the American Phytopathological Society.12 March 2020. Northampton, MA (*Poster).*

FL

**Gómez, C.** 2020. Indoor propagation research and education needs, webinar presented during the GLASE Consortium Webinar Series on July 23, 2020.

**C. Gómez.** 2020. Indoor home gardening, webinar presented during the Orange County Extension Master Gardener Lunch 'N' Learn series on May 20, 2020.

**Gómez, C.** 2019. Physiological disorders in Controlled Environments. Plant Health on The Go! Apopka, FL.

**Gómez, C.** 2019. The ‘ultimate’ plug. Vertifarm, Wageningen, The Netherlands. (poster pitch and poster)

**Gómez, C.** 2019. The ‘ultimate’ plug. USDA NIFA ‘Controlled Environment Indoor and Vertical Food Production Coordinated Research Conference’, Tucson, AZ.

ME

Sanchez, O., S. Burnett, and B.J. Peterson. 2019. Photosynthesis of cuttings propagated in overhead mist, submist, and a combination system. HortScience 54:202.

Machesney, L.M., S. Burnett, and B.J. Peterson. 2019. Effects of commercial fertilizers and mycorrhizal inoculants during commercial production of ‘Mrs. Burns Lemon Basil’. HortScience 54:292.

MI

Walters, K.J. and R.G. Lopez. 2019. The influence of average daily temperature and daily light integral on growth, development, and color of purple basil, sage, and spearmint. HortScience, 54(9), S75.

Walters, K.J., B.K. Behe, and R.G. Lopez. 2019. Consumer sensory preferences in response to manipulating fresh basil flavor through controlled environment light, temperature, and carbon dioxide management. HortScience, 54(9), S90. Second Place Award

Kohler, A.E. and R.G. Lopez. 2019. Short duration prior-to-shipping cooling and red and blue radiation enhances foliage color of ornamental cabbage and kale. ISHS International symposium on advanced technologies and management for innovative greenhouses. Meeting, 16−20 June, 2019. Angers, France.

Lopez, R.G., A.J. Soster, and K.J. Walters. 2019. Supplemental lighting providing blue radiation induces flowering of long-day perennials. ISHS International symposium on advanced technologies and management for innovative greenhouses. Meeting, 16−20 June, 2019. Angers, France.

Walters, K.J. and R.G. Lopez. 2019. Temperature and daily light integral influence growth and development of sweet basil. ISHS International symposium on advanced technologies and management for innovative greenhouses. Meeting, 16−20 June, 2019. Angers, France.

Kohler, A.E. and R.G. Lopez. 2019. Enhancing foliage color of ornamental cabbage and kale

with prior-to-shipping light and temperature treatments in coolers. NCERA 101: Committee on Controlled Environment Technology and Use Annual Meeting. 14-17 Apr., 2019. Montreal, Quebec, Canada.

NE

Meyer, G. E., E. T. Paparozzi, Erin Stevens. 2020. Classification of Plant Moisture Conditions Using Canopy and Leaf Temperature Responses to Step Changes of Incident Radiation. ASABE paper 2001085. The American Society of Agricultural and Biological Engineering. 16 pp.

NJ

Brumfield, R.G., D. Greenwood, M. Flahive DiNardo, A. Rowe, J. Zientek, R. VanVranken, J. Heckman, M. Melendez, L. Lawson, N. Polanin, A.J. Both, A. Rouff, and M. Taylor. 2020. Annie’s Project: Farming in New Jersey’s Cities and the Urban Fringe. Presented Virtually at the Extension Risk Management Educators National Conference, April 1-2, 2020.

Brumfield, R.G., B. Özkan, and E. Ilbasmis. 2020. A profile of women farmers who participated in Empowering Women Farmers with Agricultural Business Management Training (EMWOFA) training program. Paper accepted for presentation at the 2020 Annual Conference of the American Society for Horticultural Science (ASHS), Virtual, August 9-13, 2020.

Gottlieb, P.D., R.G. Brumfield, and R. Cabrera. 2020. Estimating the private return for water recycling investments at nurseries: multiple simulations using the beta version of an online computer tool. Paper accepted for presentation at the 2020 Annual Conference of the American Society for Horticultural Science (ASHS), Virtual, August 9-13, 2020.

