**Annual Meeting**

The Ohio State University

Columbus, OH

July 17-18, 2018

**Multistate Research Project**

**Annual Station Publications Report**

PROJECT NUMBER: NE-1335

TITLE: Resource Management in Commercial Greenhouse Production

PROJECT DURATION: October 1, 2013 – September 30, 2018

EXPERIMENT STATION: New Hampshire Agriculture Experiment Station

PARTICIPANTS: Ryan Dickson

REPORTING PERIOD**:** July 1, 2013 – July 17, 2018

REPORT DATE: 5 September 2018

**PUBLICATIONS:**

**Dissertations, Theses (Published)**

ME:

* Foster, J. 2014. Effects of Light, Volumetric Water Content, and Soil Nutrition on Greenhouse Propagation of the Clonal Sub-Shrub *Linnaea borealis*. Univ. Maine, Orono, MS Thesis. Abstr. 2099.
* Zhen, S. 2013. Production of Rosemary, Canadian Columbine, Cheddar Pink, and English Lavender. Univ. Maine, Orono, MS Thesis. Abstr. 1977.

NJ:

*Completed:*

* Mehra Blott, Ph.D. 2018. Dissertation title: Evaluating off-gassing from polyethylene film used to cover greenhouses and high tunnels. A.J. Both served as a member of the dissertation advisory committee.
* Swetha Kasetty, M.S. 2017. Thesis title: Using flux balance analysis to predict methyl-mercury production by sulfate reducing bacteria. A.J. Both served as co-advisor.
* Michael Johnson, Ph.D. 2017. Dissertation title: Development, optimization, and technoeconomic evaluation of a novel attached growth algae cultivation platform. A.J. Both served as major advisor.
* Isabel Armas Gutiérrez, M.S. 2015. Thesis title: Nutritional enhancement of lettuce using mutation breeding. A.J. Both served as a member of the thesis advisory committee.

*Ongoing:*

* David Lewus, Ph.D. student in Plant Biology (2017-). Project: CFD analysis of natural ventilation in high tunnels. A.J. Both serves as major advisor.
* Matthew Patterson, Ph.D. student in Environmental Sciences (2015-). Project: Estimation of heterogeneous flow using soil and geophysical data at multiple scales. A.J. Both serves as a member of the dissertation advisory committee.
* Yuan Li, Ph.D. student in Plant Biology (2013-). Project: Hydroponic crop production. A.J. Both serves as major advisor.

MSU:

* Craver, J.K. and **R.G. Lopez**. 2018. Manipulating light quality, light intensity, and carbon
* dioxide concentration to optimize indoor and greenhouse production of annual bedding plant seedlings. Purdue Univ., West Lafayette, PhD Diss.

Virginia Tech:

* Grossman, M.C. 2017. Controlling Growth of Echinacea Hybrids. Ph.D. Dissertation, Virginia Polytechnic Institute and State University.
* Mack, R.E. 2016.Best Management Practice Use and Efficacy for the Virginia Nursery and Greenhouse Industry. M.S. Thesis. Virginia Polytechnic Institute and State University.

CT:

* McGehee CS. 2018. ‘Microbial Suppression of Pythium Root Rot in Soilless Systems” Master in Science Thesis, University of Connecticut, Storrs, CT

Cornell:

* Villarino Pizarro, G. 2015. Transcriptomic analysis of *Petunia hybrida* in response to salt stress. PhD dissertation. 117 pages. (N. Mattson, special committee chair)
* Allred, J.A. 2017. Environmental and cultural practices to optimize the growth and development of three microgreen species. M.S. Thesis. Cornell University.
* Brace, S.A. 2017. Vermicompost application as a fertilizer source and substrate amendment for seedlings and transplants: practical application and microbial activity analysis. Ph.D. Dissertation, Cornell University.

**Books (Published)**

MSU:

* **Lopez, R.G.** and E. Runkle. 2017. Light Management in Controlled Environments. Meister Media Worldwide, Willoughby, OH.

**Book Chapters (Published)**

MSU:

* Faust, J.E., J.M., Dole, and **R.G. Lopez**. 2017. The floriculture cutting industry, p. 121−172. In: J. Janick (ed.). Horticultural Reviews vol. 44. John Wiley & Sons, Hoboken, NJ.
* **Lopez, R.**, P. Fisher, and E. Runkle. 2017. Chapter 1. Introduction to specialty-crop lighting, p. 12−20. In: R. Lopez and E. Runkle (ed.). Light management in controlled environments. Meister Media Worldwide, Willoughby, OH.
* Runkle, E., **R. Lopez**, and P. Fisher. 2017. Chapter 5. Photoperiodic control of flowering, p. 48−58. In: R. Lopez and E. Runkle (ed.). Light management in controlled environments. Meister Media Worldwide, Willoughby, OH.
* Faust, J., E. Runkle, **R. Lopez**, and P. Fisher. 2017. Chapter 11. Light management for stock plants, p. 100−108. In: R. Lopez and E. Runkle (ed.). Light management in controlled environments. Meister Media Worldwide, Willoughby, OH.
* **Lopez**, R., C. Currey, and E. Runkle. 2017. Chapter 12: Light and young plants, p. 109−118. In: R. Lopez and E. Runkle (ed.). Light management in controlled environments. Meister Media Worldwide, Willoughby, OH.
* Currey, C., D. Kopsell, N. Mattson, J. Craver, **R. Lopez**, J. Erwin, and C. Kubota. 2017. Chapter 18. Supplemental and sole-source lighting of leafy greens, herbs, and microgreens, p. 170−180. In: R. Lopez and E. Runkle (ed.). Light management in controlled environments. Meister Media Worldwide, Willoughby, OH.

