

Annual Meeting
Cornell University
Long Island Horticultural Research and Extension Center
Riverhead, NY
June 22-24, 2016

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

REPORTING PERIOD: April 1, 2015 – June 22, 2016

REPORT DATE: August 2, 2016

PUBLICATIONS:

Dissertations, Theses (Published)

Isabel Armas Gutiérrez, M.S. 2015. Thesis title: Nutritional enhancement of lettuce using mutation breeding. Rutgers University Library. A.J. Both served as a member of the thesis advisory committee.

Books (Published)

Book Chapters (Published)

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.

Refereed Journal Articles (Published)

Altland, J.E., L. Morris, J. Boldt, P. Fisher, and R. Raudales. 2015. Sample container and storage for paclobutrazol monitoring in irrigation water. *HortTechnology* 25:769-773.

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.

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, 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>

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., Bliet, 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.
- DeVincentis, A. J., R. G. Brumfield, P. Gottlieb, J. Johnson, 2015. Cost Analysis of Recycling Water in Greenhouses in Southern New Jersey. *HortScience* 50(8):1–6. 2015.
- 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.
- Gent, M.P.N., W.H. Elmer, K. Macherla and R.J. McAvoy. 2016. Effects of Salinity and Irrigation Management on Poinsettia. *HortScience* 51:427–434
- Gent, M.P.N. 2016. Effect of irradiance and temperature on composition of spinach. *HortScience* 51:133-140.
- Gent, M.P.N., W.H. Elmer, K. Macherla, R.J. McAvoy. 2015. Effects of Salinity and Irrigation Management on Poinsettia. *Acta Horticulturae* 1104:41-47.
- 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.
- 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.
- 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.
- Zhen, S. and S. Burnett. 2015. Effects of substrate volumetric water content on English lavender morphology and photosynthesis. *HortScience* 50:909-915.

Symposium Proceedings Articles (Published)

- Harbick, K. and Albright, L.D. 2016. Comparison of energy consumption: greenhouses and plant factories. *Acta Hort.* 1134, 285-292 DOI: 10.17660/ActaHortic.2016.1134.38
- 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.
- 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* 1134:403-411.
- Wallace, C and A.J. Both 2016. Evaluating operating characteristics of light sources for horticultural applications. *Acta Horticulturae* 1134:435-443.

Popular Articles (Published)

- Burnett, S. and S. Zhen. 2016. Irrigating English lavender. *Greenhouse Grower* (In Press) <http://www.greenhousegrower.com/production/manage-soil-moisture-for-proper-irrigation-of-english-lavender/>.
- DeVincentis, A., R.G. Brumfield, and P. Gottlieb. 2015. A clear vision: Years before state mandates, Overdevest Nursery started capturing and cleaning irrigation runoff. *Nursery Management* 31(1):36-40. <http://www.nurserymag.com/nm0115-irrigation-runoff-overdevest-nursery.aspx>.

- DeVincentis, A., R.G. Brumfield, and P. Gottlieb. 2014. A step ahead: Centerton Nursery's water recycling system provides 30 million gallons each year. *Nursery Management* 30(9):24-26, 44-45. <http://www.nurserymag.com/digital/201409/index.html>.
- DeVincentis, A., R.G. Brumfield, and P. Gottlieb. 2014. H₂O in the ozone. *Greenhouse Management* 34(8):18-22. <http://www.greenhousemag.com/digital/201408/index.html>.
- DeVincentis, A., R.G. Brumfield, and P. Gottlieb. 2014. Keeping water clean with copper. *Greenhouse Management* 34(10):42-47. <http://www.greenhousemag.com/gm1014-kube-pak-water-disinfection.aspx>.
- DeVincentis, A., R.G. Brumfield, and P. Gottlieb. 2014. 10 tips for recycling irrigation water. *Greenhouse Management* 34(12):21-23. <http://www.greenhousemag.com/gm1014-kube-pak-water-disinfection.aspx>.
- Fisher, P., Raudales, R. E., Huang J. 2016. Select the Right Filter for Ebb-and Flood Irrigation. *Greenhouse Grower Magazine: New Technology Development in Water Treatment Series*. *Greenhouse Grower* July 2016: 46-50
- Fisher, P., Raudales, R.E. 2016. Minimize iron build-up on your water pipes. *Greenhouse Grower*. June 2016:66-70
- Fisher, P., Grant, G., Zayaz, V., Raudales, R. E., Altland, J., Boldt, J. 2016. New Technology Development in Water Treatment. *Greenhouse Grower Technology*. May/June 2016: 20-22
- Hutchins, K., W. Miller, N. Mattson, Cheni Filios. 2016. Combos that are pretty & tasty. *GrowerTalks*. 79(9):90-91.
- Mattson, N. 2015. Growing greenhouse tomatoes in containers. *Inside Grower*. October:20-22.
- Mattson, N. 2015. Selecting fertilizer rates for several spring bedding plants. *Greenhouse Grower Magazine*. 33 (August).
- Mattson, N. 2015. 10 tips to improve retail shelf life of bedding plants. *Greenhouse Grower Magazine*. 33 (June).
- Wallace, C. and A.J. Both. 2016. Putting lights to the test. *GrowerTalks*, June issue. pp. 60, 62, 64.
- Raudales, R. E., Pundt, L. 2016. Maintaining high quality plants in retail settings. *E-Gro Alerts* 5(31):1-6
- Raudales, R. E. 2016. Algae on the nutrient solution and surfaces. *E-Gro Edibles* 1(6):1-44
- Raudales, R. E., McGehee, C. 2016. Pythium root rot of hydroponic crops. *E-Gro Edibles* 1(4):1-5

