2025 NCERA-101 Station Report – Cornell University

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1. New Facilities and Equipment.

- Cornell University has equipped a 3,000 square foot greenhouse section with Photobio T 300W LED supplemental lighting fixtures. The fixtures greatly increase the lighting capacity and uniformity vs. the prior legacy HPS fixtures. The greenhouse is used for experiments with hemp, tomatoes, and lettuce as well as the location for Mattson's Fall Semester Hydroponic Food Production course.

2. Unique Plant Responses.

- In a sole-source controlled environment chamber study with 5 petunia cultivars, two background daily light integrals (DLI) and additive far-red (FR) varying from 2 to 22%, both FR and DLI impacted plant quality and flowering. Depending on cultivar, increased FR hastened flowering by 7 to 20 days with results more prominent under a background low DLI.

3. Accomplishments:

3.A. Short-term Outcomes:

- We conducted a study using fish biosolids as a natural fertilizer for growing organic tomato seedlings. The fish biosolids was sourced from a commercial aquaculture producer in NYS that was originally had large volumes of landfill waste weekly. We conducted an experiment in a greenhouse, comparing fish biosolids to other organic fertilizers and a common inorganic controlled release fertilizer, Osmocote. We tested different concentrations of fish biosolids to see how well they supported plant growth (Schembri et al., 2025). The results were promising! The highest concentration of fish biosolids (800 mg N/L) performed just as well, if not better, than the inorganic fertilizer in terms of plant health and growth. This suggests that fish biosolids could be a viable and eco-friendly alternative for organic farming. By using fish waste, we can reduce reliance on synthetic fertilizers and promote more sustainable agricultural practices.

3.B. Outputs:

- Cornell University work on this project resulted in 6 published academic journal articles and 5 extension publications. Our outreach efforts included 33 in-state workshops/presentations/tours reaching 1,048 participants and resulting in 1,275 contact hours during the reporting period. Within these efforts, the aquaponic research lab and hydroponic greenhouses were used as the basis of 20 tours to middle school, high school, FFA and college students as well as adult learners reaching 663 participants. Additionally, 2 high school student, 3 undergraduate

students and 5 graduate students were trained in aquaponics/hydroponics independent research and outreach. Our out-of-state efforts included 6 presentations, reaching 435 participants with 289 contact hours.
- A signature outreach activity that was co-organized was the 2025 Short-Course on recirculating aquaculture, hydroponics and aquaponics. The format was online for 14 hours over 5 days (38 attendees).
- The Greenhouse Lighting and Systems Engineering (GLASE) consortium which Mattson co-leads partnered in 2024 to launch the Vivid Canopy initiative which included 4 panels/receptions at national industry conferences. The initiative seeks to expand the agricultural workforce by engaging women and traditionally underserved groups in discussion and networking.

3.C. Activities:

- We collaborated with NCSU on two studies using data-driven nutrient interpretation ranges for greenhouse lettuce. The first used a large dataset to create more accurate nutrient guidelines. This helps growers better understand and address nutrient deficiencies, ensuring healthier plants. Another study explored the use of machine learning algorithms to classify lettuce foliar tissue samples into deficiency, sufficiency, and toxicity levels. By training models on known data, the researchers achieved high accuracy in identifying nutrient levels, reducing human error and improving nutrient management strategies.
- A study led by MPS student, Antoszewski, investigated the use of hand-held Raman spectroscopy to detect nitrogen deficiency. This non-invasive method identified nutrient deficiencies before visible symptoms appeared, allowing for timely and non-destructive detection.
- In a collaboration with UMN and UC Davis, M.S. student Abby Pace is investigating the use of Plasma Activated Water (PAW) to enhance seed germination, seedling vigor, and nitrogen nutrition in greenhouse tomatoes.
- PhD student Ava Forystek is leading research to model the impact of climate conditions on teen-leaf lettuce cultivars used in high density, automated greenhouse production system.

3.D. Milestones:

- Cornell University and collaborators at Rutgers University and Rensselaer Polytechnic Institute held the GLASE (Greenhouse Lighting and Systems Engineering) Summit to provide technical information to CEA industry members in Montreal Quebec, November 6, 2024. There were 84 participants. Topics included presentations and panel discussions on dynamic greenhouse lighting, artificial intelligence, and greenhouse climate control.