OSU:

* **Kubota, C**., A. de Gelder, and M. Peet. 2018. Greenhouse tomato production. In: (E. Heuvelink, ed.) Tomatoes, 2nd Edition. CAB International. (in press)
* **Kubota, C.,** M. Chao, S. Masoud, Y.J. Son, R. Tronstad. 2018. Advanced technologies for large-scale plant factories – integration of industrial and systems engineering approach in controlled environment crop production. In: (M. Anpo, H. Fukuda, and T. Wada, eds.) Plant factory using artificial light. Elsevier (in press)

CT:

* Raudales RE. 2016. Chapter 2 Nutritional Disorders of Florist Crops. Handbook of Florist’s Crop Diseases (Ed. RJ McGovern and WH Elmer). Springer Publishing Co. Berlin, Germany. <https://link.springer.com/referenceworkentry/10.1007/978-3-319-32374-9_2-1>
* Fisher PR, J Huang, RE Raudales, DP Meador. 2014. Ch. 20. Chlorine for irrigation water treatment. *Biology, detection, and management of plant pathogens in irrigation water* (978-0-89054-426-6 ed., pp. 448). APS Press (St Paul, MN). <http://www.apsnet.org/apsstore/shopapspress/Pages/44266.aspx>

NJ:

* Both, A.J. and J.E. Faust. 2017. Light transmission: The impact of glazing material and greenhouse design. Chapter 6 in ‘*Light Management in Controlled Environments*’ (R. Lopez and E.S. Runkle, eds.), Meister Media Worldwide, Willoughby, OH.
* Fisher, P., A.J. Both, and B. Bugbee. 2017. Supplemental lighting technology, costs and efficiency. Chapter 8 in ‘*Light Management in Controlled Environments*’ (R. Lopez and E.S. Runkle, eds.), Meister Media Worldwide, Willoughby, OH.
* Both, A.J., J.M. Frantz, B. Bugbee. 2017. Carbon dioxide enrichment in greenhouses. Chapter 9 in ‘*Light Management in Controlled Environments*’ (R. Lopez and E.S. Runkle, eds.), Meister Media Worldwide, Willoughby, OH.
* Runkle, E. and A.J. Both. 2017. Delivering long-day lighting – Technology options and costs. Chapter 10 in ‘*Light Management in Controlled Environments*’ (R. Lopez and E.S. Runkle, eds.), Meister Media Worldwide, Willoughby, OH.
* Mitchell, C.A., J.F. Burr, M.J. Dzakovich, C. Gómez, R. Lopez, R. Hernández, C. Kubota, C.J. Currey, Q. Meng, E.S. Runkle, C.M. Bourget, R.C. Morrow, and A.J. Both. 2015. Light-Emitting Diodes in horticulture. Horticultural Reviews 43:1-87. John Wiley & Sons, Inc., Hoboken, NJ.

Cornell:

* Currey, C.J., Kopsell, D.A., Mattson, N.S., Craver, J.K., Lopez, R.G., Erwin, J.E. and C. Kubota. 2017. Supplemental and sole-source lighting of leafy greens, herbs, and microgreens. Chapter 18 in ‘Light Management in Controlled Environments’ (R.G. Lopez and E.S. Runkle, eds.). Meister Media Worldwide, Willoughby, OH. pp. 170-180.
* Erwin, J., Mattson, N., and R. Warner. 2017. Light effects on bedding plants. Chapter 13 in ‘Light Management in Controlled Environments’ (R.G. Lopez and E.S. Runkle, eds.). Meister Media Worldwide, Willoughby, OH. pp. 119-134.

**Refereed Journal Articles (Published)**

UNH:

* Dickson, R.W., Fisher, P.R., and Argo, W.R. 2017. Quantifying acidity and basicity of fifteen floriculture species in peat substrate. HortScience 52 (8): 1065-1072.
* Dickson, R.W., Fisher, P.R., Padhye, S.R., and Argo, W.R. 2016. Evaluating calibrachoa (*Calibrachoa* × *hybrida* Cerv.) genotype sensitivity to iron deficiency at high substrate pH. HortScience. 200: 1452-1457.
* Dickson, R. W., Fisher, P. R., Argo, W. R., Jacques, D. J., Sartain, J. B., Trenholm, L. E., and Yeager, T. H. 2016. Solution ammonium: nitrate ratio and cation/anion uptake affect acidity or basicity with floriculture species in hydroponics. Scientia Horticulturae, 200, 36-44.

ME:

* Peterson, B., S. Burnett, and O. Sanchez. 2018. Submist is effective for propagtion of *Syringa* and *Ilex* by stem cuttings. HortTechnology 28:378-381.
* Peterson, B.J., O. Sanchez, S. Burnett, and D.J. Hayes. 2018. Sub-Mist is an effective alternative to overhead mist for the propagation of coleus by stem cuttings. HortTechnology 28:143-148.
* Foster, J.J., S. Burnett, and L.B. Stack. 2017. Effects of light, soil moisture, and nutrition on greenhouse propagation of *Linnaea borealis*. HortTechnology 27:782-788.
* Burnett, S., N. Mattson, and K. Williams. 2016. Substrates and fertilizers for organic container production of herbs, vegetable transplants, and herbaceous ornamental plants grown in greenhouses in the United States Sci. Hort. 208:111-119.
* Zhen, S. and S. Burnett. 2015. Effects of substrate volumetric water content on English lavender morphology and photosynthesis. HortScience 50:909-915.
* Zhen, S., S. Burnett, M.E. Day, and M.W. van Iersel. 2014. Effects of substrate water content on morphology and physiology of rosemary, Canadian columbine, and cheddar pink. HortScience 49:486-492.
* Papparozzi, E., N. Mattson, M. Grossman, and S. Burnett. 2013. Creative thinking, creative funding: Research, extension, and teaching consortiums – the 2013 National Floriculture Forum. HortTechnology 23:794-795.

