Michigan State University 2017 Station Report
NCERA-101: Committee on Controlled Environment Technology & Use

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New Equipment and Facilities

- The Controlled-Environment Lighting Laboratory (CELL) was completed in February, 2017 and the first plants were grown in the facility in March. CELL consists of two independently controlled and refrigerated growth rooms, each with 12 deep-flow hydroponic shelves. Sole-source lighting in CELL utilizes customized LED arrays developed in collaboration with OSRAM Innovation and Osram Opto Semiconductors. The arrays are composed of seven LED types: UV-A, blue, green, red, far red, warm white, and mint white, and each is independently controlled and programmable for each shelf.
- Two existing walk-in growth chambers were retrofitted with white LED arrays; CO_2 injection and scrubbing; four Licor LI90R quantum sensors; and four Apogee ST-100 thermistors per chamber. To facilitate greenhouse hydroponics research, 24 modular deep flow hydroponics systems were installed in six greenhouse compartments.

Accomplishment Summaries

- M.S. student Mengzi Zhang and adviser Erik Runkle assessed the effectiveness of hybrid supplemental lighting on greenhouse cut lettuce quality (growth, yield, and leaf coloration) when provided at different growth phases. Supplemental lighting produced a more compact lettuce and increased yield. A combination of red and blue light was more effective at reducing lightness and yellowness and increased red pigmentation for red-leaf lettuce.
- Ph.D. candidate Qingwu (William) Meng and advisor Erik Runkle investigated the role of green light in growth and morphology of lettuce and kale grown hydroponically indoors. Similar to far-red light, green light antagonized blue light effects, promoting leaf expansion and biomass accumulation.
- Ph.D. student Yujin Park and adviser Erik Runkle investigated the cause of stem elongation and subsequent flowering promotion in some ornamental seedlings grown under mint white LEDs for sole-source lighting compared to under a mixture of blue and red light.
- Ph.D. student Kellie Walters and advisor Roberto Lopez quantified the influence of temperature and daily light integral on growth and development of greenhouse-grown sweet basil and the influence of sole-source light intensity and CO_2 concentration during seedling development. In general, increasing temperature resulted in greater biomass at higher light intensities. By increasing sole-source light intensity from 100 to 600 $\mu mol \cdot m^{-2} \cdot s^{-1}$, fresh mass of seedling transplants increased resulting in a subsequent harvestable basil yield increase of 80%.
- Ph.D. student Joshua Craver and advisor Roberto Lopez evaluated the morphological and physiological responses of petunia seedlings to varying light intensities, light qualities, and CO_2 concentrations for indoor production. While seedlings showed significantly

higher photosynthesis per unit leaf area under increased intensities of blue radiation, the increase in leaf area observed under increased intensities of red radiation ultimately led to greater light interception and dry mass accumulation. Additionally, acclimation to elevated CO_2 concentrations (reduced carboxylation efficiency) may limit potential gains from this input.

- MS student Alison Hurt and Ph.D. student Kellie Walters and advisor Roberto Lopez evaluated the photoperiodic responses of several foliage annuals. Some species were day neutral while others were obligate short-day plants requiring a 14-h photoperiod or longer to inhibit flower.
- M.S. student Charlie Garcia and advisor Roberto Lopez evaluated the photoperiodic responses of basil species and cultivars. *Ocimum basilicum* var. *citriodora* and *O. tenuiflorum* can be classified as facultative short-day plants and *O. basilicum* and *O. ×citriodorum* as day-neutral plants.
- M.S. student QiuXia Chen and adviser Ryan Warner utilized a genetic mapping population in *Petunia* grown at four field locations around the country (CA, PA, NC and FL) to identify chromosomal regions (QTL) that control field flowering performance traits. These data were then used to identify greenhouse production traits that may be predictive of field performance.

Impact Statements

- Supplemental lighting with light-emitting diodes during different growth phases can help growers customize the shape and color of the lettuce product, increase yield, and potentially reduce electrical costs.
- Substituting green light for blue light in vertical farming increased lettuce leaf expansion by up to 37% and shoot dry weight by up to 54%. This would allow indoor growers to achieve a marketable mass in less time and increase turnover and revenue. The inclusion of green light in sole-source lighting renders the natural appearance of crops, creating a visually pleasant environment that facilitates crop assessment.
- Compared to blue and red LED arrays commonly used for indoor lighting of plants, an increase in green and far-red radiation from white LEDs can promote stem elongation and flowering in some ornamental crops. In addition, the visual quality of a broader spectrum is substantially improved and creates a more pleasant working environment.
- Optimizing the inputs of light and CO_2 in an indoor production environment can potentially increase ornamental seedling quality and decrease production time. Although petunia seedlings grown under elevated CO_2 concentrations showed increased biomass accumulation, acclimation responses to this enriched environment and inadequate light intensities ultimately limited the potential benefit of this input. While this research establishes a foundation for understanding seedling responses to light and CO_2 in an indoor production environment, future studies are required to optimize production regarding the timing and extent of these inputs.
- Due to increased plant densities during herb seedling production, fewer inputs per plant are required, creating the potential to increase production efficiency. Faster growth rates with increased light intensity can reduce production time, potentially increasing the harvestable yield and thus, grower profitability.
- Flowering of foliage annuals is not desired due to growth inhibition and aesthetics; therefore, flower inhibition by photoperiodic control is possible.

- Under long-day photoperiods, growers may be able to prevent or delay flowering of cultivar 'Holy Basil' (*Ocimum tenuiflorum*) by 6, 7, or 10 days under a 15-h, 16-h, or NI treatment, respectively, in comparison to a 9-h short day.
- Molecular markers useful for breeding new petunia cultivars with improved greenhouse and field performance were developed.

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