# Fluence 2023 Station Report

NCERA-101: Committee on Controlled Environment Technology and Use
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1. **New Facilities and Equipment:**
    - Upgraded internal lab at Austin headquarters with hydroponic growing systems that include new 96 RAZR-M LED lights, hydroponic containers, water pumps, and various irrigation equipment and supplies.
    - Fluence cannabis research partner, Texas Original Compassionate Cultivation is currently constructing a new production facility in Bastrop, Texas, 30 minutes from Fluence HQ in Austin. This facility will also include a dedicated research wing for Fluence with three large production rooms and seven smaller chambers allowing for expanded high-THC cannabis research under light intensities up to 3000 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and precise environmental control. Completion date is expected Q4-2023 and research will move there from the current Manchaca, TX facility shortly thereafter.
        - In addition to advancing Fluence's research roadmap, we are open to potential collaborative research or executing contract research in this space.
2. **Unique Plant Responses:**
    - Photobleaching, or the absence of chlorophyll in cannabis inflorescence material, has a strong positive correlation to the total amount of red photons delivered to the canopy as compared to the percentage of red photons within a given spectrum.
3. **Accomplishments:**

    **3.B. Outputs**
    - As the percentage of red photons of a given spectrum increases, the efficacy of THC production (milligrams of THC produced per kilowatt-hour consumed) increases, however the drawbacks of a high-red environment do not usually justify the increase such as photobleaching and worker comfort. (Poel)
    - Increasing the percentage of red light in a spectrum delivered via intra-canopy lighting (ICL) did not significantly affect yield, morphology, or potency at the intensity tested. This may be repeated with a higher proportion of total light delivered via ICL in the future.
    - Broad White Light Study – Aesthetic work environment (Barickman, Schultz, Hawley)
        - Different broad white LED light quality has varying impact on lettuce morphology, yield, and red leaf coloration; white spectra with relatively similar appearance and R:G:B ratios can produce significantly different plant responses.
        - Physiospec (higher red) had increased fresh mass and dry mass compared to the other white lights.
        - Observed stronger red pigmentation in plants grown under Physiospec vs other "white" spectra tested.

- Photoperiod Impacts butterhead lettuce morphology and yield. (Barickman, Schultz, Hawley)
    - Butterhead lettuce plants had increased leaf area, plant height, and fresh weight at a 24 h photoperiod compared to an 18 and 21 h photoperiod at 17.82 DLI.
- Beta testing novel vertical farm light qualities with increased efficacy with and without far-red light impacts sweet crisp lettuce morphology, yield, biomass accumulation. Adaption of Energy Efficient Technology; Reduced Cost to the Consumer. (Barickman and Schultz)
    - Lettuce plants under the far-red beta light had increased fresh mass (g/plant; $kg \cdot m^2$), dry mass, plant height, leaf area, and specific leaf area compared to beta lights without far-red.
    - There was a 13 and 24 % increase in Danstar and Finstar fresh mass, respectively, when comparing the far-red LED light quality to the novel standard light quality.
    - Continue the project with new novel energy efficient LED spectrum by end of Q3 2023.

**3.D. Milestones**

- An indoor (sole-source lighting) cannabis study is underway looking at the optimal distribution of light to the canopy for maximizing influorescence yield and/or quality and uniformity throughout the canopy by delivering varied amounts of light either via top-lighting alone or increasing proportions of intra-canopy lighting. Results expected by Q4-2023. (Poel and Hawley)
- A greenhouse (supplemental lighting) intra-canopy light experiment in medical cannabis comparing two different light distributions (top light only vs top light + intra-canopy), normalized on total photon flux. Results expected during Q2-2023. (Olschowski and Hawley)
- Investigation of light spectrum and genetic interactions in ever-bearing strawberries in a Dutch greenhouse environment. (Olschowski)
- Investigation of spectrum and intensity on lettuce (teen green) development in a northern Dutch greenhouse, focusing on the effects of high-red spectral fraction on crop quality and morphology (Olschowski)
- DLI study with novel lettuce genetics for vertical farms. (Barickman and Schultz)
    - Analyzing results and will continue the project with more combinations of DLI and environmental parameters by the end of Q2 2023.
- Butterhead growth curve study (Barickman and Schultz)
    - 275 PPFD; 18 h photoperiod; 17.82 DLI
    - At 39 d found lettuce optimal mass at around 150-200 g/plant
    - Increased tip burn was observed after 47 d.

**4. Impact Statements**

- Experiments on cannabis focusing on increasing the amount of red in a given spectrum have led to potential product opportunities production guidelines that would reduce energy input (by increasing efficacy) while maintaining plant quality otherwise eroded by photobleaching. Additionally, recommendations for optimal light spectrum can be made depending on the end-use of floral material. For instance, cannabis grown specifically for

extraction can be grown under high red (>80%) and achieve a higher yield efficacy ($mg_{THC}$/kW·h).

- Experiments on commercial horticulture crops, such as leafy greens, strawberry, and vine crops have focused on research that leads to generating new novel LED spectrums with increased energy efficiency (>3.6 umol/J). Furthermore, Fluence commercial horticulture crop research is providing recommendations for the best light spectrum coupled with environmental conditions for optimal growth conditions that ultimately reduce crop cycle times, increase yields, market quality, nutrition, and post-harvest shelf life.