NJ:

* Brumfield, R.G., L.B. Kenny, A.J. DeVincentis, A.K. Koeser, S. Verlinden, A.J. Both, G. Bi, S.T. Lovell, and J.R. Stewart. 2018. Analysis of economic and social costs of growing Petunia x hybrida in a greenhouse production system using alternative containers. Accepted for publication in HortScience.
* Hernández, C.P., H.A. Imbuzeiro, L.D. Pimentel, P.J. Hamakawa, and A.J. Both. 2018. Morphological, physiological and nutritional effects of irrigation frequency on Macaúba palm seedlings. Journal of Agricultural Research 10(4):24-36.
* Roy, I., Y. Naumova, and A. J. Both. 2018. Assessment of electricity-free hydroponics in India: A proof of concept field study. Journal of Agricultural Research 10(1):45-55.
* Both, A.J., B. Bugbee, C. Kubota, R.G. Lopez, C. Mitchell, E.S. Runkle, and C. Wallace. 2017. Proposed product label for electric lamps used in the plant sciences. HortTechnology 27(4):544-549.
* Brumfield, R.G., B. Ozkan, and R. Vezne. 2017. A train-the-trainer program to train Extension educators to teach business management skills to women farmers. International Journal of Economics and Management Systems, ISSN: 2367-8925, 2, 86-90. http://www.iaras.org/iaras/journals/ijems.
* Polanin, N., M. Melendez, J. Carleo, J. Matthews, R. Brumfield, B. O’Neill, and J. Heckman. 2017. Social media: Cultivating peer-to-peer farm women networks in New Jersey. International Journal of Agricultural Science, ISSN 2367-9026, 2, 37-41. http://iaras.org/iaras/journals/ijas.
* Brumfield, R.G., A.J. DeVincentis, X. Wang, R.T. Fernandez, S. Nambuthiri, R.L. Geneve, A. K. Koeser, G. Bi, T. Li, Y. Sun, G. Niu, D. Cochran, A. Fulcher, and J.R. Stewart. 2015. Economics of Utilizing Alternative Containers in Ornamental Crop Production Systems. HortTechnology 25(1):17-25. http://horttech.ashspublications.org/content/25/1/17.full.pdf
* DeVincentis, A.J., R.G. Brumfield, P. Gottlieb, and J. Johnson, 2015. Cost Analysis of Recycling Water in Greenhouses in Southern New Jersey. HortScience 50(8):1–6. 2015.
* Both, A.J., L. Benjamin, J. Franklin, G. Holroyd, L.D. Incoll, M.G. Lefsrud, and G. Pitkin. 2015. Guidelines for measuring and reporting environmental parameters for experiments in greenhouses. Plant Methods 11(43). 18 pp.
* Johnson, M., T.S. Villani, A. Azmat, J.E. Simon, and A.J. Both. 2015. Evaluation of algal biomass production on vertical aeroponic substrates. Algal Research 10:240-248.
* Mears, D.R., L. Okushima, S. Sase, T. Takakura, H. Moriyama, S. Furuno and M. Ishii. 2014. The cooling capacities of the greenhouses with the heat pump systems in Japan. Journal of the Society of Agricultural Structures, Japan, Vol.45, No.2, June, 2014. (In Japanese, English version online). http://www.naro.affrc.go.jp/org/nkk/soshiki/soshiki04-nouchi/04nougyoushisetsu/ceac\_news/2014\_HP\_cool\_paper\_final.pdf

Virginia Tech:

* Harris, W.K., J.R. Freeborn, J. Latimer and H.L. Scoggins. 2016. Overwintering Survival and Vigor of Container-Grown Fountain Grass: Influence of Protective Covers, Fertilizer Rate and Substrate Moisture Content. HortTechnology 25(6):791-795.
* Aiken, M.G., H.L. Scoggins, and J.G. Latimer. 2015. Substrate pH impacts efficacy of ethephon drenches on growth of herbaceous perennials. HortScience 50:1187-1191.
* Grossman\* M., J. Freeborn, H. Scoggins, J. Latimer. 2014. Effects of Application Time of Benzyladenine on the Branching and Growth of Herbaceous Perennial Liners. Acta Hort 1042:237-242.
* Grossman, M., J. Freeborn, H. Scoggins, J. Latimer. 2013. Timing of benzyladenine and sodium dikegulac application affects branching of liners and finished herbaceous perennial plants. HortSceince 48:875-882.

OSU:

* Masoud, S., Y.J. Son, **C. Kubota**, and R. Tronstad. 2018. Evaluation of simulation based optimization in grafting labor allocation. Applied Engineering in Agriculture. 34(3): 479-489.
* **Kubota, C.\*,** T. Eguchi\*, and M. Kroggel. 2017. UV-B radiation dose requirement for suppressing intumescence injury on tomato plants. Scientia Horticulturae 226:366-371. [\*equally contributing to the work]
* **Kubota, C**., C. Meng, Y.J. Son, M. Lewis, H. Spalholz, and R. Tronstad. 2017. Horticultural, systems-engineering and economic evaluations of short-term plant storage techniques as a labor management tool for vegetable grafting nurseries. PLOS ONE <http://dx.doi.org/10.1371/journal.pone.0170614>

CT:

* Grant GA, PR Fisher, JE Barrett, PC Wilson, RE Raudales. 2018. Paclobutrazol removal from irrigation water using a commercial-scale granular activated carbon system. Scientia Horticulturae 241: 160-166 <https://doi.org/10.1016/j.scienta.2018.06.093>
* McGehee CS, RE Raudales, WH Elmer. 2018. First report of *Pythium dissotocum* causing Pythium root rot on hydroponically-grown lettuce in Connecticut. Plant Disease <https://doi.org/10.1094/PDIS-02-18-0365-PDN>
* Raudales RE, PR Fisher and C. Hall. 2017. The cost of irrigation sources and water treatment in greenhouse production. Irrigation Science 35: 43–54 <https://link.springer.com/article/10.1007/s00271-016-0517-5>
* Altland, JE, L Morris, J Boldt, PR Fisher, RE Raudales. 2015. Sample container and storage for paclobutrazol monitoring in irrigation water. *HortTechnology, 25*(6), 769-773 <http://horttech.ashspublications.org/content/25/6/769.full>
* Raudales RE, JL Parke, C Guy, PR Fisher. 2014. Control of waterborne microbes in irrigation: A review. *Agricultural Water Management* 143:9-28 <http://www.sciencedirect.com/science/article/pii/S0378377414001838>
* Raudales RE, TA Irani, CR Hall, PR Fisher. 2014. Modified-Delphi survey on key attributes for selection of water-treatment technologies for horticulture irrigation. *HortTechnology, 24*(3):355-368 <http://horttech.ashspublications.org/content/24/3/355.abstract>