4. **Impact Statements**.

- Research associate, Tim Shelford, led a project focused on implementing energy-efficient lighting control systems to enhance the profitability of New York State commercial greenhouses. We collaborated with four greenhouses in installing advanced lighting control systems using the Cornell-developed LASSI algorithm. This system optimizes supplemental lighting based on crop needs,

weather conditions, and electricity costs. These systems provided precise control over lighting, helping growers achieve their target daily light integrals (DLI) and improve crop performance. The results were promising, with growers reporting better understanding and management of light levels. Some greenhouses even planned to expand their lighting capacity and integrate shading controls. The project demonstrated significant potential for energy savings and improved crop yields, encouraging broader adoption of advanced lighting technologies.

- Proactive methods of detecting plant nutrient deficiencies were developed using laboratory approaches for hydroponic lettuce (2 publications) and using Raman spectroscopic imaging technique (a non-detective technique that could detect nitrogen deficiencies several days before humans) (1 publication). While, more work is needed on the economics of adoption, these studies highlight the potential of innovative technologies to proactively detect crop nutrient disorders in greenhouse crops leading to more sustainable and productive agricultural practices.

5. **Published Written Works**

Refereed Journal Articles

Schembri, C., Kaczmar, N., Osborn, J., Timmons, M.B. and Mattson, N.S., 2025. Evaluation of Fish Biosolids as a Fertilizer for Organic Tomato Transplant Production. Horticulturae, 11(1), p.57.

Antoszewski, G., Guenther, J.F., Roberts III, J.K., Adler, M., Dalle Molle, M., Kaczmar, N.S., Miller, W.B., Mattson, N.S. and Grab, H., 2024. Non-Invasive Detection of Nitrogen Deficiency in Cannabis sativa Using Hand-Held Raman Spectroscopy. Agronomy, 14(10), p.2390.

Xia, J. and Mattson, N., 2024. Daily Light Integral and Far-Red Radiation Influence Morphology and Quality of Liners and Subsequent Flowering and Development of Petunia in Controlled Greenhouses. Horticulturae, 10(10), p.1106.

Chiu, L.V., Nicholson, C.F., Gómez, M.I. and Mattson, N.S., 2024. A meta-analysis of yields and environmental performance of controlled-environment production systems for tomatoes, lettuce and strawberries. Journal of Cleaner Production, 469, p.143142.

Weingarten, M., Mattson, N. and Grab, H., 2024. Evaluating propagation techniques for Cannabis sativa L. cultivation: A comparative analysis of soilless methods and aeroponic parameters. Plants, 13(9), p.1256.

Veazie, P., Chen, H., Hicks, K., Holley, J., Eylands, N., Mattson, N., Boldt, J., Brewer, D., Lopez, R. and Whipker, B.E., 2024. A Data-driven approach for generating leaf tissue nutrient interpretation ranges for greenhouse lettuce. HortScience, 59(3), pp.267-277.

Theses and Dissertations

Xia, J. 2024. Evaluating the photomorphogenetic and molecular response of petunia to far-red radiation and daily light integral, and modeling horticultural strategies for enhancing plant factory profitability. PhD Dissertation. Cornell University. 337 pp.

Industry Articles

Mattson, N. 2025. Square foot weeks: quantify space-use efficiency for greens and herbs. E-Gro Edible Alert 10(3). pp. 6. https://e-gro.org/pdf/e1003.pdf

Allred, J. and N. Mattson. 2024. Dialing in microgreens production. Produce Grower Magazine. (December).

Karall, J. and N. Mattson. 2024. Do microgreens respond to fertilizer concentration and substrate depth? E-Gro Edible Alert 9(6). pp. 6. https://e-gro.org/pdf/e906.pdf

Karall, J. and N. Mattson. 2024. Do microgreens respond to daily light integral and carbon dioxide enrichment? E-Gro Edible Alert 9(4). pp. 6. https://e-gro.org/pdf/e904.pdf

Mattson, N. 2024. CEA is growing: Trends from the U.S. 2022 census of agriculture. E-Gro Edible Alert 9(3). pp. 5. https://e-gro.org/pdf/e903.pdf