Brumfield, R.G., P. Gottlieb, and R. Cabrera. 2019. Recycling irrigation water at New Jersey nurseries: Creation of a comprehensive decision-making system. Paper Presented at the 2019 Annual Conference of the American Society for Horticultural Science (ASHS), Las Vegas, NV, July 21-25, 2019. <https://ashs.confex.com/ashs/2019/oral/papers/index.cgi?username=31189&password=143123>.

Brumfield, R.G., B. Özkan, and E. Ilbasmis. 2019. Empowering women greenhouse owners in Antalya, Turkey by teaching them best management practices. Paper Presented at the 2019 Annual Conference of the American Society for Horticultural Science (ASHS), Las Vegas, NV, July 21-25, 2019. <https://ashs.confex.com/ashs/2019/oral/papers/index.cgi?username=31201&password=242815>.

Brumfield, R.G., B. Özkan, and R. Vezne. 2019. Using Workbooks and E-Learning Videos using adult learning techniques to help Small Scale Vegetable Farmers better manage their farms. Presented at the Extension Risk Management Educators National Conference, Louisville, KY, April 3-4, 2019. <https://agrisk.umn.edu/Conferences/Presentation/using_workbooks_and_elearning_videos_using_ad>.

OH

Ling, Peter. 2019. Greenhouse Environmental Control - basics. Workshop for K-12 Educators. Wooster, OH. 6/12/2019.

Ling, Peter. 2019. Greenhouse Control – aerial environment. Workshop for K-12 Educators. Wooster, OH. 6/13/2019.

Ling, Peter. 2020. Greenhouse temperature & humidity management. Greenhouse Management Workshop. Wooster, OH. 1/16/2020.

Ling, Peter. 2020. Greenhouse balance of energy, water and CO2. Greenhouse Management Workshop. Wooster, OH. 1/16/2020.

UT

Chen, J. and **Y. Sun.** (2019, July 24). Comparing the salt tolerance of three landscape plants using near-continuous gradient dosing system, Annual Conference of ASHS, Las Vegas, NV.

Hershkowitz, [J.](https://ashs.confex.com/ashs/2019/meetingapp.cgi/Person/38881) and **Y. Sun.** (2019, July 24). Salt tolerance of five spirea species. Annual Conference of the American Society for Horticultural Science (ASHS), Las Vegas, NV.

Palmer, A. and **Y. Sun.** (2019, July 23). Responses of four ornamental grasses to saline irrigation water, Annual Conference of American Society for Horticultural Science (ASHS), Las Vegas, NV.

Paudel, A. and **Y. Sun.** (2019, July 24). Salt tolerance of Sego Supreme™ plants, Annual Conference of ASHS, Las Vegas, NV.

**Other Creative Works:**

AZ

**Giacomelli, G**. Panel member for the FY2019 USDA-NIFA-AFRI Foundational Knowledge of Agricultural Production Systems (A1102) program.

**Giacomelli, G.** Design/Operations assistance for the Roof Top Greenhouse to Todd Miley, Executive Director Student Union Memorial Center.

FL

**Peer-reviewed Extension Publications in the Electronic Data Information Source (EDIS)**

J.A. Watson, **C. Gómez**, D.E. Buffington, R.A. Bucklin, R.W. Henley, and D.B. McConnell. 2019. Heating greenhouses. UFL Ag. Bio. Eng. Dept. AE11 <https://edis.ifas.ufl.edu/ae015>

J.A. Watson, **C. Gómez**, D.E. Buffington, R.A. Bucklin, R.W. Henley, and D.B. McConnell. 2019. Greenhouse ventilation. UFL Ag. Bio. Eng. Dept. AE10 <https://edis.ifas.ufl.edu/ae030>

J.A. Watson, **C. Gómez**, R.A. Bucklin, J.D. Leary, D.B. McConnell, and E.G. Wilkerson. 2019. Fan and pad greenhouse evaporative cooling systems UFL Ag. Bio. Eng. Dept. CIR1135 <https://edis.ifas.ufl.edu/ae069>

**Gómez, C.** 2020. Visited six commercial farms in Guatemala and provided individual best production practice recommendations as part of the ‘Greenhouse Ornamental Commission’ organized by the USAID’s Partners Farmer-to-Farmer (F2F) Program.