Cornell:

* Villarino G.H., Bombarely, A., Giovannoni J.J., Scanlon M.J., and N.S. Mattson. 2014. Transcriptomic analysis of Petunia hybrida in response to salt stress using high throughput RNA sequencing. PLoS ONE 9(4): e94651. doi:10.1371/journal.pone.0094651.
* Jandricic, S.E., N.S. Mattson, S.P. Wraight and J.P. Sanderson. 2014. Within-plant distribution of foxglove aphid, Aulacorthum solani (Kaltenbach) (Hemiptera: Aphididae), on various greenhouse plants with implications for control. Journal of Economic Entomology. 107:697-707.
* Shahid, M.A., R.M. Balal, M.A. Pervez, T. Abbas, M.A. Aqeel, A. Riaz and N.S. Mattson. 2015. Exogenous 24-Epibrassinolide elevates the salt tolerance potential of pea (Pisum sativum L.) by improving osmotic adjustment capacity and leaf water relations. Journal of Plant Nutrition: 38(7):1050-1072. doi:10.1080/01904167.2014.988354
* Currey, C.J., R.G. Lopez and N.S. Mattson. 2014. Finishing bedding plants: a comparison of unheated high tunnels versus heated greenhouses in two geographic locations. HortTechnology. 24(5):527-534.
* Balal, R. M., Shahid, M. A., Javaid, M. M., Iqbal, Z., Anjum, M. A., Garcia-Sanchez, F., & Mattson, N. S. 2016. The role of selenium in amelioration of heat-induced oxidative damage in cucumber under high temperature stress. Acta Physiologiae Plantarum, 38(6), 1-14.
* Burnett, S. E., Mattson, N. S., & Williams, K. A. 2016. Substrates and fertilizers for organic container production of herbs, vegetables, and herbaceous ornamental plants grown in greenhouses in the United States. Scientia Horticulturae. doi:10.1016/j.scienta.2016.01.001
* Bombarely, A., Moser, M., Amrad, A., Bao, M., Bapaume, L., Barry, C.S., Bliek, M., Boersma, M.R., Borghi, L., Bruggmann, R. and Bucher, M.,…Mattson, N.S…. 2016. Insight into the evolution of the Solanaceae from the parental genomes of Petunia hybrida. Nature plants, 2, p.16074.
* Furtini E.D., K.V. Furtini, N.S. Mattson. 2015. Nutrition and quality in ornamental plants. Advances in Ornamental Horticulture and Landscaping. 21(2):139-150.
* Li, Y. and N.S. Mattson. 2015. Effects of seaweed extract application rate and method on post-production life of petunia and tomato transplants. HortTechnology. 25:505-510.
* Gerovac, J.R., R.G. Lopez and N.S. Mattson. 2015. High tunnel versus climate-controlled greenhouse: transplant time and production environment impact growth and morphology of cold-tolerant bedding plants. HortScience. 50:830-838.
* Jin, Q., Xu, Y., Mattson, N., Li, X., Wang, B., Zhang, X., Jiang, H., Liu, X., Wang, Y. and Yao, D., 2017. Identification of submergence-responsive microRNAs and their targets reveals complex miRNA-mediated regulatory networks in lotus (Nelumbo nucifera Gaertn). Frontiers in plant science, 8.
* Jin, Q., Wang, Y., Li, X., Wu, S., Wang, Y., Luo, J., Mattson, N. and Xu, Y., 2017. Interactions between ethylene, gibberellin and abscisic acid in regulating submergence induced petiole elongation in Nelumbo nucifera. Aquatic Botany, 137, pp.9-15.
* Jin, Q., Hu, X., Li, X., Wang, B., Wang, Y., Jiang, H., Mattson, N. and Xu, Y., 2016. Genome-wide identification and evolution analysis of Trehalose-6-phosphate synthase gene family in Nelumbo nucifera. Frontiers in Plant Science, 7, 1445 doi:10.3389/fpls.2016.01445
* Li, Y. and N.S. Mattson. 2016. Effect of different commercial substrates on growth of petunia transplants. HortTechnology. 26(4):507-513.
* Shahid, M.A., Balal, R.M., Khan, N., Zotarelli, L., Liu, G., Ghazanfar, M.U., Rathinasabapathi, B., Mattson, N.S., Martínez-Nicolas, J.J. and Garcia-Sanchez, F., 2018. Ploidy level of citrus rootstocks affects the carbon and nitrogen metabolism in the leaves of Chromium-stressed Kinnow mandarin plants. Environmental and Experimental Botany, 149, pp.70-80.
* Songsomboon K., Viands D.R., Mattson N.S. and Bergstrom G.C. 2018. Silicon amendment for control of *Bipolaris* leaf spot and seed rot of upland switchgrass, 2017. Plant Dis. Manag. Rep. 12:ST001. Online publication. doi:10.1094/PDMR12
* Xu, Y., Wang, Y., **Mattson, N.**, Yang, L. and Jin, Q., 2017. Genome-wide analysis of the Solanum tuberosum (potato) trehalose-6-phosphate synthase (TPS) gene family: evolution and differential expression during development and stress. BMC genomics, 18(1), p.926. DOI 10.1186/s12864-017-4298-x
* Villarino, G.H., Hu, Q., Scanlon, M.J., Mueller, L., Bombarely, A. and **Mattson, N.S.** 2017. Dissecting Tissue-Specific Transcriptomic Responses from Leaf and Roots under Salt Stress in Petunia hybrida Mitchell. Genes 2017, 8(8), 195. DOI 10.3390/genes8080195.
* Balal, R.M., Shahid, M.A., Vincent, C., Zotarelli, L., Liu, G., **Mattson, N.S.**, Rathinasabapathi, B., Martínez-Nicolas, J.J. and Garcia-Sanchez, F., 2017. Kinnow mandarin plants grafted on tetraploid rootstocks are more tolerant to Cr-toxicity than those grafted on its diploids one. Environmental and Experimental Botany. 140:8-18.