Presentations (Papers)

- Allred, J. and N. Mattson. 2016. Effects of varying daily light integral and carbon dioxide concentration on the growth and nutritional characteristics of three microgreen species of the Brassicaceae family. *ISHS Eighth International Symposium on Light in Horticulture*. 22-26 May, 2016. East Lansing, Michigan.
- 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).
- Brumfield, R.G. 2015. Cost Accounting, Financial Statements, and Ratios. *Horticultural Engineering You Tube Channel*. <https://www.youtube.com/watch?v=JQfiNY2U9fk>.
- Brumfield, R.G. 2015. How to price your products. *Horticultural Engineering You Tube Channel*. <https://www.youtube.com/watch?v=L3HxeoRzrRg>.
- Brumfield, R.G. 2015. Production Plan. *Horticultural Engineering You Tube Channel*. <https://www.youtube.com/watch?v=RXz5iT0qSmI>.

- Brumfield, R.G. 2015. SWOT Analysis: Strengths, Weaknesses, Opportunities and Threats. Horticultural Engineering You Tube Channel. <https://www.youtube.com/watch?v=4sZNTwEPoCI>.
- Brumfield, R.G. 2015. Writing a business plan. Horticultural Engineering You Tube Channel. https://www.youtube.com/watch?v=kciVgK_NtTM.
- Brumfield, R.G., S. Komar, and J. Carleo. 2015. Why have a business plan? Horticultural Engineering You Tube Channel. <https://www.youtube.com/watch?v=IBtirLAuJhs>.
- Burnett, S. December, 4, 2015. Growing Lovely Lavender. New England Grows. Boston, MA.
- Butterfield, A., W. Wei, M. E. Conley and E. T. Pappozzi. 2015. Winter production of basil (*Ocimum spp.*) for essential oils. *HortScience* 50(9): S265. (Abstr.)
- Carleo, J., R.G. Brumfield, and S. Komar. 2015. Developing a Mission Statement. Horticultural Engineering You Tube Channel. <https://www.youtube.com/watch?v=0V7cQxIycEk>.
- DeVincentis, A., 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>.
- Foster, J., Burnett, S., and L. Stack. 2016 (abstract). The effects of light and soil moisture on propagation of *Linnaea borealis*. *HortScience* (In Press).
- Kubota, C. and R.G. Brumfield. 2015. Vegetable Greenhouse Overview. Horticultural Engineering You Tube Channel. <https://www.youtube.com/watch?v=Gn8YKTj9018>.
- Peterson, B.J., O. Sanchez, S. Burnett, and D.J. Hayes. 2016. (abstract) Sub-Mist is an effective alternative to overhead mist for the propagation of coleus by stem cuttings. *HortScience* (In Press).
- Harbick, K. and Albright, L.D. 2016. Comparison of energy consumption: greenhouses and plant factories. ISHS Eighth International Symposium on Light in Horticulture. 22-26 May, 2016. East Lansing, Michigan.
- Kranti Macherla and Richard J. McAvoy. 2015. The Effect of Salinity on the Growth and Nutrient Status of *Zinnia* Grown Under Regulated Deficit Irrigation. ASHS 2015 (August 3-7, 2015) (<https://ashs.confex.com/ashs/2015/webprogramarchives/Paper21915.html>)
- McAvoy, R. Growing greenhouse tomatoes for optimum yield and quality, New England Vegetable and Fruit Growers Conference Manchester NH Dec 17, 2015
- Raudales, R. Nutrient Management for Hydroponics. Greenhouse Production Short-course. Bordertown, NJ. March 7, 2016.
- Raudales, R. PGRs from start to finish. Bedding Plant Meeting. Vernon, CT. February 25, 2016.
- Raudales, R. PGRs from start to finish. Bedding Plant Meeting. Torrington, CT. February 23, 2016.
- Raudales, R. Nutrient program: Selecting fertilizer, monitoring growing media, and diagnosing nutrient disorders. Hands-on Plant Nutrition Workshop: In-house testing of water and growing media. New Haven, CT. February 11, 2016
- Raudales, R. Monitoring water quality for irrigation. Long Island Greenhouse & Floriculture Conference. Long Island, NY. Jan 19, 2016
- Raudales, R. Plant diseases in container-grown ornamentals. Connecticut Nursery and Landscape Association Winter Meeting. Plantsville, CT. Jan 15, 2016
- Raudales, R. Developing a nutrient program for greenhouse crops. Maine State Florist's and Growers' Association. Augusta, ME. January 13, 2016.

