Using LEDs to Improve Longevity of Living Green Walls

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Abstract:

White light-emitting diode (LED) fixtures were used to compare growth and quality of nine ornamental species grown indoors for 4-mo in a green wall planter. Our findings indicate that 50 μmol·m−2·s−1 is a good light intensity to maintain plants indoors. Considering that only minor differences were measured in plants grown under three broadband white LED fixtures (warm-, neutral-, and cool-white), the recommendation is to purchase fixtures that have a high efficacy and good economic value.

Objectives:

In two separate experiments, this project evaluated the use of broadband white LEDs to grow ornamental plants in indoor living green walls. One experiment compared plant growth and quality under three photosynthetic photon flux densities (PPFD; light quantity). The other experiment compared the same parameters under three colors (quality) of white LED fixtures.

Methods

Two Florida growers (Oglesby and Agri-Starts) were asked to provide plant material that could be used for indoor living green walls. Figure 1 shows the different plant species that were shipped for the experiments, which included 1) Homalomena 'Emerald Gem', 2) Anthurium 'Baby Red', 3) Syngonium 'Coral', 4) Medinilla sp. 'Gregori Hambali', 5) Syngonium 'Mango Allusion', 6) Syngonium 'Glo Go', 7) Stromanthe 'Burle Marx', 8) Heucherella 'Gold Zebra', and 9) Schefflera 'Amate Soleil'. Both experiments started in mid-April 2021, immediately after receiving the plants.

Figure 1. Plants evaluated in the study.

One plant of each species was randomly transplanted into individual 0.6-L pockets within 3 × 3 green wall planters (Figure 2). Pockets were filled with a peat-based substrate and a controlled-release fertilizer was top-dressed after transplanting. Plants were hand-watered as needed throughout the duration of the experiments, and the frequency of irrigation events was recorded for each species within each experiment.

Both experiments were conducted indoors in separate 12-m2 growth rooms. Each growth room was equipped with four opposite shelving units (blocks), each with three treatment compartments (replications). Each compartment held two green wall planters, for a total of eight planters per treatment. Both growth rooms were set at a constant 22 ± 1 °C and relative humidity was maintained at 50 ± 10%. In both experiments, plants were grown under a 12-h photoperiod.

In the experiment evaluating light quantity, PPFDs of 25, 50, and 75 µmol·m−2·s−1 were used, resulting in daily light integrals (DLI) of 1.1, 2.1, and 3.2 mol·m−2·d−1. Neutral-white LED fixtures with 19% blue light were used for that trial, controlled by dimmers.

In the experiment evaluating light quality, warm-, neutral-, and cool-white LEDs were used, providing approximately 11%, 19%, and 28% of blue light, respectively. All treatments delivered and average PPFD of 50 µmol·m−2·s−1.

Plants were grown until mid-August (4 mo). Data collected included growth (plant width, leaf no. and area, shoot and root dry mass), quality (SPAD, colorimetry, and carbohydrates), and photosynthesis.

Figure 2. Representative planter at the beginning of the experiments.

Results

Preliminary results indicate that as expected, higher PPFDs increased growth of most plants. Figure 3 shows results for shoot dry mass, which generally represent the trends measured in most other growth variables. Plants grown under 25 µmol·m−2·s−1 were small and did not fill in the planters, likely making them less attractive to consumers. Further, leaf-level photosynthesis was highest under 50 µmol·m−2·s−1. These findings suggest that an intermediate PPFD could be sufficient to maintain plants indoors with limited active growth. Considering that larger plants will likely require more maintenance (e.g., due increased pruning and irrigation frequency), 50 µmol·m−2·s−1 is recommended as an adequate light intensity for living green walls use. However, further studies should evaluate the effect that limited PPFDs have on variegation patterns and leaf color, as studies have shown that low light intensities can negatively affect some of those quality attributes in plants.

Preliminary results from the light quality experiment show only minor differences among treatments, indicating that all three LED fixtures are appropriate for indoor living green-wall use. Figure 4 shows results for shoot dry mass, which indicate that Heucherella 'Gold Zebra' was the only type of plant affected by light quality, for which neutral-white LEDs increased growth compared to cool-white LEDs. Small differences in leaf area and yellowness were measured for a few other species. Considering that light quality had minor effects on the growth and quality of these plants, fixture efficacy and cost should be the deciding factor when purchasing fixtures. In addition, human perception of plant quality and health under the different types of fixtures may be an important factor to consider for interiorscaping applications.

Conclusions

Our study shows that 50 μmol·m–2·s–1 is a good target PPFD to maintain plants indoors for living green-wall use. Considering that only minor differences were measured in plants grown under the three broadband white LED fixtures evaluated, the recommendation is to purchase fixtures that have a high efficacy and good economic value. Future studies should evaluate the response of mature plants that would enable the evaluation of light on maintenance responses. We also recommend evaluating plants with similar growth habits and water requirements. Regarding plant type, Homalomena 'Emerald Gem' and Schefflera 'Amate Soleil' had the best growth and quality in both experiments, as they nicely filled in the planters. In contrast, Syngonium 'Mango Allusion' is not recommended for living green-wall use due to its vertical growth habit.