**Symposium Proceedings Articles (Published)**

UNH:

* Dickson, R.W. and Fisher, P.R. *In press*. Quantifying pH effect of fifteen floriculture species in peat substrate. Proc. IS on Growing Media and Soilless Cultivation. Acta Hort.
* Dickson, R.W, and Fisher, P.R. 2017. Ammonium-nitrate ration and cation/anion uptake affect the acidity or basicity of floriculture species. Proc. IS on Growing Media and Soilless Cultivation. Acta Hort. 1168, ISHS
* Fisher, P.R. and Dickson, R.W. 2016. Improving irrigation practices in container stock plant production of herbaceous plant cuttings. International Symposium on Protected Cultivation in Tropical and Temperate Climates. Acta Hort. *In press*.
* Fisher, P.R., Dickson, R.W., Mohammad-pour, G.S., Huang, J. 2014. Effect of solution electrical conductivity (EC) and pre-plant nutrient form on the pH of a peat-perlite substrate. Proc. IS on Growing Media and Soilless Cultivation. Acta Hort. 1034, ISHS

NJ:

* Ishii, M., L. Okushima, H. Moriyama, S. Sase, N. Fukuchi, T. Maruo, and A.J. Both. 2017. Evaluating environmental conditions in open-roof greenhouses. Acta Horticulturae 1170: 897-904.
* Wallace, C and A.J. Both. 2016. Evaluating operating characteristics of light sources for horticultural applications. Acta Horticulturae 1134: 435-444.
* Kubota, C., M. Kroggel, A.J. Both, J.F. Burr, and M. Whalen. 2016. Does supplemental lighting make sense for my crop? – Empirical evaluations. Acta Horticulturae 1134: 403-412.
* Özkan, B., R.G. Brumfield, R. Vezne. 2016. Empowering women farmers with agricultural business management training (EMWOFA). AEON International Multidisciplinary Conference on Social Sciences and Arts. Pp. 184-192. ISBN 978-619-90803-0-6. http://aeonconferences.org/documents/Aeon\_Conference\_Proceedings.pdf.
* Ishii, M., L. Okushima, H. Moriyama, S. Sase, N. Fukuchi, and A.J. Both. 2015. Experimental study of natural ventilation in an open-roof greenhouse during the summer. Acta Horticulturae 1107:67-74.

*Extension meetings/abstracts (NJ)*

* Both, A.J. 2016. Crop lighting. Proceedings of the 61th New Jersey Agricultural Convention and Trade Show. February 9. Atlantic City, NJ. pp. 32.
* Both, A.J. 2015. LED Lighting. Proceedings of the 60th New Jersey Agricultural Convention and Trade Show. February 4. Atlantic City, NJ. pp. 89.
* Both, A.J. 2015. High Tunnel Construction and Operation Update. Proceedings of the 60th New Jersey Agricultural Convention and Trade Show. February 3. Atlantic City, NJ. pp. 52.
* Both, A.J. 2014. Greenhouses. Proceedings of the 59th New Jersey Agricultural Convention and Trade Show. February 4. Atlantic City, NJ. pp. 1.
* Both, A.J. 2014. Hydroponic lettuce production. Proceedings of the Mid Atlantic Fruit and Vegetable Convention. January 28-30. Hershey, PA. pp. 58-59.

*Rutgers Cooperative Extension Fact Sheet*

* Manning, T., A.J. Both, and J. Rabin. 2014. Assessing on-farm equipment efficiency and energy use. (Rutgers Cooperative Extension Web Publication). Available at: http://sustainable-farming.rutgers.edu/assessing-farm-equipment-efficiency/

*Online Extension Teaching*

* Both, A.J. 2015. A video presentation titled ‘Greenhouse Energy Efficiency’ was delivered as part of the NE-SARE funded Farm Energy IQ project (collaboration with Penn State and the University of Vermont).
* DeVincentis, A.J., R.G. Brumfield, and P. Gottlieb. 2015. Recycling Waste Water Videos. We developed a series of videos to help greenhouse and nursery owners with costs and systems for recycling their waste water: http://aesop.rutgers.edu/~farmmgmt/recycling-water/index.html.
* Both, A.J. 2014. A total of eight video presentations were delivered as part of the multi-institutional USDA-HEC project (Ohio State, University of Arizona and Rutgers University). The titles include: Alternative Energy and Resource Use; Carbon Dioxide Enrichment; Evaporative Cooling and Shading; Greenhouse Heating Basics; Greenhouse Heating Systems; Greenhouse Location and Structures; Supplemental Lighting and Shading; Greenhouse (Mechanical) Ventilation.
* Brumfield, R.G. 2014. A total of eight video presentations were delivered as part of the multi-institutional USDA-HEC project (Ohio State, University of Arizona and Rutgers University). The titles include: Cost Accounting, Financial Statements, and Ratios; How to Price Your Products; Production Plan; SWOT Analysis: Strengths, Weaknesses, Opportunities and Threats; Writing a Business Plan; Why Have a Business Plan?; Developing a Mission Statement; Vegetable Greenhouse Overview.
* Both, A.J. 2014. Two webinars were delivered as part of the USDA-NRCS funded project titled ‘On-Farm Energy Quality Assurance Training Program' that was organized through the University of Wisconsin. The webinar titles were ‘Greenhouse heating and ventilation considerations’ and ‘Evaporative cooling, supplemental lighting and shading’.

Virginia Tech:

* Latimer, J., M. Grossman, E. Lyons, M. Aiken and H. Scoggins. 2015. Using PGRs for early control of plant growth and development. Proc. 31st Annual Pest and Production Management Conf., Soc. American Florists 31:24-30.
* Grossman\* M., J. Freeborn, H. Scoggins, J. Latimer. 2014. Effects of Application Time of Benzyladenine on the Branching and Growth of Herbaceous Perennial Liners. Acta Hort 1042:237-242.

