New Equipment and Facilities

- A Portable spectrometer (LI-180) was purchased to measure photon flux density from 380 to 780 nm in 1-nm increments, as well as several other parameters.
- An MC-100 chlorophyll concentration meter was purchased, to quantify chlorophyll, CCI, and SPAD.
- One existing walk-in growth chamber was retrofitted with RAY66 Fluence LED fixtures, CO₂ injection, and four Apogee ST-100 thermistors.
- To expand our greenhouse hydroponic research capacity, 7 modular deep flow hydroponics systems were built.

Accomplishment Summaries

- Led by Ph.D. candidate Jose Llera in Engineering, we used a multi-objective evolutionary algorithm (NSGA-II) to evolve the setpoints for microclimate control in a greenhouse simulation with two objectives: minimizing variable costs and maximizing the value of the tomato crop yield. Results show that the evolved setpoints can provide the grower a variety of improved solutions, resulting in greater profitability compared to prior simulated results.
- Post-doctoral researcher Yujin Park and Erik Runkle determined whether early flowering of petunia under a mint-white LED could be attributed to greater green radiation or far-red radiation. The results suggest that early flowering was caused by a relatively small amount of far-red radiation that is emitted by the mint-white LED.
- Ph.D. candidate Qingwu Meng evaluated the efficacy of green radiation (LEDs with peak emission of 521 nm) at regulating flowering of ornamentals during truncated short days in the greenhouse. Increasing the green photon flux density from 0 to 25 µmol·m⁻²·s⁻¹ as a 7-h day extension accelerated flowering of all long-day plants and delayed flowering of all short-day plants.
- Ph.D. student Kellie Walters and Roberto Lopez evaluated the influence of light intensity, average daily temperature, and carbon dioxide concentration on consumer preference of sweet basil. Consumers preferred basil grown under 200 µmol·m⁻²·s⁻¹ compared to 100, 400, or 600 µmol·m⁻²·s⁻¹ because these samples had a less bitter taste, milder aftertaste, deeper green color, crisper texture, more moderate flavor, and more pleasant aroma. Consumers indicated no differences in flavor between the CO₂ treatments. However, they preferred the appearance, texture, and color of basil grown under higher temperatures (26 or 29 to 35 °C) compared to 23 °C.
- Ph.D. student Kellie Walters and Roberto Lopez quantified the influence of temperature and daily light integral (DLI) on growth and development of greenhouse-grown dill, parsley, purple basil, sage, spearmint, and watercress to develop temperature response curves.


- M.S. student Charlie Garcia and advisor Roberto Lopez quantified the effects of supplemental light quality on cucumber, tomato, and pepper transplants for high-wire production, in an effort to optimize transplant production. Most responses were generally species-specific. However, the most compact transplants were those grown under a ratio of 75:25 red:blue radiation.

Impact Statements
- In the production of vegetable crops inside greenhouses, the environment influences crop growth (including the harvestable yield) as well as the amount of energy consumed to maintain desired air temperatures. Information generated in our greenhouse simulations compare the trade-offs that exist between fruit yield of tomato and input costs for heating.

- We have a greater understanding of the roles of far-red radiation (700 to 800 nm) on growth of leafy green vegetables as well as growth and subsequent flowering of ornamentals. There are compelling reasons to include far-red radiation in a sole-source lighting spectrum.

- A common misconception is that green radiation (500 to 600 nm) is less (or not) useful to plants for photosynthesis, and that green light is not perceived as a long-day stimulus. We have demonstrated that many plants perceive a low intensity of green radiation when delivered for a prolonged (e.g., hours) period of time during an otherwise long night.

- Light intensity and temperature can influence sweet basil secondary metabolite production and flavor. We have demonstrated that altering the growing environment influences taste and have identified consumer preferences.

- By understanding and modeling the effect of temperature and DLI on culinary herbs, growers can conduct cost-benefit analysis to increase profitability and group plants with similar light and temperature responses in a common environment.

- Lavender, oregano, spearmint, and watercress can be classified as long-day plants. This information is of great benefit for many greenhouse growers who struggle to maintain herb crops such as vegetative. Growers can use the information to modify practices and prolong their harvest period.

- We have demonstration that the addition of green radiation to supplemental lighting containing red and blue radiation can promote leaf expansion and biomass accumulation of vegetable transplants.

Published Written Works (*denotes peer reviewed)