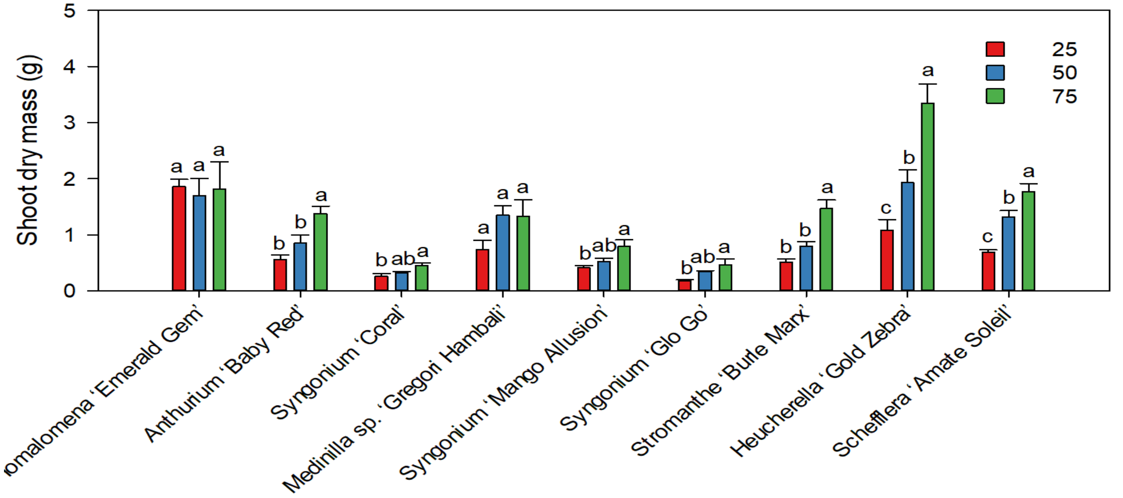

Figure 3. Shoot dry mass of nine species grown indoors under three photosynthetic photon flux densities.

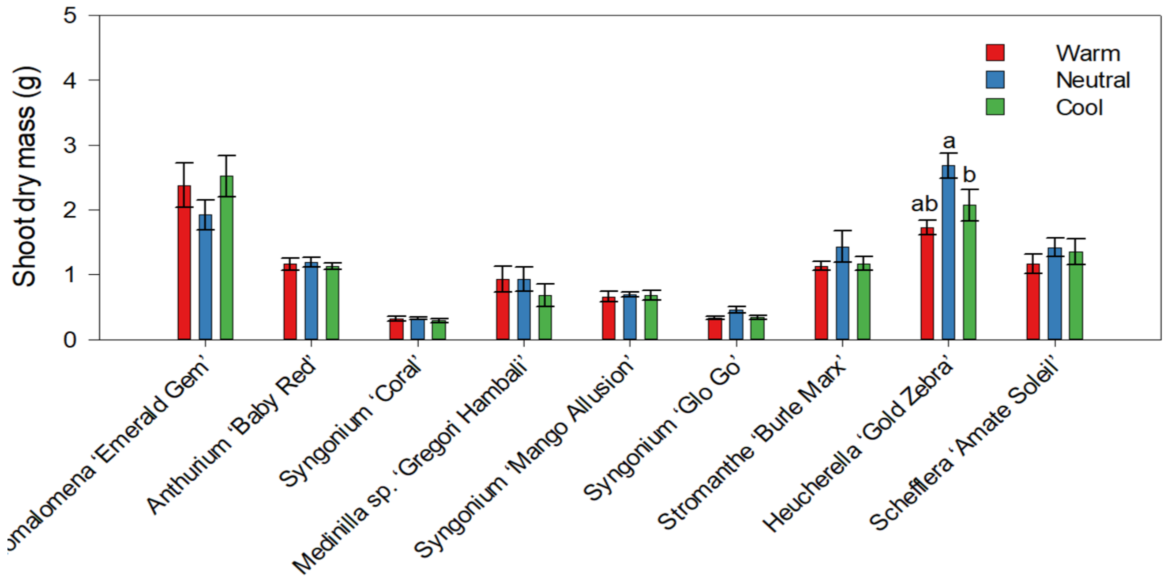

Figure 4. Shoot dry mass of nine plant species grown indoors under three types of broadband white LEDs.

Dr. Gómez has research and teaching responsibilities in the Environmental Horticulture Department at the University of Florida. The research component of her program includes evaluation of new crops and innovative production systems for the controlled environment horticulture industry. She leads several projects that typically belong to one of three subject areas: 1) indoor propagation of high-value crops, focused on leveraging indoor farming technologies to acclimate hard-to-root young plants; 2) urban gardening, focused on supporting the increasing consumer interest in growing vegetables in residential environments; and 3) lighting for indoor plant production, focused primarily on evaluating plant responses to light spectrum or quantity. In collaboration with industry partners, she established the 'Research on Urban Gardening' (RUG) consortium to help develop research-based solutions for the horticulture industry and for consumers in the edible gardening sector. Dr. Gómez is also involved in other projects that are of interest to Florida growers.