OSU:

* Garcia, K. and **C. Kubota**. 2017. Physiology of strawberry plants under controlled environment: Diurnal change in leaf net photosynthetic rate. Acta Horticulturae 1156:445-452.
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* Dickson, R. Having success with container edibles. GrowerTalks. September 2017.
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* Dickson, R. and P. Fisher. Why do geraniums drop pH? GrowerTalks. May 2017.
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**Presentations (Papers)**

UNH:

* Quantifying the acidity and basicity of fifteen floriculture species grown in peat-based substrate. ISHS International Growing Media and Substrates Conference. Portland, OR 2017.
* Quantifying the acidity and basicity of fifteen floriculture species. American Society for Horticultural Sciences Annual Conference. Kona, HA 2017.
* Evaluating calibrachoa genotype sensitivity to iron deficiency at high substrate pH. American Society for Horticultural Sciences Annual Conference. Atlanta, GA 2016.
* Solution ammonium:nitrate ratio and cation/anion uptake affect acidity or basicity with floriculture species in hydroponics. ISHS International Growing Media and Substrates Conference (SUSGRO 2015). Vienna, Austria, 2015.
* Species Effects on Acidity or Basicity in Hydroponic Solutions. American Society for Horticultural Sciences Annual Conference. Orlando, FL 2014.
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MSU:

* Owen, W.G. and **R.G. Lopez.** Stacking substrate-filled containers influence root and shoot growth of bedding plants. International Symposium on Growing Media, Soilless Cultivation, and Compost Utilization in Horticulture. 20-25 Aug., 2017. Portland, OR.
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OSU:

* **Kubota, C.,** S. Masoud, Y.J. Son, and R. Tronstad. Integration of industrial and systems engineering approach in optimizing nursery operations for vegetable grafting. Annual Conference for American Society for Horticultural Science, July 30-August 3, 2018, Washington DC.
* McKean, T.W., M. Kroggel, **C. Kubota**, and R. Naasz. 2018. Preliminary evaluation of four soilless substrates and supplemental arbuscular microrrhizal fungi for greenhouse strawberry production. Annual Conference for American Society for Horticultural Science, July 30-August 3, 2018, Washington DC.

CT:

* McGehee CS, RE Raudales (2018) “Efficacy of biofungicides to control Pythium root rot and Damping-off in hydroponically-grown arugula (*Eruca sativa*). 2018 American Society for Horticultural Sciences Annual Conference. Washington, DC. 1 Aug 2018.
* Cabrera JC, RE Raudales (2018) “Poinsettia (*Euphorbia pulcherrima*) growth and root rot incidence in the presence of biofilm on irrigation pipes”. 2018 American Society for Horticultural Sciences Annual Conference. Washington, DC. 1 Aug 2018.
* Cabrera JC, RE Raudales (2018) “Efficacy of biofungicides to control *Pythium* root rot and Damping-off in lettuce (*Lactuca sativa*) seedlings”. 2018 American Society for Horticultural Sciences Annual Conference. Washington, DC. 1 Aug 2018. *(Poster)*
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* Allred, J. and N. Mattson. 2016. Effects of daily light integral and carbon dioxide on microgreens. Abstract and poster at the Fifth International Controlled Environment Conference. Canberra, Australia, September 18-23, 2016.
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* Nishimura, S., Harbick, K., Schuster, R., Hubert, J., Holley, J., Mattson, N.S. and M. Yelton. 2017. Creating light uniformity in the greenhouse. Abstract and presentation at Annual ASHS Conference. Waikoloa, HI, September 19-22, 2017.
* Allred, J.A. and N.S. Mattson. 2017. Environmental practices to optimize the growth, development, and nutritional quality of microgreens. Abstract and presentation at Annual ASHS Conference. Waikoloa, HI, September 19-22, 2017.
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**Other Creative Works**

Virginia Tech:

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* Latimer, J. and M. Grossman. 2013. Branching agents enhance herbaceous perennial plant liners. Greenhouse Grower’s FloriCAST. December 2013.

OSU:

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

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**Workshop Sponsor**

Virginia Tech:

# Whipker, B. and J. Latimer, organizers and presenters. 2015. e-GRO’s PGR University Webinar. Conducted on January 23, 2015. <http://e-gro.org/webinars.php>

# My talks: Other Considerations for Using PGRs; <https://www.youtube.com/watch?v=ZzlKWqaNUPk>.

* + PGR Sprays and Liner Soaks
  + <https://www.youtube.com/watch?v=1pG-2SyD4Do>
  + Using Branching Agents
  + <https://www.youtube.com/watch?v=ncAopU-6dFc>
* Latimer, J. organizer. 2015. e-GRO’s Biocontrol Webinar. Conducted on January 30, 2015. <http://e-gro.org/webinars.php>
* Latimer J. organizer and presenter. 2014. "Greenhouse Energy Conservation Practices and Opportunities", Getting Started in the Greenhouse Business School, Southern Piedmont AREC, Blackstone, VA, Nov. 11-12, 2014. Audience industry and Extension agents.
* Owen, J. And J. Latimer. Water Management for Ornamental Crops: Irrigation, Water Quality and Treatment, BMPs, Pond Management, October 2013.

CT:

* Raudales RE, G Njue, R Dickson. Growing Healthy Roots in: New England Greenhouse Webinar Series. 17 Jan-14 Mar 2018
* Pundt L, RE Raudales. Bedding plant meeting. Vernon & Torrington, CT. 13 & 22 February 2017
* Raudales RE, L Pundt. Greenhouse Vegetable Production in Hydroponics and Soilless Systems. Storrs, CT. 9 December 2017
* Raudales RE, L Pundt. Hydroponic Production Short Course: How to Start a Commercial Hydroponic Production Greenhouse. Storrs, CT. 11 November 2017
* Wallace V, RE Raudales, L. Pundt. Pond Management Workshop. Windsor, CT. 15 August 2017
* Pundt L, RE Raudales. Bedding Plant Meeting. Vernon, CT. 16 February 2017
* Pundt L, RE Raudales. Bedding Plant Meeting. Torrington, CT. 18 February 2017
* Tewksbury E, R Raudales. Northeast Greenhouse Conference. Boxborough, MA. 8-10 November 2016
* Raudales RE, L Pundt. Practical Applications in Greenhouse Nutrient Management. New Haven, CT. 9 November 2016
* Raudales R, L Pundt, CGGA. Financial Decisions for Greenhouse Businesses. New Haven CT. 29 August 2016
* Campbell B, L Pundt, RE Raudales. Smart Marketing= More Customers. New Haven, CT. 3 November 2016
* Raudales R, L Pundt. Monitoring Water and Growing Media. New Haven, CT. 11 February 2016
* Pundt L, RE Raudales, Bedding Plant Meeting. Vernon, CT. February 2016
* Pundt L, RE Raudales. Bedding Plant Meeting. Torrington, CT. 23 February 2016
* Raudales RE, L Pundt. Hands-on Plant Nutrition Workshop: In-house testing of water and growing media. New Haven, CT. 11 February 2016
* Raudales RE, L Pundt. Growing Vegetables in the Greenhouse. New Haven, CT. 23 June 2015