NJ

Both, A.J. 2020. High tunnel design and control. Abstract in the Proceedings of the 65th New Jersey Agricultural Convention and Trade Show. Atlantic City, NJ. February 4.

Lewus, D.C. and A.J. Both. 2020. Using CFD to improve high tunnel ventilation. Abstract in the Proceedings of the 65th New Jersey Agricultural Convention and Trade Show. Atlantic City, NJ. February 4.

Lubna, F. and A.J. Both. 2020. Poster: Life cycle assessment (LCA) of supplemental lighting systems used for controlled environment crop production. Northeastern Plant, Pest, and Soils Conference. Philadelphia, PA. January 6-9.

Mattson, N. and A.J. Both. 2020. Horticultural lighting systems energy-savings calculations. GLASE Webinar. February 20. Available at: https://glase.org/resources/webinars/

Both, A.J. 2019. Greenhouses: An overview. Presentation for the Department of Veterans Affairs Medical Center in East Orange, NJ. May 3.

Both, A.J., K. Demchak, E. Hanson, C. Heidenreich, G. Loeb, L. McDermott, M, Pritts, and C. Weber. 2019. High tunnel production guide for raspberries and blackberries. Available at: https://www.tunnelberries.org/

OH

*Website and social media*

* Kubota Lab (Controlled Environment Plant Physiology and Technology): <http://u.osu.edu/cepptlab>
* Hydroponics / Soilless Culture Information

<https://u.osu.edu/hydroponics>

* Controlled Environment Berry Production Information

<https://u.osu.edu/indoorberry>

* Facebook for Controlled Environment Plant Physiology and Technology Lab: <https://www.facebook.com/CEPPTLAB/>
* Indoor Ag Science Café YouTube Channel: <https://www.youtube.com/playlist?list=PLjwIeYlKrzH_uppaf2SwMIg4JyGb7LRXC>

UT

Palmer, A., Y. Wang, and **Y. Sun**. 2019. Responses of four ornamental grasses to saline irrigation water. HortScience 54(9): S111.

Chen, J., Y. Wang, A. Paudel, and **Y. Sun**. 2019. Comparing the salt tolerance of three landscape plants using near continuous gradient dosing system. HortScience 54(9): S283.

Hershkowitz, [J.](https://ashs.confex.com/ashs/2019/meetingapp.cgi/Person/38881), L. Li, Y. Wang, **Y. Sun**, and X. Dai. 2019. Salt tolerance of five spirea species. HortScience 54(9): S290.

**Paudel, A.**, S. Guo, **J. Chen**, Y. Wang, **Y. Sun**, L. Rupp, and R. Anderson. 2019. Salt tolerance of Sego SupremeTM plants. HortScience 54(9): S283.

**Workshop Sponsor:**

AZ

Giacomelli, G., M. Kacira and J. Ruiz, 2019. USDA-NIFA AzCEA Conference Indoor Agriculture, Sept 9 – 12, Biosphere 2. Tucson, AZ.

Kacira, M., G. Giacomelli, S. Tollefson, B. Pryor, E. Worth. 2020. 19th Annual Greenhouse Crop Production and Engineering Design Short Course. The University of Arizona, Controlled Environment Agriculture Center, March 2020.

CT

Raudales, RE. L, Pundt. Tomato Production in Soilless Media in Greenhouses: Pest & Disease Control. 25 March 2020 (Webinars)

Raudales, RE. L, Pundt. Tomato Production in Soilless Media in Greenhouses. 18 March 2020 (Webinars)

Pundt L, RE Raudales. Bedding plant meeting. Vernon & Torrington, CT. 7 & 22 February 2018

Raudales RE, CS McGehee. A Week in Hydroponics.3-7 December 2019 (Webinars)

Raudales, RE, L Pundt. Water & Nutrient Management for Container Production. New Haven, CT. 11 July 2019

FL

**Gómez, C.** 2020. Two-day short-course about ‘Greenhouse Ornamental Plant Production’ organized by the USAID’s Partners Farmer-to-Farmer (F2F) Program, Guatemala City, Guatemala.