- Raudales, R. Maintaining high quality plants in postharvest. Maine State Florist's and Growers' Association. Augusta, ME. January 13, 2016.
- Raudales, R. Understanding water quality for irrigation. SiFLOR. Quito, EC. November 23-27, 2015.
- R. Raudales. Maintaining high quality plants in retail. Smart Marketing= More Customers. New Haven, CT. November 3, 2016
- Raudales, R. Water conservation options and resources. Twilight Workshop. Climate Change Adaptation Strategies for CT. Windsor, CT. September 29, 2015
- Raudales, R. Water conservation options and resources. Exploring Climate Change Adaptation Strategies for CT Agriculture. Woodbridge, CT. September 23, 2015
- Raudales, R. E. Water disinfectants interacting with nutrient solutions and substrates. XVIII International Plant Protection Conference. International. Berlin, Germany August 26, 2015
- Raudales, R. Waterborne pathogens: Problem and management. It's All About Water and Increasing Your Bottom Line Workshop. Michigan. July 28, 2015

Other Creative Works

- Both, A.J. 2016. Crop lighting (abstract). Proceedings of the 61th New Jersey Agricultural Convention and Trade Show. February 9. Atlantic City, NJ. pp. 32.
- Mattson, N. 2015. Infographic: How indoor agriculture is a boon to New York's foodies. Created jointly with Indoor Ag Con. www.cornellcea.com/images/indoor-ag-infographic42x12.pdf
- Mattson, N. and T. Merrill. 2015. Symptoms of common nutrient deficiencies in hydroponic lettuce. e-Gro Research Update #2015.09. 10 pp. http://e-gro.org/pdf/Mattson_Lettuce_2015_9.pdf
- Mattson, N. 2015. Tipburn of hydroponic lettuce. e-Gro Alerts 4.31. 7 pp. http://www.e-gro.org/pdf/2015_431.pdf
- Mattson, N. 2015. Ethylene in the greenhouse. e-Gro Alerts 4.15. 5 pp. http://www.e-gro.org/pdf/2015_415.pdf
- Brace, S.A. and N.S. Mattson. 2015. Webinar: Vermicompost as organic nutrient and substrate amendment. Oct. 30, 2015 Hosted by electronic grower resource online (e-Gro.org). 110 participants. Available online: <https://www.youtube.com/watch?v=5Jq-FebidUw>
- Mattson, N.S. 2015. Webinar: Silicon as a beneficial nutrient in greenhouse production. Hosted by electronic grower resource online (e-Gro.org). Oct. 30, 2015. 110 participants. Available online: <https://www.youtube.com/watch?v=dzez3yIvARI>
- Mattson, N.S. 2016. Webinar: Lighting Strategies and Cost. Hosted by electronic grower resource online (e-Gro.org). Feb. 22, 2016. 105 participants. Available online: <https://www.youtube.com/watch?v=253lk2DmewE>
- Mattson, N.S. 2016. Webinar: Managing nutrient solutions for hydroponic leafy greens and herbs. Hosted by electronic grower resource online (e-Gro.org). Jan. 19, 2016. 110 participants. Available online: <https://www.youtube.com/watch?v=nHatTEQydZQ>
- Paparozzi E. and Meyer, G. 2016. Revision/updating of CEA website – www.agronomy.unl.edu/cea-grant
- Raudales, R.E., B. MacKay, P.R. Fisher. Waterborne Solutions: Online searchable database on efficacy of water treatments to control plant pathogens <http://www.backpocketgrower.com/waterbornesolutions.asp>