Cornell:

* Seeley Summit. 2014. Water: Horticulture’s Next Game Changer? June 22-24, Lisle, IL. 55 participants. *Co-organizer.*

**Workshop Participant**

Virginia Tech:

* 2016 e-GRO’s PGR University Webinar Conference, Whipker, B. and J. Latimer, organizers and presenters, 4-hour webinar conference that included three other speakers. All presentations were recorded and posted on the e-GRO Webinars YouTube channel at <https://www.youtube.com/channel/UCH-u0VBGulYyVsqYyz3Drxg>
* **International e-GRO Webinar Conference 1/21/14 Participant, Branching Out with PGRs webinar.**

OSU:

* Ohio Winter Strawberry Day and Open House was organized on January 6, 2018 with 52 participants from Ohio and neighboring states.
* The 2018 Greenhouse Management Workshop was organized by Peter Ling with 88 participants. This year’s focus was hydroponics and the program included controlled environment production practices of different crops (tomato, lettuce, and strawberry), lighting technologies, as well as humidity management, pest/disease management, as well as food safety.

CT:

* Raudales RE. Microbial inoculants in soilless systems. Greenhouse Planning for 2019. Portsmouth, RI. 24 Aug 2018
* Raudales RE. Closed
* Raudales RE. Water quality and recycling nutrient solutions. Controlled-Environment Agriculture Short-Course. University of Arizona. Tucson, AZ. 12 March 2018.
* Raudales RE. What happened in 2017? Connecticut Bedding Plant Meeting. Torrington, CT. 13 February 2018
* Raudales RE. What happened in 2017? Connecticut Bedding Plant Meeting. Vernon, CT 22 February 2018
* Raudales RE. Root diseases: Identification and control. Northeast Greenhouse Webinar Series. 24 January 2018
* Raudales RE. Microbes, chemicals and particles in irrigation water. Greenhouse Crops and Floriculture workshop. UMASS Extension. Sturbridge, MA 11 January 2018
* Katz DE, RE Raudales. Daily maintenance of vine crops: Hands-on session. Hydroponic Production Short Course: How to Start a Commercial Hydroponic Production Greenhouse. Storrs, CT. 11 November 2017
* Aziz S, RE Raudales. Setting up a hydroponic system: Hands-on session. Hydroponic Production Short Course: How to Start a Commercial Hydroponic Production Greenhouse. Storrs, CT. 11 November 2017
* Cabrera JC, RE Raudales. Monitoring nutrient solutions: Hands-on session. Hydroponic Production Short Course: How to Start a Commercial Hydroponic Production Greenhouse. Storrs, CT. 11 November 2017
* McGehee C, RE Raudales. Seedling Production: Hands-on session. Hydroponic Production Short Course: How to Start a Commercial Hydroponic Production Greenhouse. Storrs, CT. 11 November 2017
* Raudales RE. Nutrition 101. Hydroponic Production Short Course: How to Start a Commercial Hydroponic Production Greenhouse. Storrs, CT. 11 November 2017
* Raudales RE. Basic hydroponic systems. Hydroponic Production Short Course: How to Start a Commercial Hydroponic Production Greenhouse. Storrs, CT. 11 November 2017.
* Raudales RE. Nutrient management in research trials. DuPont Pioneer. Johnston IA. 2 November 2017
* Raudales RE. Water sanitation and filtration: Technical attributes and costs. 4th Annual Iowa State University Greenhouse Short Course. Ames, IA. 3 November 2017
* Raudales RE. Water quality for irrigation of greenhouse crops. 4th Annual Iowa State University Greenhouse Short Course. Ames, IA. 3 November 2017
* Raudales RE. Water treatment: From filtration to sanitation. UConn Pond Management workshop. Windsor, CT. 15 August 2017
* Raudales RE. Controlled Release Fertilizers for Container Production. Connecticut Bedding Plant Meeting. Torrington, CT. 18 February 2017
* Raudales RE. Controlled Release Fertilizers for Container Production. Connecticut Bedding Plant Meeting. Vernon, CT 16 February 2017
* Raudales RE. Diagnóstico de enfermedades y desordenes nutricionales. Casertano Greenhouses. 14 February 2017
* Raudales RE. Nutrient Programs for Hydroponic Crops. e-Gro Nutrient Webinars. 27 January 2017
* Raudales RE. Principios de Nutrición Vegetal en Producción de Contenedores. Connecticut Nursery and Landscape Association Winter Symposium. Plantsville, CT. 26 January 2017
* Raudales RE. Plant Nutrition in Container Production. Connecticut Nursery and Landscape Association Winter Symposium. Plantsville, CT. 26 January 2017
* Raudales RE. Greenhouse Plant Nutrition: Fertilizing Container Crops with Water Soluble and Controlled Release Fertilizers. UMASS Greenhouse Management and Production. Sturbridge, MA. 11 January 2017
* Raudales RE.2017. Case Study on Irrigation: The cost of clogging and the benefit of unclogging. e-Gro Research Update 2017.01
* Raudales RE. Hydroponic Production of Lettuce and Herbs Connecticut Vegetable & Small Fruit Growers Conference. South Windsor, CT. 9 January 2017
* Raudales RE, JC Cabrera. Hands-on Monitoring Growing Media. Northeast Greenhouse Conference. Boxborough, MA. 10 November 2016
* Raudales RE. Diagnóstico: ¿Enfermedad, desorden abiótico o normal? Northeast Greenhouse Conference. Boxborough, MA. 9 November 2016
* Pundt, L, RE Raudales. Greenhouse IPM poster. Northeast Greenhouse Conference. Boxborough, MA. 9 November 2016