ME

Co-organized the Educational session at the National Floriculture Forum in Charlotte, NC (February 28-29, 2020) with Marc van Iersel

NJ

Our annual Greenhouse Crop Production Short Course was cancelled due to COVID-19. It was originally scheduled for March 19-20, 2020.

Six-Week Annie’s Project: Farming in New Jersey’s Cities and the Urban Fringe, 128 Blake Hall, Cook Campus, New Brunswick, NJ, and via WebEx to Roseland and Mays’ Landing, NJ, December 3, 2019 – January 21, 2020.

OH

See the Ohio accomplishment report

* The 2020 Greenhouse Management Workshop was organized by Peter Ling and Chieri Kubota with 106 participants (including 16 online). This year’s focus was ‘Sustainable & Safe Crop Production’ covering both ornamental and food crops. (1/16-17/2020)
* A new workshop series “Basics of the Greenhouse Environment for K-12 Educators” was offered second time in 2019. The workshop was organized by Uttara Samarakoon, Kimberly Sayers, and Peter Ling with 24 participants. (6/12-13/2019).

**Workshop Participant**

AZ

**Giacomelli, G. 2019.** AzCEA Conference Session Moderator, Sept -12. Biosphere 2.

**Giacomelli, G.** 2020. Greenhouse Structures- Glazing and Environmental Control. Presented at 19th UA-CEAC Annual Greenhouse Crop Production and Engineering Design Short Course, March 2-6, Marriott Park University Hotel, The University of Arizona, Tucson, AZ.

**Giacomelli, G.** 2020. Greenhouse Energy Conservation Practices. Presented at 19th UA-CEAC Annual Greenhouse Crop Production and Engineering Design Short Course, March 2-6, Marriott Park University Hotel, The University of Arizona, Tucson, AZ.

**Giacomelli, G.** 2020. Design, Monitoring and Control of Recirculating Nutrient Delivery Systems. Presented at 19th UA-CEAC Annual Greenhouse Crop Production and Engineering Design Short Course, March 2-6, Marriott Park University Hotel, The University of Arizona, Tucson, AZ.

**Kacira, M.** 2020. Monitoring Your Greenhouse Environment: Simple Tools to Technology Trends, Presented at 19th UA-CEAC Annual Greenhouse Crop Production and Engineering Design Short Course, March 2-6, Marriott Park University Hotel, The University of Arizona, Tucson, AZ.

**Kacira, M.** 2020. Sensors and Environmental Controls. Hands-on Workshop, 19th UA-CEAC Annual Greenhouse Crop Production and Engineering Design Short Course, March 2-6, Marriott Park University Hotel, The University of Arizona, Tucson, AZ.

CT

Raudales RE. 2020. “*Clean Surfaces to Prevent Diseases*” Cultivate’20 Virtual. 13 July 2020

Raudales RE. 2020. “*Recirculation, microbial issues, and treatment systems”* Greenhouse Crop Production & Engineering Design Short Course. Tucson, AZ.3 Mar 2020

Raudales RE. 2020. “*Nutrient programs based on analyses of water, nutrient solutions & plant tissue”* Greenhouse Crop Production & Engineering Design Short Course. Tucson, AZ.3 Mar 2020

Raudales RE. *“What do growers ask a greenhouse specialist?”* Bedding Plant Meeting. Vernon, CT. 10 Feb 2020

Raudales RE. *“What do growers ask a greenhouse specialist?*” Bedding Plant Meeting. Vernon, CT. 6 Feb 2020

Raudales RE. “*Water management in containers: How to train your staff”* Connecticut Landscape and Nursery Association Annual Meeting, Plantsville, CT, 23 Jan 2020.

Raudales RE. *“Manejo de nutrientes y agua en propagación”* Plug & Cutting Conference. Raleigh, NC. 5 Sept, 2019

Raudales RE. *“Enfermedades de raíz: Diagnóstico y control”* Plug & Cutting Conference. Raleigh, North Carolina 5 Sept, 2019

Raudales RE. *“Selecting water treatments for control of plant pathogens”* Plug & Cutting Conference. Raleigh, North Carolina 5 Sept, 2019

Raudales RE. *“Water quality for healthy crops and clean irrigation lines”* Plug & Cutting Conference. Raleigh, North Carolina 5 Sept, 2019

Raudales RE. “*Testing water quality”* Water & Nutrient Management for Container Production. UConn Extension. New Haven, CT. 11 July 2019

FL

**Gómez, C.** 2019. Presenter at the Plant Health on The Go! Workshop, Apopka, FL.

**Gómez, C.** 2019. Panel member for the ‘Production Systems’ session during the ‘Controlled Environment Indoor and Vertical Food Production Coordinated Research Conference’, Tucson, AZ.

