RUTGERS
New Jersey Agricultural Experiment Station

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1. New Facilities and Equipment

   We conducted preliminary measurements within the canopy of a lean-and-lower tomato crop, comparing a LI-COR spherical quantum sensor (LI-193) with a combination of an upward and downward facing regular quantum sensors (LI-190R). Results showed that the spherical quantum sensor captures more radiation. The calculated DLIs were on average 1.55 higher when measured with the spherical quantum sensor compared to the DLI measured with an upward facing regular quantum sensor (n = 54, St. Dev. = 0.13). We plan to conduct additional experiments with the setup we designed.

2. Unique Plant Responses

   None.

3. Accomplishment Summary

   We continue to evaluate a variety of lamp fixtures for light output, light distribution and power consumption using our 2-meter integrating sphere and a small darkroom. We are continuing to work on a comprehensive evaluation of ventilation strategies for high tunnel crop production (David Lewus). We are continuing our work using life cycle assessment tools to assess the environmental impacts of switching from high-pressure sodium lighting to LED lighting (Farzana Afrose Lubna).

4. Impact Statement

   Nationwide, Extension and NRCS personnel and commercial greenhouse growers have been exposed to research and outreach efforts through various presentations and publications. It is estimated that this information has led to proper designs of controlled environment plant production facilities and to updated operational strategies that saved an average sized (1-acre) business a total of $25,000 in operating and maintenance costs annually. Crop lighting presentations and written materials on controlled environment crop production techniques have been prepared and delivered to local and regional audiences. Greenhouse growers who implemented the information resulting from our research and outreach materials have been able to realize energy savings between 5 and 30%.

5. Published Written Works

   Book chapter:

   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 (open access). 28 pp.

   Refereed journal article:

   Shelford, T.J. and A.J. Both. 2021. On the technical performance characteristics of horticultural lamps. AgriEngineering 3:716–727. https://doi.org/10.3390/agriengineering3040046

   Trade articles:

   Both, A.J. 2021. The science and art of crop irrigation. In Ball Redbook (19th Edition), C. Beytes (ed.), Volume 1: Greenhouse Structures, Equipment, and Technology. Ball Publishing. pp. 64-68.

   Both, A.J. 2021. Glazing: It's what makes the greenhouse. In Ball Redbook (19th Edition), C. Beytes (ed.), Volume 1: Greenhouse Structures, Equipment, and Technology. Ball Publishing. pp. 26-30.6.

   Shelford, T.S. and A.J. Both. 2020. Plant lighting fact sheet. Published by Greenhouse Lighting and Systems Engineering (GLASE; https://glase.org/). 4 pp.

6. Scientific and Outreach Oral Presentations

Both, A.J. 2021. Plant lighting for CEA crop production. Presentation for the Plant Production Lunch and Learn Webinar Series for Green Industries, hosted by the University of New Hampshire. March 2.

Sciarappa, W., A.J. Both, and A. Ayeni. 2021. Hydroponics/Controlled Environment Systems. Four-hour virtual workshop that was part of the 66th New Jersey Agricultural Convention and Trade Show. February 22-25.

7. Other Relevant Accomplishments and Activities

Agrivoltaics

NJ has ambitious renewable energy goals and has a history of promoting photovoltaics. A logical option would be to allow for more solar farming. However, solar farming typically takes the land out of agricultural production. In a small and densely populated state like NJ, that is a less attractive option. Raising the photovoltaic panels on taller posts and reducing their density would allow for a combination of agricultural production and electricity generation with photovoltaic panels. The NJ Agricultural Experiment Station and the state legislature have provided over $2M of funding to a team of researchers to develop a number of research and demonstration facilities at various university farms across the state. The team is planning to construct these facilities over the next year and will conduct experiments involving field and forage crop trials.

Pending publications

Both, A.J. 202x. Greenhouse energy efficiency and management, Chapter 11. Submitted for publication in Regional Perspectives on Farm Energy. 10 pp.

Both, A.J. 202x. On-farm energy production – Solar, wind, geothermal, Chapter 12. Submitted for publication in Regional Perspectives on Farm Energy. 13 pp.

Brumfield, R.G., D. Greenwood, M. Flahive DiNardo, A.J. Both, J.R. Heckman, R. Govindasamy, N. Polanin, A.A. Rouff, A. Rowe, R. VanVranken, and S. Arumugam. 202x. A non-parametric approach to evaluate a risk management-training program designed to empower women farmers in New Jersey. Submitted for publication to Vimarsh Journal.

Llewellyn, D., T.J. Shelford, Y. Zheng, and A.J. Both. 202x. Measuring and reporting lighting characteristics important for controlled environment plant production. Accepted for publication in Acta Horticulturae. Presented at LightSym, Malmö, Sweden, June 2021.

Shelford, T.J., A.J. Both, and N. Mattson. 202x. A greenhouse daily light integral control algorithm that takes advantage of day ahead market electricity pricing. Submitted for publication to Acta Horticulturae. Presented at LightSym, Malmö, Sweden, June 2021.