* Cabrera JC, RE Raudales. Hydroponic systems for New Farmers. Solid Ground Farmer Trainings. Stamford, CT. 26 October 2016
* Raudales RE, R Dickson, JC Cabrera. Water and Media Testing Practical Applications in Greenhouse Nutrient Management. New Haven, CT. 27 September 2016
* Raudales RE. Selecting fertilizers: Step by Step. Practical Applications in Greenhouse Nutrient Management. New Haven, CT. 27 September 2016
* Raudales RE. Production and Problem Management: Unscripted. Plug and Cutting Conference– Carlsbad CA. 21 September 2016
* Raudales RE. Enfermedades: Identificación y Control. Plug and Cutting Conference– Carlsbad CA. 21 September 2016
* Raudales RE. Control de Crecimiento en Plántulas. Plug and Cutting Conference– Carlsbad CA. 20 September 2016
* Raudales RE. Calidad de Agua para Plántulas. Plug and Cutting Conference– Carlsbad CA. 20 September 2016
* Raudales RE. *Nutrient management for hydroponics.* Greenhouse Production Short Course- Bordertown, NJ. 7 March 2016
* Raudales RE. *PGRs from start to finish.* Bedding Plant Meeting–Vernon, CT. 25 February 2016
* Raudales RE. *PGRs from start to finish*. Bedding Plant Meeting–Torrington, CT. 23 February 2016
* Raudales RE. *Water and growing media: In-house testing.* Hands-on Plant Nutrition Workshop: In-house testing of water and growing media– New Haven, CT. 11 February 2016
* McGehee C, RE Raudales. *Diagnosis of nutrient disorders* Hands-on Plant Nutrition Workshop: In-house testing of water and growing media –New Haven, CT. 11 February 2016
* Cabrera JC, RE Raudales. *Monitoring water and growing media*. Hands-on Plant Nutrition Workshop: In- house testing of water and growing media – New Haven, CT. 11 February 2016
* Raudales RE. *Monitoring water quality for irrigation* Long Island Greenhouse & Floriculture Conference – Long Island, NY. 19 January 2016
* Raudales RE. *Enfermedades de plantas en viveros ornamentales* Connecticut Nursery and Landscape Association Winter Meeting. Plantsville, CT. 15 January 2016
* Raudales RE. *Developing a nutrient program for greenhouse crops* Maine State Florist’s and Growers’ Association Annual Meeting –Augusta, ME. 13 January 2016
* Raudales RE. *Maintaining high quality plants at the garden center.* Maine State Florist’s and Growers’ Association Annual Meeting –Augusta, ME. 13 January 2016
* Raudales RE. *Calidad de agua para irrigación: Conceptos y casos*. Simposio de Floricultura– Quito, EC. 23-27 November 2015
* Raudales RE, JC Cabrera. *Building a hydroponic system.* UConn 4-H Adventures in STEM conference– Storrs, CT. 7 November 2016
* Raudales RE. *Maintaining high quality plants in retails settings.* Smart Marketing= More Customers. New Haven, CT. 3 November 2016
* Raudales RE. *Water conservation options and resources.* Twilight Workshop: Climate Change Adaptation Strategies for CT. Windsor, CT. 29 September 2015
* Raudales RE. *Water conservation options and resources.* Exploring Climate Change Adaptation Strategies for CT Agriculture –Woodbridge, CT. 23 September 2015
* Raudales RE. *Waterborne pathogens: Problems and management.* It’s all about Water and Increasing Your Bottom Line Workshop. Michigan State University. Grand Rapids, MI. 28 July 2015
* Raudales RE. *Being an Extension Specialist*. The Fitting Room- The place to find a future that fits.” 26 June 2015 (recorded), Storrs, CT.
* Raudales RE. *Maintaining root health in hydroponic systems*. Growing Vegetables in the Greenhouse Workshop. Connecticut Greenhouse Growers Association. New Haven, CT. 23 June 2015.
* Raudales RE. "Women in Plant Science: Rosa & Friends". Women in Science Series. Naugatuck Valley Community College. Waterbury, CT. 7 April 2015
* Raudales RE. *Fertilizing container grown crops with water-soluble fertilizers*. Plant Nutrition and Organic Certification. University of Massachusetts and the Massachusetts Flower Growers’ Association. Stow, MA. 26 February 2015
* Raudales RE. *Monitoring Water Quality in the Greenhouse* and *Feeding Bedding Plants in the Greenhouse*. Bedding Plant Meeting. State. University of Connecticut Greenhouse IPM Program. 3 February 2015
* Raudales RE. *Monitoring Water Quality in the Greenhouse* and *Feeding Bedding Plants in the Greenhouse*. Bedding Plant Meeting. State. University of Connecticut Greenhouse IPM Program. 5 February 2015
* Raudales RE. *Alimentando a las plantas: agua y nutrientes* Connecticut Nursery and Landscape Association Winter Symposium. New Haven, CT. 8 January 2015
* Raudales RE. *Water quality for container-grown crops*. Connecticut Nursery and Landscape Association Winter Symposium. New Haven, CT. 8 January 2015
* Raudales RE. *Monitoring Irrigation Water Quality*. Northeast Greenhouse Conference. Springfield, MA. 6 November 2014
* Raudales RE. *Managing Water Quality in the Green Industry.* Making Cents Webinar Series. Online. 13 January 2014

**Refereed Journal Articles (Pending)**

CT:

* McGehee CS, RE Raudales, WH Elmer. Efficacy of Biofungicides against Root Rot and Damping-off of Microgreens caused by *Pythium* spp. J. Crop Protection (Under review)
* Cabrera J, RE Raudales. Biofilm establishment in irrigation systems by pipe material and irrigation schedule. J. Agricultural Water Management (Under review)