University of California, Davis 2023 Station Report NCERA-101: Committee on Controlled Environment Technology & Use

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Shamim Ahamed, Assistant Professor, Department of Biological and Agricultural Engineering, UC Davis. Email: mahamed@ucdavis.edu
Gail Taylor, Professor, and Chair, Plant Sciences, University of California, Davis, email: gtaylor@ucdavis.edu
Heiner Lieth, Professor, Plant Sciences, University of California, Davis, email: jhlieth@ucdavis.edu

New Equipment and Facilities (sensors, instruments, and control systems purchased/installed)

1. Controlled Environment Engineering (CEE) Lab: We have completed the design and currently working on installing a customized indoor vertical farming system in a shipping container for cutting-edge research related to indoor vertical farming systems. CEE Lab also installed 18 LED bars in another indoor vertical farming system that can control the lighting intensity from 300-800 micro-mol/m^2.s, which includes the capacity to provide different lighting recipes, including far-red light. Besides, CEE Lab has also installed the complete set-up precision nutrient monitoring and management system by integrating various ion-selective sensors.

Accomplishment Summaries

1. CEE Lab investigated the potential of a ground source heat pump for nursery greenhouse production in California. The study indicates the ground source heat pump can provide the most loads for heating and cooling year-round except for the peak loads.
2. CEE Lab investigates UV exposure and thermal comfort issues with greenhouse workers in evaporative cooling pad-operated greenhouses (glass and polycarbonate greenhouses). The research shows key information about UV exposure and the thermal comfort of greenhouse workers.

Impact Statement

1. CEE Lab investigates the potential health risk and thermal comfort of greenhouse workers' greenhouses. The study indicates greenhouse workers may be exposed to UV radiation that exceeds the safe level, and thermal comfort could reach beyond the permitted limit even in climate control greenhouse. The study suggests the greenhouse industry to safety measures and provides guidelines for their well-being. CEE Lab also investigated the potential of geothermal and solar energy for CEA applications and found significant potential for net-zero food production.

   Four undergraduate students work with Dr. Ahamed as part of a senior-year design project for designing autonomous nutrient monitoring and management systems for hydroponic production.

Also, three undergraduate students were actively involved in the CEE lab for research related to CEA.

Published written works

Refereed Journal Articles and Book Chapters

Journal Articles:

1. Ahsan, T. M. A.; Ahamed, M. S, (2023). Potential of Solar-assisted Adsorption Cooling System for Mediterranean Greenhouses. Acta Horticulture.
2. Lagergren, J., Pavicic, M., Chhetri, H. B., York, L. M., Hyatt, P. D., Kainer, D., ... & Streich, J. (2023). Few-Shot Learning Enables Population-Scale Analysis of Leaf Traits in Populus trichocarpa. arXiv preprint arXiv:2301.10351.

Book Chapters and Editorial:

1. Asfahan, H. M., Sultan, M., Ahmad, F., Majeed, F., Ahamed, M. S., Aziz, M., ... & Farooq, M. (2022). Agrovoltaic and Smart Irrigation: Pakistan Perspective. In *Irrigation and Drainage-Recent Advances*. IntechOpen.
2. Sultan, M., Mahmood, M. H., Ahamed, M. S., Shamshiri, R. R., & Shahzad, M. W. (2022). Energy Systems and Applications in Agriculture. Energies, 15(23), 9132.

Symposium Proceedings, Oral and Poster Presentation

1. T M Abir Ahsan, Shamim Ahamed (2023). Optimized Energy Requirement of Nursery Greenhouses Under Mediterranean Climate, NCERA 101 2023 Annual Meeting, UC Davis, April 19-21.