Workshop Sponsor

- Both, A.J. and D. Specca. Greenhouse Production Short Course, NJ EcoComplex. Columbus, NJ. March 7-8, 2016. Robin Brumfield made a presentation on the basics for developing a greenhouse business plan, Rosa Raudales (UCONN) made a presentation on nutrient management for hydroponics.
- Johnstonbaugh, E., D. Ciolokoz, G. Musgarve, G. Roth, C. Callahan, S. Hawkins, A.J. Both, Z. Helsel, T. Manning. Farm Energy IQ workshops (In-service training). Columbus, NJ. April 8-10, 2015.
- McAvoy, R. The Innovation Connection Growing Green: Technology & Challenges Wednesday, March 30, 2016 Grower Direct Farms, Inc. Somers, CT 06071 Co-sponsored by UConn School of Business, School of Engineering, and the College of Agriculture Health and Natural Resources
- Campbell, B, L. Pundt, R. Raudales. Smart Marketing= More Customers. New Haven, CT. November 3, 2016
- Pundt, L., Raudales, R. Bedding Plant Meeting. Vernon and Torrington, CT. February 23-25, 2016.
- Raudales, R. L. Pundt. Hands-on Plant Nutrition Workshop: In-house testing of water and growing media. New Haven, CT. February 11, 2016

Workshop Participant

- Both, A.J. 2016. Urban agriculture. Presented at the 2016 Urban Agriculture as an Economic Tool Conference, hosted by the New Jersey Urban Mayors Association. Trenton, NJ. May 5.

Refereed Journal Articles (Pending)

- Johnson, M., T.S. Villani, J.E. Simon, A.J. Both. 2016. Effects of nitrogen, CO₂ and harvesting method on various algae species grown on vertical substrates. Submitted for publication in the Journal of Applied Phycology.
- Ishii, M., L. Okushima, H. Moriyama, S. Sase, N. Fukuchi, T. Maruo, and A.J. Both. 2015. Evaluating environmental conditions in open-roof greenhouses. Accepted for publication in Acta Horticulturae.
- Raudales, R.E., P. Fisher, C. Hall. 2016. Cost Analysis of Water Treatments in Irrigation. Submitted for publication in the journal of Irrigation Science (*accepted with minor revisions on July 11, 2016*).

Book Chapters (Pending)

- Both, A.J., J.M. Frantz, B. Bugbee. 2016. Carbon dioxide enrichment in greenhouses. Submitted for publication in 'Light Management in Controlled Environments' (R. Lopez and E. Runkle, eds.) to be published by Meister Media.
- Runkle, E. and A.J. Both. 2016. Delivering long-day lighting – Technology options and costs. Submitted for publication in 'Light Management in Controlled Environments' (R. Lopez and E. Runkle, eds.) to be published by Meister Media.
- Both, A.J. and J.E. Faust. 2016. Light transmission: The impact of glazing material and greenhouse design. Submitted for publication in 'Light Management in Controlled Environments' (R. Lopez and E. Runkle, eds.) to be published by Meister Media.
- Fisher, P., A.J. Both, and B. Bugbee. 2016. Supplemental lighting technology, costs and efficiency. Submitted for publication in 'Light Management in Controlled Environments' (R. Lopez and E. Runkle, eds.) to be published by Meister Media.

Raudales, R.E. Nutritional disorders of florists' crops. Ch.2. In: McGovern R.J. and W.H. Elmer. Handbook of Florists' Crop Diseases. Springer, Berlin, Germany.