ME

Burnett, S. Integrating Service Learning into Floriculture Classes and Labs. National Floriculture Forum. February 29, 2020. Charlotte, NC.

NJ

Both, A.J. 2019. Hydroponics: Benefits and risks. Presentation during the Annie’s Project Workshop titled: Farming in New Jersey’s Cities and the Urban Fringe. New Brunswick, NJ.

Brumfield, R.G. 2020. Developing a mission/vision statement for your farm. Presentation during the Annie’s Project Workshop titled: Farming in New Jersey’s Cities and the Urban Fringe. New Brunswick, NJ. December 10, 2019

Brumfield, R.G. 2020. Rutgers cost accounting program: A tool to estimate your production costs. Presentation during the Annie’s Project Workshop titled: Farming in New Jersey’s Cities and the Urban Fringe. New Brunswick, NJ. January 7, 2020.

OH

See the Ohio accomplishment report

**Refereed Journal Articles (Pending):**

AZ

C. H. Parrish II, D. Hebert, A. Jackson, K. Ramasamy, H. McDaniel**, G.A. Giacomelli** and M.R. Bergren. 2020. Optimizing spectral quality with quantum dots to enhance crop yield in controlled environments. Manuscript submitted to Communications Biology (COMMSBIO- 20-2162-T) (*In review*)

FL

Solis-Toapanta, E.G, P.R. Fisher, and **C. Gómez**. 2020. Effects of nutrient solution management and environment on tomato in small-scale hydroponics. HortTechnology *accepted pending revision.*

**Zhang, Y.** and Kacira, M. (Forthcoming). "Comparison of energy use efficiency of greenhouse and indoor plant factory system," European Journal of Horticultural Science.

NE

Paparozzi, E.T., Z. Li, E. E. Blankenship and M. E. Conley. Purple leaf basil plants express micronutrient deficiencies symptoms differently than green leaf basil plants. Scientia horticulturae (in review).

Paparozzi, E. T. and M. E. Conley. Static Liquid Hydroponic Systems for Teaching. HortTechonolgy (in submission).

NJ

Shelford, T., C. Wallace and A.J. Both. 2019. Calculating and reporting key light ratios for plant research. Accepted for publication in Acta Horticulturae.

Lewus, D. and A.J. Both. 2019. Using computational fluid dynamics (CFD) to improve high tunnel ventilation. Accepted for publication in Acta Horticulturae.

Both, A.J. 2020. Crop irrigation. Chapter submitted for the 19th edition of the Ball Redbook. 4 pp.

Both, A.J. 2020. Glazing. Chapter submitted for the 19th edition of the Ball Redbook. 6 pp.

Li, Y., J. Heckman, A. Wyenandt, N. Mattson, E. Durner, and A.J. Both. 2020. Potential benefits of Silicon nutrition to hydroponically grown sweet basil. Submitted for review to HortScience.

Greenwood, D., R.G. Brumfield, M. Flahive DiNardo, A.J. Both, J.R. Heckman, N. Polanin, A. Rouff, A. Rowe, and R. VanVranken. 2020. Annie’s Project: Farming in New Jersey’s Cities and the Urban Fringe. Submitted for review to the Journal of Extension.

Llewellyn, D., T.J. Shelford, Y. Zheng, and A.J. Both. 2021. Measuring and reporting lighting characteristics important for controlled environment plant production. Submitted for review to Acta Horticulturae. (The LightSym meeting in Malmö, Sweden was postponed to 2021).

Shelford, T.J., N. Mattson, and A.J. Both. 2021. A greenhouse daily light integral control algorithm that takes advantage of day ahead market electricity pricing. Submitted for review to Acta Horticulturae. (The LightSym meeting in Malmö, Sweden was postponed to 2021).